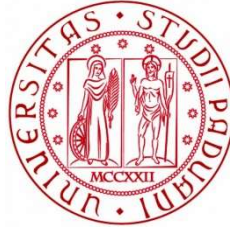


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PhD Thesis

**THE DEVELOPMENT OF
PROJECT RISK MANAGEMENT
IN SMALL AND MEDIUM ENTERPRISES**

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Abstract

Small and Medium Enterprises (SMEs) are considered the backbone of European economics and growth; however, their peculiar vulnerability and the limited financial and human resources drive them to adopt specific tools and methods that cannot be simply the same used in large companies. In particular, the Risk Management (RM) approach adapted for SMEs seems not to be systematically studied and understood. To this extent, the first phase of this thesis, that is developed in two phases, aimed at outlining the development and the state of the art of RM in SMEs, grasping new future research opportunities in this field. The results were achieved through a systematic literature review of 61 relevant papers published until the end of 2016. A descriptive and content analysis with bibliometric tools was conducted, demonstrating, in particular, that the operational and financial risk types and two RM streams, that are Financial RM and Enterprise RM, are among the most studied ones in the literature. Moreover, there are new emerging RM streams. In particular, the relevance of Project RM, Strategic RM and Supply Chain RM has been increasing, and it pushes researchers and practitioners to deepen the knowledge of the tools and practices that characterise them.

Given the depicted emergence of Project RM (PRM), the second phase of the thesis was devoted to it. Despite its strategical importance, its diffusion is limited mainly to large companies, leaving a lack of empirical evidence addressing SMEs. In order to address this gap, the second objective of this research was to analyse how to adopt PRM in SMEs with a positive cost-benefit ratio, considering RM phases, activities, tools, procedures and organisational aspects that enable the effective implementation of PRM in SMEs. SMEs grow and innovate through projects and PRM offers a relevant contribution to a successful project management.

An empirical framework with the fundamental dimensions to be analysed was built, and a pilot case study was conducted to test its validity and improve it. The final questionnaire was the main tool for collecting data in three Italian cases and seven Spanish cases in which PRM was successfully adopted in a SME project. Through the analyses of the cases, three clusters were built and indications about

how to implement PRM in SMEs with a positive cost-benefit ratio considering different project characteristics to achieve a high/very high level of benefits were presented. Moreover, after the cases analysis, the benefits obtained and the difficulties faced through the adoption of PRM were discussed.

This research provides a new combined methodology of bibliometric and content analysis to analyse the state of the art of RM in SMEs and present its results, to which practitioners can refer to in order to decide to which RM stream they should address the RM implementation in the company.

In the second part of the thesis, the development of a specific empirical framework for analysing SMEs projects with PRM adoption is presented. Such a framework was not found in the literature and can be used in future research. Moreover, the results of this part of the thesis contribute to the diffusion of the theme and give practical indications about how to implement PRM, specifically regarding PRM phases and PRM organizational aspects to be considered in different types of industries for its successful implementation. The indications given for a successful PRM implementation in SMEs can be followed in other projects, so that other SMEs can also benefit from the advantages provided by PRM and ensure the project's success and the company's growth.

Sommario

Le piccole e medie imprese (PMI) sono considerate il motore della dell'economia e della crescita europea; tuttavia, la loro particolare vulnerabilità e le limitate risorse finanziarie e umane richiedono l'adozione di strumenti e metodi di governo specifici, che non possono essere semplicemente gli stessi utilizzati nelle grandi imprese. In particolare, l'approccio al *Risk Management* (RM) adatto alle PMI non sembra essere studiato e compreso in modo sistematico. Per tale motivo, l'obiettivo della prima fase di questa tesi, è quello di delineare lo sviluppo e lo stato dell'arte del RM nelle PMI, identificando anche le opportunità di ricerca in questo ambito. I risultati sono stati raggiunti attraverso una revisione sistematica della letteratura che ha portato ad individuare 61 articoli rilevanti pubblicati fino alla fine del 2016 che sono stati oggetto di un'analisi descrittiva e dei contenuti, utilizzando anche strumenti bibliografici. I risultati ottenuti indicano che i rischi di tipo operativo e finanziario e due ambiti di applicazione specifici del RM, ovvero il *Financial RM* e l'*Enterprise RM*, sono tra i più studiati in letteratura. Si evidenziano, inoltre, tre ambiti di applicazione del RM emergenti: il *Project RM*, lo *Strategic RM* e il *Supply Chain RM* che richiamano una crescente attenzione e spingono ricercatori e professionisti ad approfondire la conoscenza degli strumenti e delle pratiche che li caratterizzano.

Data la crescente importanza del *Project RM* (PRM) sia nella letteratura sia nella pratica manageriale, ad esso è stata dedicata la seconda parte della tesi. Nonostante la sua rilevanza nel promuovere il successo dei progetti innovativi e strategici condotti dalle imprese, la sua diffusione è limitata principalmente alle grandi aziende, lasciando una mancanza di evidenze empiriche rivolte alle PMI. Per colmare questa lacuna, il secondo obiettivo di questa ricerca è stato quello di analizzare come sia possibile adottare il PRM nelle PMI con un positivo rapporto costi-benefici, considerando le fasi, le attività, gli strumenti, le procedure e gli aspetti organizzativi che ne consentono un'efficace implementazione. Le PMI crescono ed innovano attraverso progetti ed il PRM offre un contributo rilevante per una gestione dei progetti di successo.

A tal fine è stato costruito un *framework* empirico comprendente le dimensioni fondamentali da rilevare ed analizzare. Sulla base di tale framework è stato costruito un questionario per la raccolta dati che è stato testato attraverso la conduzione di un caso pilota al fine di validarlo e raffinarlo. Il questionario così ottenuto è stato lo strumento principale per la raccolta dati in tre casi italiani e sette casi spagnoli in cui il PRM è stato adottato con successo in un progetto di una PMI. Al termine dell'analisi empirica è stato possibile raggruppare i progetti in esame in tre cluster, che rappresentano ciascuno una modalità di implementazione del PRM nelle PMI con un rapporto costi-benefici positivo. In particolare, dall'esame di tali cluster sono emerse le caratteristiche del PRM in termini di attività, strumenti e modalità organizzative che, al variare delle peculiarità del progetto e del suo contesto, risultano produrre elevati livelli di benefici.

Questa ricerca, da un punto di vista teorico presenta una nuova metodologia che integra l'analisi bibliometrica e l'analisi dei contenuti della letteratura. Tale metodologia utilizzata per studiare l'evoluzione del RM nelle PMI ha permesso di coglierne lo stato dell'arte e di evidenziarne gli ambiti di applicazione emergenti, a cui professionisti e manager possono fare riferimento per decidere a quale ambito di RM indirizzare l'implementazione del RM in azienda. Nella seconda parte della tesi viene presentato lo sviluppo di un *framework* empirico specifico per l'analisi di progetti delle PMI con adozione di PRM. Tale *framework* non è stato trovato in letteratura e può essere utilizzato nelle ricerche future. Inoltre, i risultati dell'analisi empirica contribuiscono alla diffusione del tema e forniscono indicazioni pratiche su come implementare il PRM, in particolare per quanto riguarda le fasi e strumenti del processo di PRM e le modalità organizzative da considerare in diversi tipi di industrie per una sua efficace implementazione. Le indicazioni fornite per un'implementazione di successo del PRM nelle PMI possono essere seguite in altri progetti, affinché anche altre imprese possano beneficiare dai vantaggi offerti dal PRM che assicura il successo dei progetti e garantisce la crescita dell'azienda.

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INTRODUCTION

Given the constant increase of competitiveness in every business and the economic challenges to be overcome, companies must seek high quality standards to attend to customers' demands and to be well-positioned in the market. Due to the external unpredictability of the business, caused by political issues, economic situation, natural factors, and technological advances, Risk Management (RM) has been one of the major approaches for companies to ensure their survival and overcome uncertainties to reach their goals.

RM has considerable implications for competitiveness and business, since it enables, for instance, the development of a strategy to reduce potential losses while exploiting new business opportunities (Radner and Shepp 1996). Notwithstanding, its adoption in companies is still considered inconsistent (Faisal, Banwet and Shankar 2007). Many firms lack knowledge, resources and reliable tools to support the application of RM, and this is particularly notable for SMEs (Brustbauer 2016).

SMEs are companies with scant resources and with more difficulties in their attempts to manage risks. In addition, the tools used by large firms are usually not suitable per se to SMEs, because they are either too expensive or too complex (Pereira, *et al.* 2015). Resources to support their application are unrealistic for SMEs and are beyond their capability and affordability (Association for Project Management 2013). The adoption of RM in SMEs using the same guidelines defined for large companies would compel the SMEs to take up extensive efforts and time. Therefore, SMEs managers consider those guidelines inapplicable because of the specific characteristics of their firms.

Nevertheless, as for the risk exposure, SMEs are more vulnerable than large companies, so they should be more engaged into RM (Blanc Alquier and Lagasse Tignol 2006). Indeed, SMEs are more challenged in terms of access to resources, are less diversified in their economic activities, have a weaker financial structure and have more difficulties in downsizing in case of a crisis, as they are already small (OECD 2009, Kim and Vonortas 2014, Calvo-Mora, et al. 2016). Even so, SMEs are far

from adopting a proactive RM approach, despite its critical importance for their sustainability and for generating business value for the SMEs (Pereira, *et al.* 2015).

As stated by many researchers, the literature on RM has focused mainly on large companies, leaving a gap of empirical evidence addressing small companies (Kim and Vonortas 2014). Despite the increasing number and the relevance of SMEs in Western economies, only a few academic studies have addressed the theme of RM in SMEs (Ellegaard 2008, Thun, Drüke and Hoenig 2011, Marcelino-Sádaba, *et al.* 2014, Rostami, *et al.* 2015, Toulová, Tuzová and Veselá 2016).

SMEs are considered the backbone of EU countries' growth: They represent 99 percent (99%) of the enterprises and 67 percent (67%) of all employment in the EU (OECD 2012). Therefore, improving SMEs' managerial knowledge and competencies is crucial in order to leverage the development of the whole economy (Hussain, *et al.* 2006).

Knowing the importance of SMEs, the specific characteristics of RM for SMEs and the aforementioned significant gap in the literature and the valuable research opportunities, this thesis is focused on RM in SMEs and was developed in two phases. During the first phase, with the objective of outlining the development, the state of the art and the possible future research directions of RM in SMEs, a systematic literature review (SLR) was conducted in order to answer the following research questions:

RQ1. How has RM been developing in SMEs?

RQ2. What is the state of the art in RM for SMEs? What are the conceptual structures and the key research streams of RM in SMEs?

Among the results of the SLR, the Project Risk Management (PRM) stream was identified as an emerging relevant stream only slightly studied. Based on these results, the second phase of the thesis was devoted to the topic of PRM in SMEs, with the objective of understanding how to adopt PRM in SMEs with a positive cost-benefit ratio considering RM phases, activities, tools and organizational

aspects that enable the effective implementation of PRM in SMEs. To achieve the objective, the following research questions were formulated:

RQ3. Which are the main RM phases, activities, tools and organizational aspects adopted in the PRM process in SMEs?

RQ4. What are the outcomes and evidences of the PRM adoption in SMEs?

RQ5. Which are the enabling and hindering factors to perform PRM in SMEs?

To answer to these three research questions, an exploratory and explanatory research through multiple case studies was conducted as it is the most suitable methodology for this type of study (Yin, 1994; Voss, 2002, Eisenhardt and Graebner, 2007).

Through the results of the analysis of the SLR and of the case studies conducted, both objectives of the thesis were successfully achieved, giving a contribution from an academic and a managerial point of view to the fields of RM in SMEs and, more particularly, to an effective and efficient implementation of PRM in SMEs.

Antecedents and structure of the thesis

The importance of RM for SMEs and the impact of PRM in SMEs have led to three years of studies about these topics with the objective of giving a significant contribution to the literature and to practitioners. Given the interest for the themes and the quality of the research developed, substantial results were obtained, which led to several international publications:

- Ferreira de Araujo Lima, P., Crema, M. & Verbano, C. (2017). Adoption of Risk Management in SMEs: A systematic literature review. Proceedings of the 10th Annual Conference of the EuroMed Academy of Business;

- Ferreira de Araujo Lima, P. & Verbano, C. (2018). Project Risk Management in Small and Medium-Enterprises: first results from an empirical analysis. Proceedings of the 11th Annual Conference of the EuroMed Academy of Business;
- Ferreira de Araujo Lima, P. & Verbano, C. (2019). Project Risk Management implementation in SMEs: A case study from Italy. *Journal of Technology Management & Innovation*, 14 (1), 3-10;
- Ferreira de Araujo Lima, P., Crema, M. & Verbano, C. (2019). Risk Management in SMEs: a systematic literature review and future directions. *European Management Journal*, available online June 25;
- Testorelli, R., Ferreira de Araujo Lima, P. & Verbano, C. (2019). Project Risk Management for SMEs: lesson learnt from a systematic literature review. Proceedings of the 12th Annual Conference of the EuroMed Academy of Business;
- Ferreira de Araujo Lima, P., Marcelino-Sabada, S., Echeverria-Lazcano, A.M. & Verbano, C. (2019). An empirical study on the implementation of Project Risk Management in Spanish SMEs. Proceedings of the 12th Annual Conference of the EuroMed Academy of Business.

This thesis is based on improved and extended versions of these publications and on other analyses not published yet. It is structured in 5 chapters. In Chapter 1, the research topic, the objective and the methodology of the first phase of the thesis are presented. Chapter 1 also contains the systematic literature review and its results. Based on these results, the theme of the second part of the thesis was defined. In Chapter 2, the objective and methodology for analysing PRM in SMEs are presented, while the results of the empirical analysis of PRM in SMEs are discussed in Chapter 3. Chapter 4 is the last chapter of the thesis, with the final discussion of the results and of the thesis contribution.

Figure 1 displays the correlation between the thesis research process and the thesis structure.

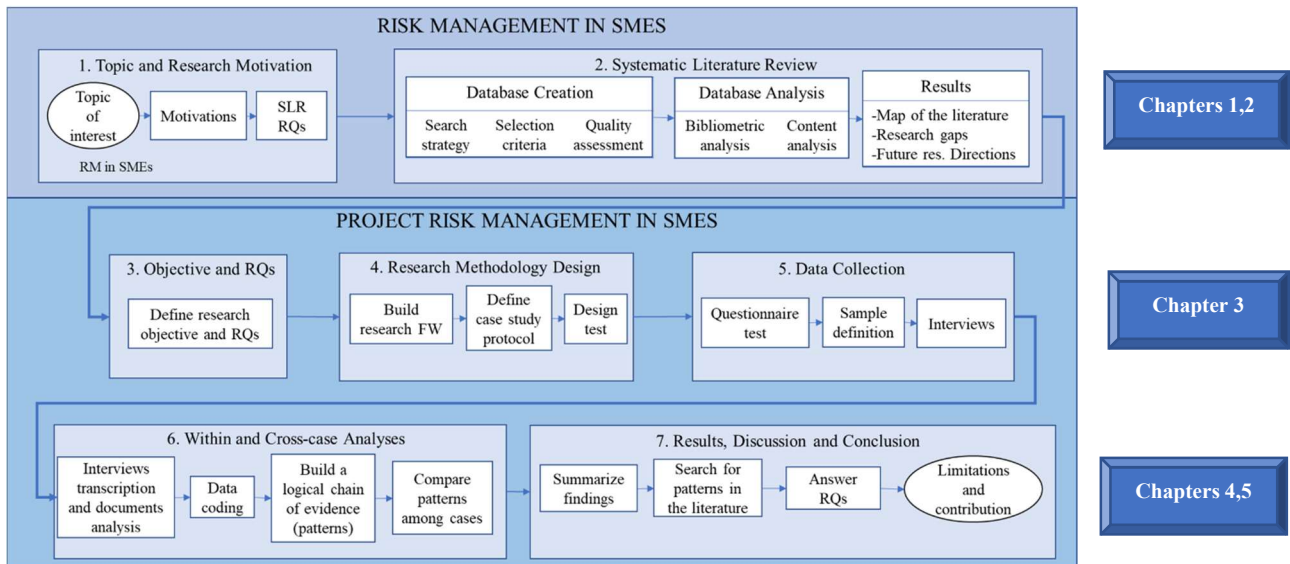


Figure 1: Thesis research process and thesis structure

CHAPTER 1

THE EVOLUTION OF RISK MANAGEMENT IN SMES

In this chapter the basic concepts of risk, RM and RM in SMEs are introduced (Sections 1.1 and 1.2). Based on the gap of studies regarding the topic of RM in SMEs, the objective, the research questions and the methodology of the first part of the thesis are explained in detail, followed by the database construction and its content and descriptive analysis (Section 1.3). In Section 1.4, the results from the SLR are presented, while the discussion of the results, which led to the definition of the topic of the second part of the thesis, are in Section 1.5.

1.1 Introduction to Risk Management

1.1.1 Risk concept

Risk is everywhere and derives directly from unpredictability (Hopkin 2018). The concept of risk has evolved along time, as it was initially seen as an event with negative consequences, and nowadays, as it is defined by the ISO Guide 73 (2009), risk is an effect of uncertainty on objectives, and an effect with positive or negative consequences, or a deviation from the expected results. The Institute of Internal Auditors (2004) defines risk as the uncertainty originated from an event that could impact on the achievement of objectives. Threats and/or opportunities are the downsides and upsides of risk, defined as an uncertainty that can have either positive or negative consequences originated from different events (Islam, Tedford and Haemmerle 2008).

These events can be caused by external factors (economic, environmental, social, political and technological aspects) or internal factors (infrastructure, human resources, process and technology used by a company) (COSO 2004). With the rise of products' and services' complexity, risk exposure

has also grown (Faisal 2016). Nevertheless, in many situations, risk can be predicted and managed (Verbano and Venturini 2011).

Different classifications of risk types can be found in the literature.

Hopkin (2018) uses the classification indicated in Guide 73, which divides risks into three categories: hazard (pure) risks, control (uncertainty) risks and opportunity (speculative) risks. The hazard risk events can only result in negative outcomes and may be thought of as operational or insurable risks; the control risks give rise to uncertainty about the outcome of a situation and can be associated with the benefits that a project produces; the opportunity risks are the risks taken deliberately by organizations in order to achieve a positive return (Hopkin 2018).

According to Mowbray et al. (1979), in a macro classification, risks can be divided into two groups: pure or static risk (it causes only damage without the opportunity of earning from its occurrence) and speculative or dynamic risk (it can either cause damages or earn an opportunity), which are typical entrepreneurial risks.

Enterprises are exposed to risks that can be categorised into the following four types: financial, hazard, operational and strategic risks (Casualty Actuarial Society 2003).

Financial risks stem from market forces, financial assets or liabilities. They occur in different forms, such as capital risk, investment risk, interest rate risk, credit risk, currency risk and financial market risk (Mutezo 2013, Giorgino and Travaglini 2008).

Hazard risks are the so-called “pure risks” and their effects are always negative. They arise from natural or intentional accidents caused by third parties. Consequences of these risks can be, for example, property damages and personnel diseases and disabilities (Jørgensen, Duijm and Troen 2010, Verbano and Venturini 2011). These risks are usually treated with insurance contracts (risk transfer).

The operational risks arise from failures generated from both potential human and process errors that can occur in business functional units (e.g., those regarding product development, human resources, IT), or in process management. Therefore, there may be product failures and process failures that can

compromise the achievement of some of the company's specific objectives (Krane, Olsson and Rolstadas 2012), but not the entire project nor the company (Marcelino-Sádaba, *et al.* 2014).

Finally, the strategic risks are those that may be an obstacle for the company in achieving its strategic goals (Chatterjee, *et al.* 2003). They derive from economic shifts and from changes in the society, in the politics and in the environment. The strategic risks also refer to damages to reputation, customer satisfaction and technological innovation (Casualty Actuarial Society 2003).

1.1.2 Risk Management

Risk Management (RM) provides a framework for organizations to deal with risks and ensure that correct business decisions are taken (Hopkin 2018). A range of benefits arise from successful RM implementation which ensure that the organization achieves efficacious strategy, effective processes and projects and efficient operations (Hopkin 2018).

The origins of RM are in the insurance management function, followed by the financial risks. Now, RM is a well-established discipline that can be classified into nine different streams according to its field of application: Clinical RM, Disaster RM, Engineering RM, Enterprise RM, Financial RM, Insurance RM, Project RM, Strategic RM and Supply Chain RM (Verbano and Venturini 2011).

The Clinical RM (CRM) stream aims at improving the safety and the quality in healthcare through the identification of the circumstances that put patients at risk of harm and then acting to prevent or control these risks (Walshe and Dineen 1998, Walshe 2001).

The Disaster RM (DRM) stream primarily involves hazard risks, as they derive from natural phenomena (e.g., earthquake, fire, etc.), epidemics and terrorism. It is an approach to govern a community in reducing the risks and mitigating the spread of a disaster (Wedawatta and Ingirige 2016, Ahrens and Rudolph 2006).

The Engineering RM (EnRM) stream involves the complete management of an engineering system, which is complex and continuous, with the aim of ensuring the system's reliability (Verbano and Venturini 2013, Baron and Pate-Cornell 1999). As the engineering system may be under risk due to

technical and operational factors, applying the Engineering RM process to the system can reduce the incidence of such risks.

The Financial RM (FRM) stream deals with the exposure to the different subtypes of financial risks (Bodnar, et al. 2013). Although the financial risks are not a core issue for non-financial companies, they have a significant influence on the business operations, financial performance and long-term sustainability of any kind of firm (Belás, *et al.* 2015).

The Insurance RM (IRM) stream deals only with the consequences of damaging events. It allows transferring risks, investigating how the company may be prevented from bearing extra expenses through the possession of insurance (Dionne 2013, Kwon 2003).

Another stream is the Project RM (PRM) one. When a project is implemented in a company, it is essential to design all of the project's life cycle and identify all the possible sources of risks that can be: operational, technical, organisational, financial and political (Badri 2015, Raz e Michael 2001). Identifying such risks, the managers are able to study the possible positive and negative outcomes and define the correct response to treat them in order to assure the success of the entire project.

The Strategic RM (SRM) stream is vital for the company's success as it permits management of the risks that may be an obstacle for the company. It helps in defining the most suitable strategy and translates it into actions (Frigo and Anderson 2011). It is an integrated and continuous process of identification, assessment and management of strategic risks (Chatterjee, et al. 2003).

The Supply Chain RM (ScRM) is shared among the stakeholders in the supply chain: All the actors involved must have a RM process to deal with the risks that may affect the supply chain – impacting logistics, information, relationships and delays. It is a very critical process as the risk treatment is achieved through the collaboration and application of RM tools by all the players in order to ensure the continuity of product or service delivery to the customers (Faisal, Banwet and Shankar 2007, Ho 2015).

The most complex and most innovative stream is the Enterprise RM (ERM), also known as Holistic RM, which is an extension of the Financial RM stream to all kinds of non-financial risks. It is applied across the whole enterprise, aiming at identifying and managing all potential events that may affect the company and provide reasonable assurance regarding the achievement of its objectives (COSO 2017, De Loach 2000).

1.1.2.1 Risk Management process

The “International Organisation for Standardisation” provides in the ISO 31000 (2018) generic guidelines and principles on RM and, more recently, also the ISO 9001 (2015) requires the “risk based thinking” as a mandatory requisite inside total quality management in all types of companies. When implemented in a company, the design and implementation of RM need to take into account the specific varying needs of the organisation; however, the RM process is usually articulated in a preliminary phase and four main following phases (PMI 2017).

The preliminary phase is the context analysis in which the objectives of the RM process are first defined, coherently with the company’s strategic goals, and, secondly, the resources; the organisation and the process itself needed to apply RM can be specified. The following main phases are: the risk identification (relate the possible risks), the risk evaluation (determine the probability and the consequence of occurrence of the identified risk), the risk treatment (identify how to reduce the occurrence or consequences of acceptable risks, how to reduce the impact of non-acceptable risks and choose the proper answers to them); and the monitor and review phase (observe the incidence of the risks and if the treatment is being effective or not) (ISO 31000 2018).

The last activity of the process is the communication and consultation with the stakeholders about the process conducted and the risk exposure. Depending on the context, different sets of tools and techniques to identify, evaluate and treat risks are applied. These tools may be qualitative or quantitative and objective or subjective. Table 1 presents some widely-used tools reported in literature to conduct risk assessment. In addition, many software programs were created ad-hoc to perform a quantitative risk analysis (Leopoulos, Kirytopoulos and Malandrakis 2006).

Quantitative tools	Qualitative tools
Decision Tree Diagram	Brainstorming
Expected Value	Delphi Technique
Failure Mode and Effect Analysis (FMEA)	Expert Judgement
Fault Tree Analysis (FTA)	FRAP (Facilitated Risk Analysis Process)
Latin Hyper Cube Simulation	HazOp (hazard and operability analysis)
Monte Carlo Simulation	Interviews
Risk matrix approach	Probability-Impact Matrix
Scenario analysis	Risk Categorization
Sensitivity Analysis	Risk Register
	SWOT analysis

Table 1: Main risk assessment tools (Leopoulos, Kirytopoulos and Malandrakis 2006, Milestone Consulting International 2018)

1.2 Risk Management in SMEs

Several authors and associations that study RM have proposed different frameworks to address the theme, but they regard mostly large companies and not all sectors; in particular, manufacturing and financial sectors are preferred (Verbano and Venturini 2013, Bérard and Teyssier 2017). RM, with its definition and concepts, is generated in large firms and in specific sectors.

According to previous studies, the magnitude of risks depends on the industrial sector (Henschel 2010, Aureli and Salvatori 2013). Other researchers demonstrate that RM does not depend on the industry type and on the ownership nature of the firm, but it can be influenced by the experience, risk knowledge, beliefs and attitudes of their entrepreneurs (Sparrow and Bentley 2000, Jayathilake 2012).

As stated by many scholars, there are only a few studies about RM in SMEs, regardless of the fact that it is a developing topic; in particular, the general understanding of RM in SMEs is not univocal and the research on implementations, methods and practice is scant (Poba-Nzaou and Raymond 2011, Verbano and Venturini 2013, Sunjka and Ewmanu 2015). The possibility of implementing and sustaining RM in SMEs is debated in the literature – especially regarding the development of a holistic approach. Moreover, there are no standards and guidelines commonly shared among companies describing how to adopt a comprehensive RM approach in SMEs (Troßmann and Baumeister 2004, Crema 2017). Furthermore, RM can be applied in different ways depending on the firm size (Henschel 2010, Jayathilake 2012, CINEAS 2015, Rostami, *et al.* 2015). Particularly, RM tends to be more formal

and systematically developed when the firm is larger and more experienced, since the characteristics of medium firms are very different in respect to those of micro ones in terms of management style, number of employees, capital structure, access to external finance and default risk.

There are several managerial reports and a few papers that provide an overview of the practical experiences with RM in SMEs (Crema 2017), whereas it is more difficult to find systematic synthesis that organise the knowledge and the experiences developed in that field. There is only a literature review that synthesises the previous studies investigating the RM process, the tools adopted, and the risks managed in SMEs (Verbano and Venturini 2013); there are a few other studies, but they do not follow a comprehensive approach – analysing all the RM streams, the RM process, tools and practices and the risks managed distinguishing by the industrial sector involved.

The controversial results for RM in SMEs and the few applied studies demonstrate that this topic is still debated and emerging in the literature. However, RM means preventing the direct and indirect costs of potentially-occurring events, favouring the sustainability of the company in the long-term and assuring the achievement of the expected business value. Therefore, highlighting the development and the state of the art of RM in SMEs can support academics and practitioners to enhance the knowledge of RM in SMEs towards a univocal understanding of it and to outline future guidelines and research directions. There is a need for an in-depth understanding of RM in SMEs and how and in which industry RM has been adopted in them and which fields, models, processes and methods deserve further studies. To this extent, a systematic literature review should be conducted, in order to delineate the development of RM in SMEs. These results will help managers by providing specific references and indications regarding the context in which they work; in particular, the latter depends on the firm size and the related specific characteristics of the risks they have to manage, and thus the RM stream they have to refer.

1.3 Objective and methodology

Based on the statements presented in the previous section, the main research objective of the first part of the thesis is to outline the development, the state of the art and the possible future research directions of RM in SMEs. In more detail, specific research questions are:

RQ1. How has risk management been developing in small and medium-sized enterprises?

RQ2. What is the state of the art in risk management for small and medium-sized enterprises? What are the conceptual structures and the key research streams of risk management in small and medium-sized enterprises?

In order to answer the defined research questions, a systematic literature review has been performed and accomplished based on the guidelines proposed by Macpherson and Holt (2007) and Tranfield, Denyer and Smart (2003), adapted to this specific research and detailed in the review protocol (Fig. 2).

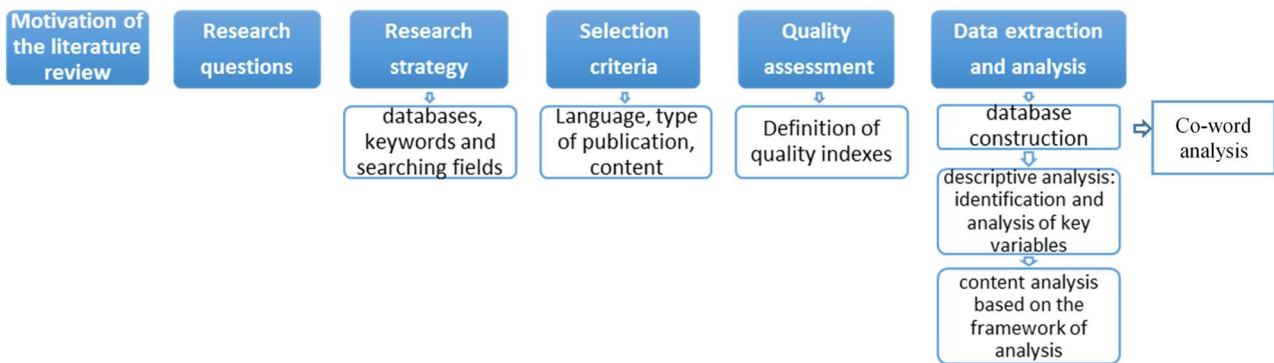


Figure 2: The systematic literature review protocol

1.3.1 Database creation

In order to build a database (DB) with the relevant articles about RM in SMEs, the two most widespread DBs for searching the literature were used: Scopus of Elsevier and Web of Science Core Collection by Clarivate Analytics (Guz and Rushchitsky 2009).

Figure 3 displays the searching process and the selecting process that were performed between December of 2016 and February of 2017. First of all, three different sets of keywords were combined to extract the results in each database without any filter on the time period. To narrow down the results,

a selection process was performed using the following filters: exclusion of proceeding papers, editorial material and notes; exclusion of articles that were not in English; exclusion of the duplicated articles among the results of the queries and of the duplicated articles between the two DBs. At this point, 270 articles were obtained, but they needed to be analysed more carefully. To do that, the abstract and further the full-text of the papers were read. The papers that did not regard RM applied to SMEs, the proceeding papers and the papers with six pages or less and with a non-scientific approach were excluded. The final DB contains 61 papers published from 1994 until the end of 2016.

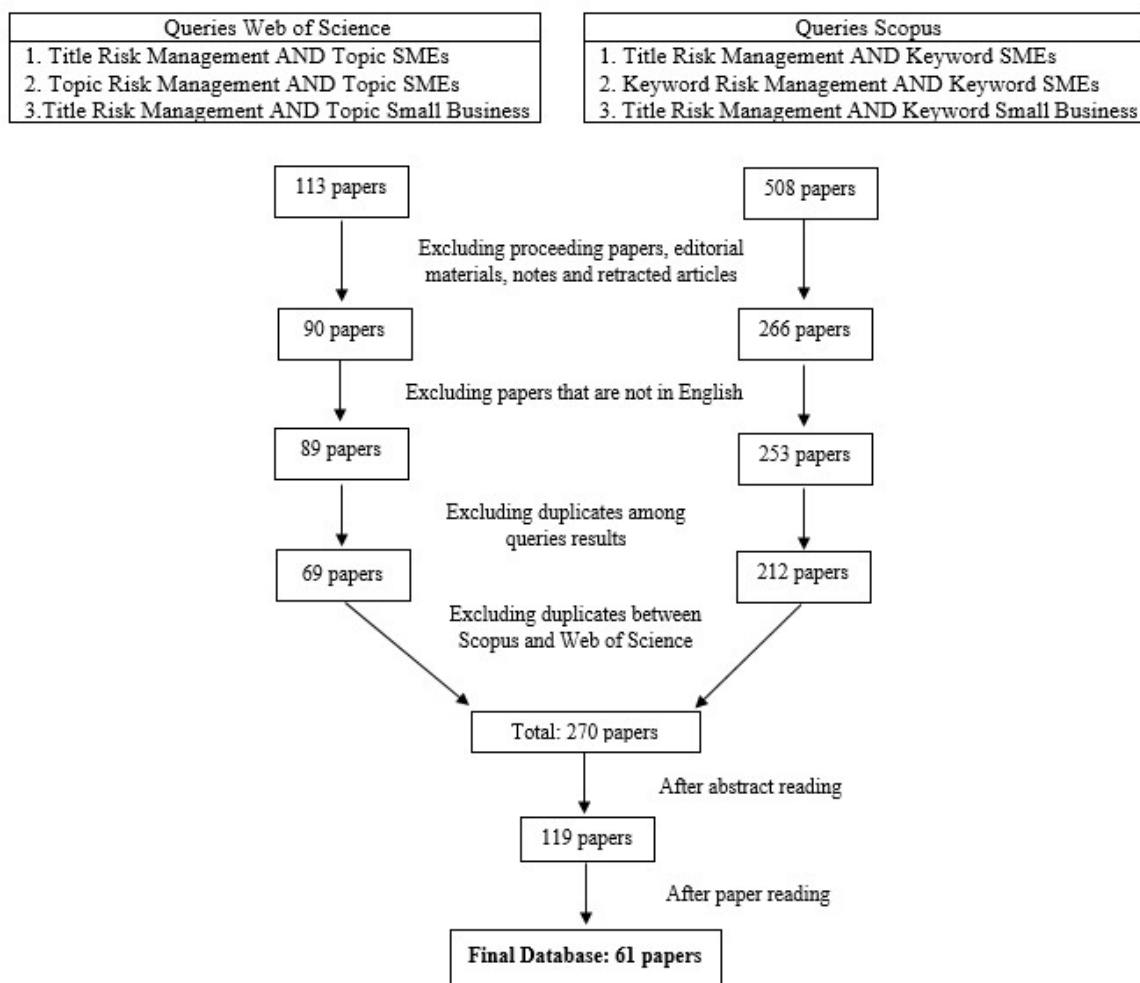


Figure 3: Searching and selecting process

1.3.2 Database analysis

1.3.2.1 Descriptive and bibliometric analysis

In order to answer the first two research questions, a descriptive analysis of the database was first realised. In this analysis, each paper was classified according to: its year of publication, its authors, its

journal, the quality index of its journal, the number of citations that it has received and the country of origin, identified as the first author's country of work.

To assess the quality of the obtained DB, the related journals were ranked based on their classification on the Scimago Journal Ranking (SJR) and on the Journals Citations Report Impact Factor (JCR IF). Both rankings categorise the journals into quartiles, with Q1 being the first quartile, containing journals with very high impact, and Q4 as the last quartile, which comprises the journals with very low impact. Based on the classifications of the papers, the following analyses were conducted: identification of the time trend of the published articles; the number of times each journal has published an article that is in the DB, the number of papers that each author has published and the geographical distribution of the selected papers. Through these analyses, the first insights of the development of RM in SMEs emerged.

In order to quantitatively answer the RQ1 and the RQ2, a bibliometric analysis was carried out. Bibliometrics is a set of statistical methods used to investigate the evolution of a given scientific field by assessing publications and mapping the structure and dynamics of the areas of interest via data obtained from these publications (McBurney and Novak 2002, Zupic and Čater 2015, Koseoglu 2016). The bibliometric maps show in a visual way the associations between the main concepts of the topic of interest discussed in the selected specific disciplines, scientific domains or research (Cobo, López-Herrera, et al. 2011).

Bibliometrics methods are categorised into evaluative techniques and relational techniques (Benckendorff and Zehrer 2013, Koseoglu 2016). One of the relational techniques is the co-word analysis, that is used to identify the main research themes, dealing directly with sets of words shared by the selected papers, mapping the pertinent literature directly from the interaction of these keywords (Delecroix and Epstein 2004). Co-word analysis is used in a longitudinal framework which tracks the evolution of a research field along consecutive time periods (Garfield 1994). In this thesis, co-word analysis has been adopted to identify the main topics of interest in the studies of RM applied to SMEs and how the main topics have been evolving over the years.

In order to build the maps of the co-word analysis, the SciMat Software Tool was adopted in this thesis due to its reliability and effective visualisation of the final results. The workflow of co-word science mapping and the choices that were made in the software for each step are shown in Figure 4. After extracting the selected papers from WoS and Scopus, in order to conduct the co-word analysis, keywords are generated (considering the author keywords and the ones extracted from the title and abstract of each paper), standardised and validated, according to the process proposed by Ding, *et al.* (2001) and Ravikumar, Agrahari and Singh (2015): remove all synonyms, remove duplicates and merge different variants of a same word. Keywords representing the same concept are clubbed into a standardised form and words having low frequency are merged into a broader term, while words not having a broader or similar term, or that are too general/common words, are ignored. The obtained keywords will be called Aggregated Keywords (AKs).

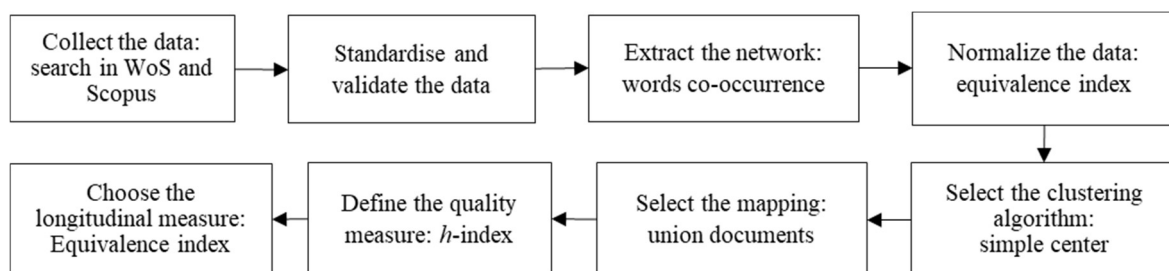


Figure 4: Workflow of the science mapping using SciMat

After this process, it was necessary to categorise the analysed papers into periods. According to Muñoz-Leiva *et al.* (2012), the first period studied is usually the longest one, in order to get a representative number of published papers. This is particularly true for young and emerging topics that have been recently discussed in the literature. Following this indication, two periods were created: the first period studied encompasses 13 years (from the first article published in this field, in 1994, until 2006) and the second one 10 years (2007-2016), so that it is possible to understand which were the main studied topics in the last 10 years.

To normalise the data and avoid errors in the co-occurrence of words results, the equivalence index, which is widely used in co-word analysis, was applied (He 1999). For each given period, clusters of AKs were built through the simple center clustering method. The quality measure applied was the *h*-

index, which shows the impact of the theme (i.e. cluster) in terms of citations received (Thomé, *et al.* 2016). To present the results, three different maps were built: the overlapping map, the evolution map and the strategic diagram.

The overlapping map and the evolution map are types of longitudinal mapping, in which a series of chronologically sequential maps can be used to detect the advances of scientific knowledge and the evolution of the field over the years (Garfield 1994). The overlapping map shows how many AKs emerged in each period, how many of them are shared by a period, its predecessor and its successor, as well as the stability index (percentage of AKs shared by both periods), while the evolution map shows the main themes for each period of analysis.

Finally, the strategic diagram is a map to visualise sets of interconnected themes (the clusters of AKs) characterised by two parameters: Callon's centrality and Callon's density (Callon, Courtial and Laville 1991). Callon's centrality measures the degree of interaction among the clusters and the cluster's importance in the development of the entire research field analysed (Muñoz-Leiva, *et al.* 2012). According to Cobo *et al.* (2011, 2012), Callon's density measures the strength of the cluster's internal ties, among all the AKs belonging to it, and its value can be interpreted as a measure of the cluster's development.

Based on the centrality (x -axis) and the density (y -axis) value ranges, a research field can be visualised as a set of research themes (clusters), mapped in a two-dimensional strategic diagram and divided into four quadrants (He 1999, Cobo *et al.* 2012):

- First quadrant (top-right): high centrality and high density. These are the main clusters: they are developed and important for the research field and are labeled as motor clusters;
- Second quadrant (top-left): low centrality and high density. It shows the developed but isolated clusters, which are very specialised but of marginal importance for the field;
- Third quadrant (bottom-left): low centrality and low density. It represents either the emerging or declining themes;

- Fourth quadrant (bottom-right): high centrality and low density. It represents the general and basic themes in the network. It includes important clusters but not well developed in the research field.

The clusters resulting in the strategic diagram are labelled inside the sphere according to the name of the most central AK inside them and the volume of the spheres is proportional to the *h*-index of the cluster, showing its impact in terms of citations received (Thomé, *et al.* 2016).

1.3.2.2 Content analysis and the reference framework

To complete the answer to the second research question, a content analysis was performed.

As mentioned in the previous section, it is possible to recognise a classification of risk types, phases of RM process and streams of RM that are shared by researchers and specialised associations. Therefore, for this study, a framework was developed to analyse the articles in the DB, considering the four main constructs recognised in the literature (Fig. 5):

- The risk types that were defined in Section 1.1.1: financial, hazard, operational and strategic risks;
- The RM process, which is divided in the literature into a preliminary phase (context analysis) and four main phases (identification, evaluation, treatment, and monitor and control), that were explained in Section 1.1.2.1;
- The research methodologies applied to the academic studies (Wacker 1998, Voss, Tsiriktsis and Frohlich 2002, Keupp, Palmié and Gassmann 2012): empirical (action research, case study and model proposal & testing), conceptual (model proposal only) or literature review. This construct was inserted because it was useful to understand how each stream has been studied;
- Types of industry or service where the research was conducted.

Across these four constructs, the RM streams, which were explained in detail in Section 1.1.2, are inserted, since the four constructs are considered in each stream.

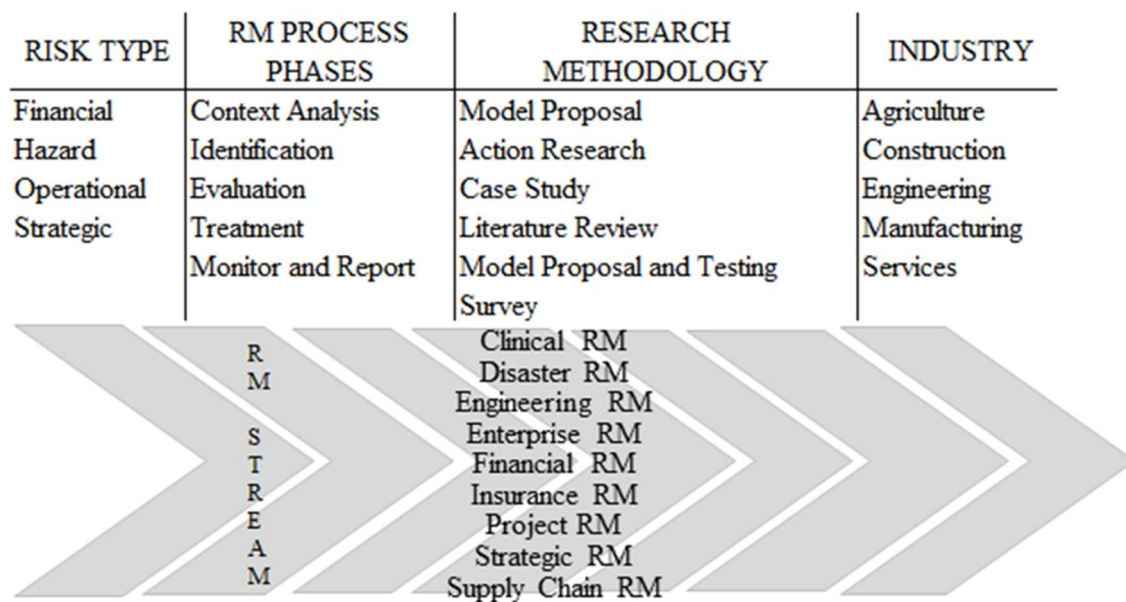


Figure 5: The Framework of analysis

Each paper was read and classified according to the dimensions included in the framework; in addition, the country/countries where the empirical research took place were recorded as descriptive variables of where RM in SMEs has been studied. From these categorisations, it was possible to determine which risk types and which RM processes and streams are the most studied ones and to which sectors of services and industries the empirical papers were applied.

Thanks to the investigation of the development and the focus of RM in SMEs by conducting a descriptive, a bibliometric and a content analysis, the future directions of RM research in SMEs were grasped and outlined.

1.4 Results from the literature analysis

1.4.1 Results of the descriptive analysis

The descriptive analysis of the DB reveals that there are no specific journals dedicated to the theme: the *Production Planning & Control Journal* has published four papers during the analysed period, while the *International Journal of Entrepreneurship and Small Business* has published three papers. All the other journals have published only one or two papers about RM in SMEs.

As for the authors, the only ones who have written more than one paper about the analysed topic are:

1- Mohd Nishat Faisal (India) and Thomas Henschel (Germany), with three papers each;

2- Anass Bayaga (South Africa) and Placide Poba-Nzou (Canada) with two papers each.

When considering the number of citations, the most cited papers in Scopus DB are:

1- Love *et al.*, 2005, “The enigma of evaluation: Benefits costs and risks of IT in Australian small-medium-sized enterprises” (99 citations);

2- Labodová, 2004, “Implementing integrated management systems using a risk analysis-based approach,” (96 citations);

3- Faisal, 2006, “Mapping Supply Chains on risk and customer sensitivity dimensions” (49 citations).

Figure 6 displays the geographical distribution of the selected papers (based on the first author’s country) and the journal’s ranking. The country with more research in this field is the United Kingdom (15%), followed by Czech Republic (8%) and Germany (7%). Studies in the area have been conducted in many other countries, but in a smaller number.

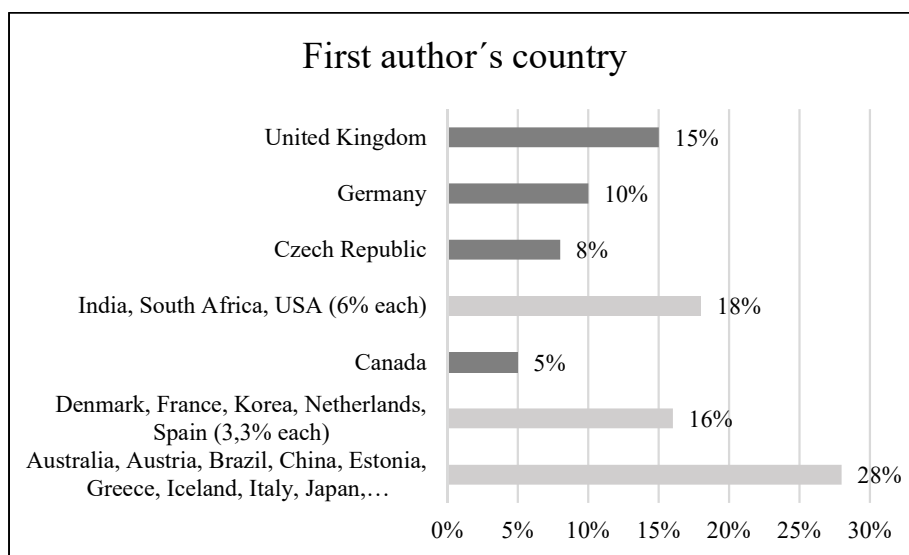


Figure 6: The geographical distribution of the selected paper based on the first author’s country

Considering the quality index of SJR and JCR IF (described in paragraph 2.1.2.1), most journals in the DB belong to the first two quartiles, which assures the high quality of the DB (Fig. 7).

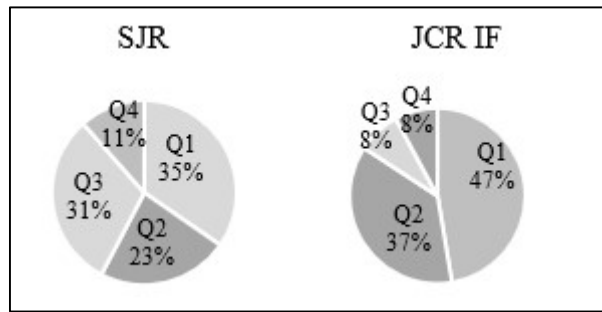


Figure 7: Quality assessment

1.4.2 The development of Risk Management in SMEs

The number of studies about RM in SMEs has been increasing over the years, which means that there is a growing interest for the topic (Fig. 8).

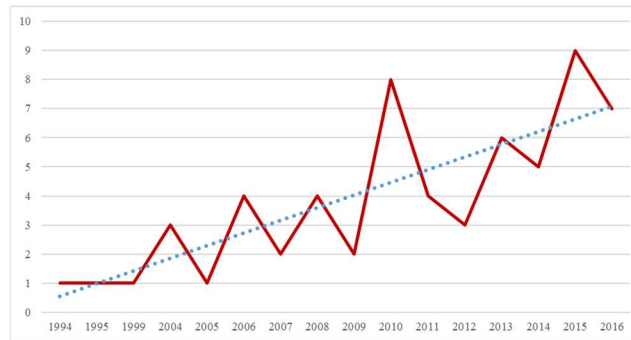


Figure 8: Number of papers published per year

Moving on to the results of the co-word analysis, after data reduction and validation and considering a minimum frequency of occurrence of six documents, a total of 18 AKs were obtained (Fig. 9). The first column corresponds to the label given to the AKs, the second one to the number of keywords that were aggregated based on similarities in the meaning to compose the AK, and the last one corresponds to the number of documents in which those keywords were reported. To allow a better visualisation of the following maps, acronyms were used to name the AKs.

In the overlapping map (Fig. 10), the number inside the circles shows the number of AKs found in the period considered. The numbers above the outgoing and incoming arrows indicate, respectively, the number of AKs lost and received between one period and another. Moreover, the first number above the arrow linking the circles indicates the number of AKs that were kept between two periods and the second number, in brackets, reports the stability index (proportion of AKs kept from one period to another), which indicates the alterations of the themes over time.

Aggregated Keywords Acronym	Included Keywords	Citing Documents
BNKS - Banking Sector	7	8
DM - Decision-Making	2	6
ERM - Enterprise RM	3	12
FR - Financial Risks	11	15
FRM - Financial RM	1	11
HSOR - Health and Safety Occup. Risks	23	6
INDS - Industrial Sector	20	13
ITR - IT Risks	8	11
OPR - Operational Risks	2	18
PJRM - Project RM	5	6
RA - Risk Analysis	9	20
RISKS	12	18
RM - Risk Management	7	40
RP - Risk Perception	6	12
SCRM - Supply Chain RM	8	7
SMES	25	61
SR - Strategic Risks	4	11
SRV - Services	9	11

Figure 9: Aggregated Keywords extraction

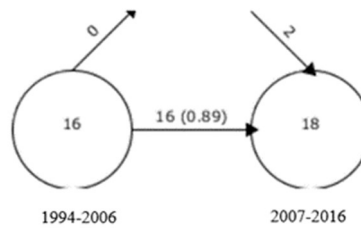


Figure 10: Overlapping map

In Figure 11 the evolution map is depicted, showing the clusters of AKs (the themes) that emerged in each period and their evolution over time. It can be seen that the connection among some of the AKs has changed overtime. More specifically, for instance, when analysing the first cluster of each period, it can be observed that in the second period the financial risks (FR) have been more studied specifically in the Financial RM stream (FRM), while in the previous period the FR were in the same cluster of RM, meaning that they were not related to a specific RM stream. On the other hand, observing the over mentioned clusters, it can be noticed that the banking sector (BNKS) was the main industrial sector in which FRM was applied in both periods of analysis.

Moreover, the size of each ball is proportional to the impact of the cluster (measured by the *h*-index). In that figure, the main AK of each cluster is the one that is immediately on the right of the ball. The

continuous line means that the main AK of the cluster appears also in the next period, while the dotted line means that the clusters share AKs, but not the main one. The thickness of the line is proportional to the number of AKs shared by the clusters.

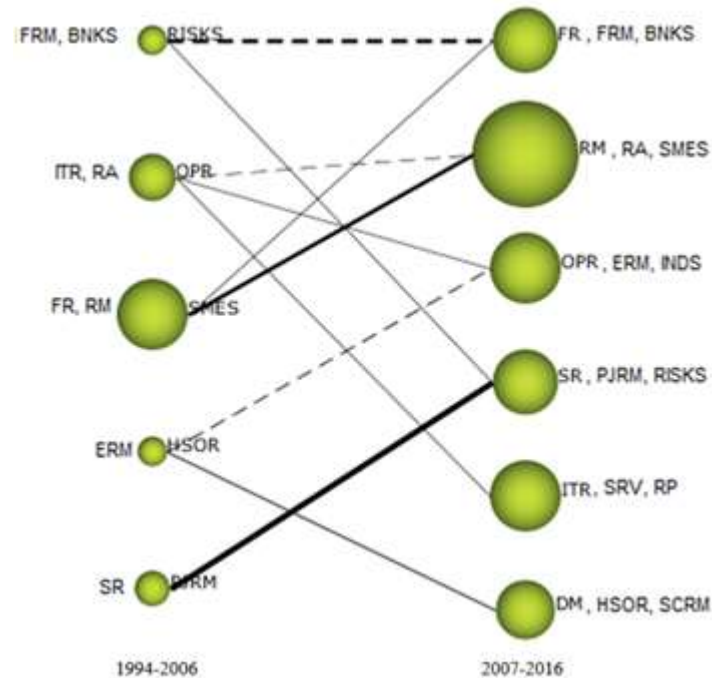


Figure 11: Evolution map

The results of the third type of analysis (described in Section 1.3.2.1) is represented in two strategic diagrams (one for each period), positioning the clusters according to their centrality (degree of interaction among the clusters and the cluster's importance in the development of the analysed field) and density (strength of the cluster's internal ties among all its AKs) (Fig. 12). Also, in these maps, the size of the circles varies according to the h-index of the cluster (impact of the cluster).

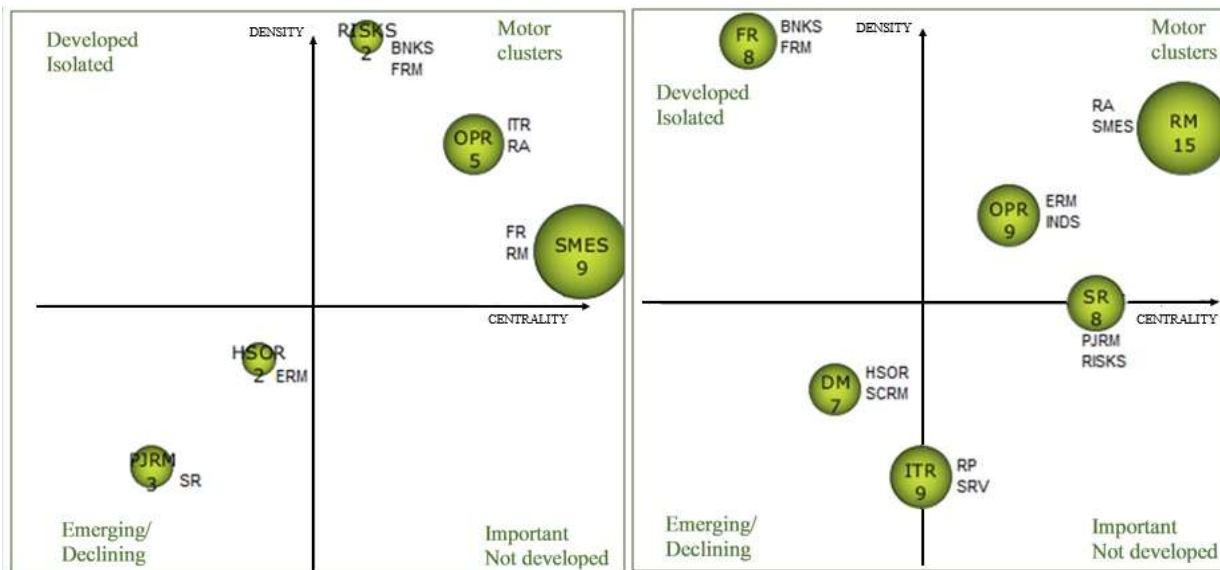


Figure 12: Strategic diagrams for both periods 1994-2006 (left) and 2007-2016 (right)

When analysing the results obtained in all the maps (Figs. 10, 11 and 12), it can be observed that the number of AKs is overall stable along the years: only two AKs (DM and INDS) were added and none was lost when passing from the first period to the second one.

In more details, in the first period (1994-2006), from the 16 AKs, 13 were grouped into five different clusters, while three (“Supply Chain RM”, “Services” and “Risk Perception”) were not shown, as there is no co-occurrence between them and other AKs in the period. When analysing specifically the strategic diagrams (Fig. 12), the first period presents three motor clusters (RM themes):

- The most cited and central motor cluster merges “Financial Risks”, “SMEs” and “Risk Management”, with the latter two being the search terms used to generate the DB;
- The motor cluster with the highest density is built with the AKs “Risks”, “Banking Sector” and “Financial RM”;
- The third motor cluster merges “Operational Risks”, “Risk Analysis” and “IT Risks”.

The last two clusters of the first period are emerging themes: the one that is slightly more developed merges “Health and Safety Occupational Risks”, that belongs both to hazard and operational risks, with “Enterprise RM”, which is the stream that usually comprises both of them. The other cluster links “Project RM” with “Strategic Risks”, since the strategic point of view is very relevant in the achievement of the project objectives.

In the second period (2007-2016), the AKs “industrial sector” and “decision making” were added to the 16 AKs previously resulted; the 18 AKs obtained are all grouped into six different clusters:

- The main motor cluster merges “Risk Analysis”, “Risk Management” and “SMEs”, which are all very important since they characterise all the studies in analysis;
- The other motor cluster contains “Enterprise RM”, “Operational Risks” and “Industrial Sector”. There are more studies in this period that consider, in different industrial sectors, the operational risks with an integrated view throughout the company, according to the Enterprise RM approach, but rarely do they include all types of risk (operational, strategic, financial, hazard risks); therefore, it could be considered a partial ERM approach;
- The third motor cluster includes “Risks”, “Strategic Risks” and “Project RM”. The Risks AK, obviously highly connected in the network, has increased the centrality of the cluster, that was previously built only by “Strategic Risks” and “Project RM”; notwithstanding also the latter two AKs have developed individually in this second period, highlighting their importance in the analysed topic.

The most specialised cluster is formed by “Financial Risks”, “Financial RM” and “Banking Sector”, that is well developed, but peripheral in the network. Moreover, an emerging cluster has been built with the AKs “Decision-Making”, “Supply Chain RM” and “Health and Safety Occupational Risks”. This means that Supply Chain RM stream is growing in importance among SMEs; it usually deals with the operational risks – being the health and safety occupational risks – one of the operational risks’ subtypes in the analysed paper.

Finally, the other emerging cluster comprises “IT Risks”, “Risk Perception” and “Services”. The latter two AKs had a low co-occurrence in the first period and were not shown in the diagram, while in the second period, together with IT Risks, they represent an emerging theme with medium centrality (importance) but low density (development) in the network.

1.4.3 General characteristics about the literature of RM in SMEs

All the papers in the DB were read, classified and analysed according to the framework of analysis.

In Figure 13, the main characteristics of the studies included in the DB are displayed. As it can be seen from the bar chart of Figure 13a, the operational risks are studied in 33 percent (33%) of the papers, followed by the financial risks (29%), the strategic risks (23%) and lastly the hazard risks (14%). Next to this bar chart, in Figure 13b, the main countries where the empirical studies took place are considered: United Kingdom (8 studies), Germany (6), Czech Republic (5), South Africa (4) and India (4). Other countries have been investigated in fewer cases.

Regarding the RM streams (Fig. 13c), the most studied ones are the Enterprise RM and the Financial RM, followed, with lower frequency, by the Supply Chain RM, the Project RM and the Strategic RM streams, while the Disaster RM and the Engineering RM streams are rarely investigated in SMEs. Analysing the RM process considered in the papers of the DB, it can be observed that risk identification and risk evaluation are the most studied phases (investigated in respectively 31% and 34%) of the papers, highlighting that many companies apply RM only partially, focusing on the initial phases (Fig. 13d). As for the research methodology used in the papers, it can be observed that the great majority of them are empirical studies performed with survey or case study methodology (Fig. 13e).

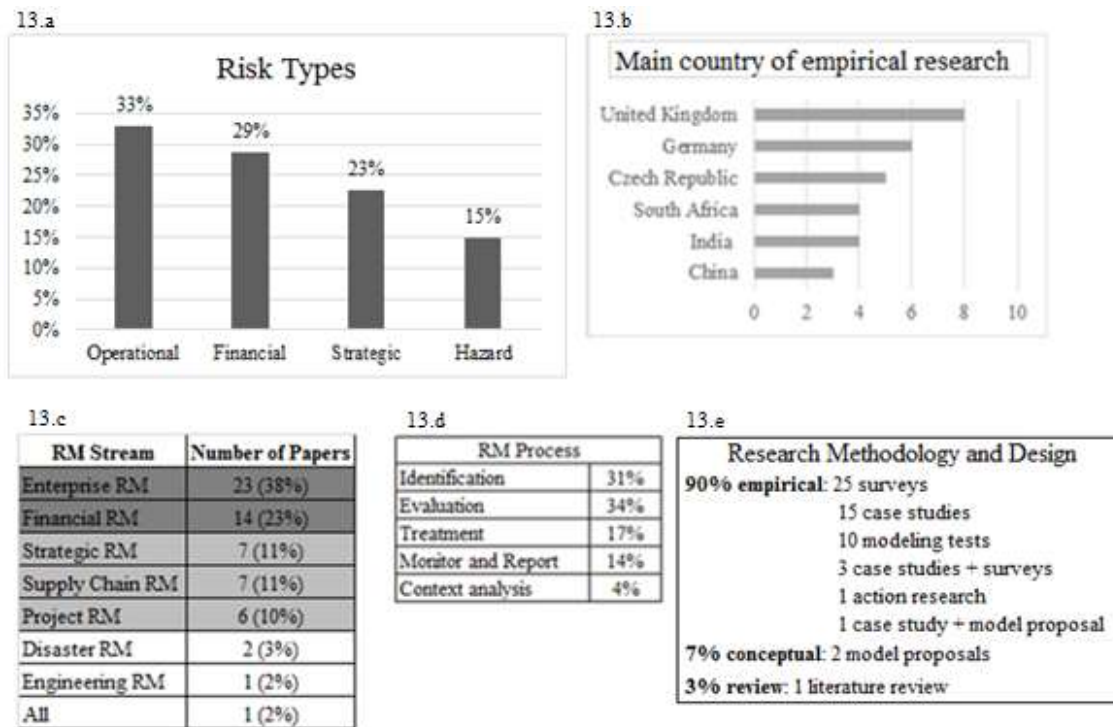


Figure 13: General characteristics of the studies about RM in SMEs

When performing an overall comparison between both periods in terms of number of papers published per stream, it can be seen that in the second period the interest for the Enterprise RM, the Financial RM and the Strategic RM streams has notably increased more than for the other streams (Fig.14). In the last ten years, more than 80% of the papers about Enterprise RM, almost 80% of the papers about Financial RM and all the papers about Strategic RM in the DB were published. Nevertheless, all the streams have been more studied in the last ten years than previously, confirming the growing interest in the RM in SMEs.

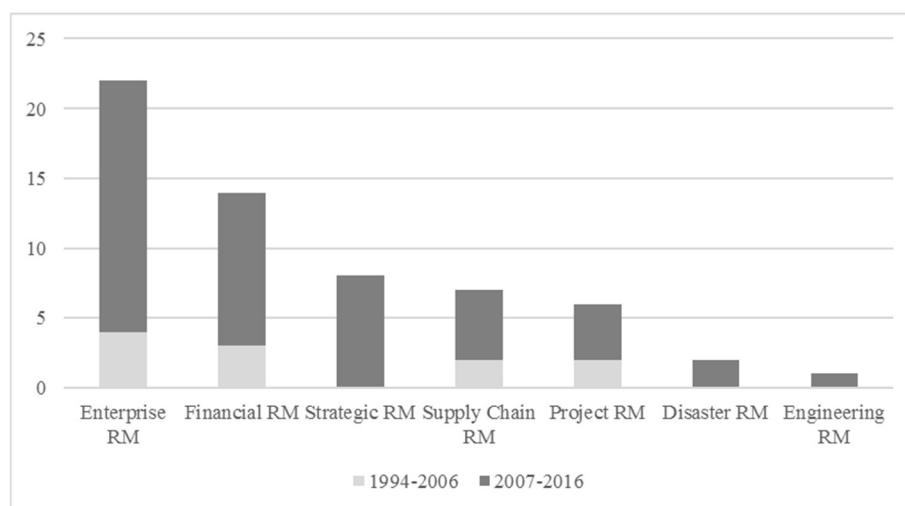


Figure 14: RM streams studied in both periods considered

Besides the increase in the number of studies in the second period, another interesting result is that the number of conceptual and empirical papers proposing and testing a new RM model has increased as well. In the first period, only three papers proposed a new model (and in two of them, the model was also tested), while in the second period there are ten papers presenting a model (and in seven of them, the model was also tested). However, analysing these numbers in relation to the total number of papers and considering the type of objectives of the papers, it emerges that most literature has been devoted to exploratory research, preferring case studies and survey methodologies.

1.4.4 In-depth analysis by research stream

Table 2 summarises the results from the content analysis regarding the Enterprise RM stream, the most studied one.

23 papers of the database (38%) are classified in the Enterprise RM stream. However, most of the papers do not report a complete Enterprise RM approach, since in some cases not all the functional units or processes of the companies are considered and, in others, not all the types of risks are taken into account (as it can be observed in Table 2); therefore, these are, in most cases, partial Enterprise RM applications. For example, the research of Labodová (2004), regards the analysis of hazard risks through the integration of quality management, environmental management and health and safety management systems. On the other hand, in the paper of Jørgensen, Duijm and Troen (2010), operational and hazard risks are analysed through the application of a new risk model throughout the company; thus that research was categorised in the Enterprise RM stream.

AUTHORS	YEAR	INDUSTRY										RESEARCH METHODOLOGY					RM PROCESS				RISK TYPE						
		agriculture	construction	manufacturing	auditing/consulting/training	commerce/e-commerce	financial	IT	logistics	other services	not available	action research	case study	conceptual model proposal	model proposal and testing	survey	0 - context analysis	1 - identification	2 - evaluation	3 - treatment	4 - monitor and report	financial	hazard	operational	strategic	not available	
Kailay & Jarratt	1995										x			x			x	x	x	x					x		
Labodová	2004										x			x			x	x							x		
Love, Irani, Standing, Lin, & Burn	2005	x	x	x		x	x			x						x		x							x		
Henschel	2006		x		x	x			x	x	x					x		x	x	x	x	x				x	x
Gurau & Ranchhod	2007			x												x		x	x	x	x				x	x	
Islam, Tedford, & Haemmerle	2008			x										x		x	x	x	x	x				x	x	x	
Wu & Olson	2009						x							x								x			x		
Henschel	2010		x		x	x		x	x	x						x		x	x	x	x	x	x	x	x	x	x
Jørgensen, Duijm, & Troen	2010									x							x							x	x		
Poba-Nzaou & Raymond	2011			x										x				x	x	x	x				x		
Bajo, Borrajo, De Paz, Corchado, & Pellicer	2012										x			x				x	x	x	x				x		
Brender & Markov	2013		x	x		x								x					x						x		
Grant, Edgar, Sukumar, & Meyer	2013					x										x		x	x					x	x	x	x
Kim & Vonortas	2014			x												x		x	x	x	x	x			x	x	
Doszhan, Mustafina, & Supugalieva	2015		x	x		x										x		x	x					x	x	x	
Garg & Makukule	2015										x						x	x	x					x	x	x	x
Kozubiková, Belás, Bilan, & Bartos	2015	x	x	x		x				x	x					x		x						x	x	x	x
Reinhold, Jarvis, & Tint	2015			x														x	x					x	x		
Rostami, Sommerville, Wong, & Lee	2015		x													x	x										x
Brustbauer	2016			x		x	x									x		x	x	x	x	x	x	x	x	x	x
Henschel & Durst	2016		x		x	x		x	x	x						x		x	x	x	x	x			x	x	x
Piskunov, Manyayeva, Tatarovskaya, & Bychkova	2016										x					x			x	x				x		x	x
Schönbohm & Juelich	2016				x													x									x

Table 2: The literature about the Enterprise Risk Management Stream

Thomas Henschel, one of the main experts in RM applied to SMEs, wrote three papers regarding this stream. In 2006, he analysed the current state of RM practices in German SMEs and the possible relationships between RM and business planning activities. In 2010, he approached the different types of RM practices and concluded that implementing and reviewing RM is not a priority for SMEs, but progress in the risk assessment phase emerges when comparing this study to the previous one. In any case, the lack of integration between the identified risks and the business planning is highlighted in Henschel (2006, 2010). Finally, the results of his latest research (Henschel and Durst 2016) show that usually the person in charge of the risk assessment is the owner-manager and that the RM process is mostly incomplete. He concluded that the biggest challenge is to integrate the risk portfolio with the company's business plan.

The work by Rostami *et al.* (2015) stated that the main difficulty in implementing the Enterprise RM in SMEs is to scale the RM process to meet the requirements and the lack of skills and knowledge

necessary to adopt RM tools and techniques. To overcome these difficulties, they suggested applying business scorecards to evaluate the Enterprise RM position of the company (Wu and Olson 2009).

Brustbauer (2016) conducted an empirical study to analyse the Enterprise RM influence on the company's strategic orientation. He proposes a model in which preconditions for Enterprise RM implementation, classification of Enterprise RM items, application of Enterprise RM approaches and the consequent effects on strategic orientation are analysed. A great effort is demanded of SMEs in order to implement Enterprise RM, but the benefits shown in the studies seem to pay off, since it permits higher risk awareness, adapts itself to the prevailing environment, seeks strategic advantages, and increases the competitiveness and the business success (Brustbauer 2016).

The results of the other RM streams are displayed in Table 3, starting with the second most studied stream, Financial RM, with 14 articles (23%). It is not a surprise that this stream is the object of many studies, since the financial issues are always ones of the main concerns for SMEs. Almost half of the studies were applied in the financial industry (banks), but some were applied in the logistics/services area and one in the IT industry, pointing out that the Financial RM stream is not limited to the financial industry. As it was expected, all the papers consider the financial risks. Regarding the research methodology, three of them propose and test a RM model, while all the other ones, except for a literature review, are surveys.

The Supply Chain RM stream is presented in seven papers (11%): Six are empirical (three case studies, one survey, one that mixes these both methodologies, and one that proposes and tests a new model) and one is conceptual. All the studies analysed the operational risks that the supply chains are exposed to, while only two of them consider other risk types as well. The survey by Thun, Drücke and Hoenig (2011), investigated the Supply Chain RM practices in 67 plants from the automotive industry, concluding that SMEs usually focus on tools to react to risks, instead of tools to prevent them. As for the paper written by Finch (2004), it mixes the survey and the case study designs and proposes a Supply Chain RM model which was successfully tested in three Indian SMEs clusters, extending the analysis

to hazard and strategic risks in addition to operational risks. Finally, the conceptual paper by Faisal (2016) tries to model supply chain risk susceptibility using diagraph and matrix methods.

RM STREAM	AUTHORS	YEAR	INDUSTRY											RESEARCH METHODOLOGY				RM PROCESS				RISK TYPE			
			agriculture	automotive/electronic/mechanic	other manufacturing	construction	auditing/consulting/training	commerce/e-commerce	financial	IT	logistics	other services	not available	case study	conceptual model proposal	literature review	model proposal and testing	survey	0 - context analysis	1- identification	2- evaluation	3- treatment	4- monitor and report	hazard	operational
Financial RM	Evers & Mehmet	1994					x									x		x					x		
	Lane & Quack	1999					x							x									x		
	Pennings & Garcia	2004									x						x						x		
	Bruns & Fletcher	2008						x									x			x			x		
	Udell	2008						x									x	x					x		
	Altman, Sabato, & Wilson	2010										x					x			x			x		x
	Beck, Klapper, & Mendoza	2010						x									x		x	x	x	x	x		
	De la Torre, Peria, & Schmukler	2010						x									x		x	x			x		x
	Sohn & Jeon	2010							x								x		x				x		x
	Mutezo	2013						x									x	x					x		
	Hariharan	2014							x								x			x	x		x		
	Supply Chain RM	Belás, Kljucnikov, Vojtovic, & Sobeková-Májková	2015	x	x	x					x	x						x		x	x			x	
Ju & Sohn		2015														x			x				x		
Virglerová, Kozubíková, & Vojtovic		2016	x		x	x					x	x					x		x	x	x	x	x		
Finch		2004									x						x		x	x	x	x		x	x
Strategic RM	Faisal & Shankar	2006			x											x								x	
	Faisal, Banwet, & Shankar	2007									x						x								x
	Ellegaard	2008			x																x				x
	Xie, Liu, Peng, Chen, & Chen	2009		x																x	x				x
	Thun, Driike, & Hoenig	2011		x													x			x	x	x			x
	Faisal	2016										x		x						x	x			x	x
	Pezderka & Sinkovics	2011									x						x			x	x				x
Project RM	Bayaga	2012								x									x						x
	Bayaga	2013									x											x			x
	Gao, Sung, & Zhang	2013						x												x					x
	Poba-Nzaou, Raymond, & Fabi	2014						x												x	x				x
	Portman-Smith & Harwood	2015									x		x								x	x	x		x
	Toulová, Tuzová, & Veselá	2016				x														x		x			x
	Blanc Alquier & Lagasse Tignol	2006				x															x	x	x	x	x
	Leopoulos, Kirytopoulos, & Malandrakis	2006					x														x	x	x	x	x
Disaster RM	Tang, Leung, & Wong	2010																			x	x			x
	Neves, da Silva, Salomon, da Silva, & Sotomonte	2014									x										x	x			x
	Marcelino-Sádaba, Pérez-Ezcurdia, Lazcano, & Vilanueva	2014		x																	x	x	x	x	x
	Pereira, Tenera, Bispo, & Wemans	2015																				x			x
	Draghici, Izvercianu, Ivascu, & Dragoi	2011																				x			x
	Wedawatta & Ingrige	2012																				x	x	x	x
Engineering RM	Kikuchi & Hirao	2010				x																			x
	All streams	Verbano & Venturini	2013																						x

Table 3: The literature on the other Risk Management Streams

Other 7 papers (11%) regard the Strategic RM stream, which is mainly empirically studied (four case studies and two surveys) and applied to different industrial and service sectors. As it was expected, the strategic risks are identified in all of them and, in a few cases, also the operational and the financial ones are considered. For example, the two papers written by Bayaga (2012, 2013) are about ICT implementation as a strategic move in financial companies. In both papers, the strategic and the operational risks related to it are investigated.

The Project RM Stream is presented in six papers (10%). All of them are empirical studies (three case studies and three model proposal and testing). Three were applied in the industrial sector, two in the service sector and one was applied to five different projects from both sectors. This last-mentioned paper was written by Marcelino-Sádaba *et al.* (2014) and it presents a project management methodology specific for small businesses that run projects beyond their normal operations. The methodology proposed is based on Project RM and includes simple tools, templates and risk checklists with recommended actions and indicators, and it was tested in five different types of real projects of industrial and service companies to be validated. The results were overall positive, since the methodology has allowed reducing the strategic risks, to properly define the project and to rapidly and easily share information about the status of the project risks, which facilitated the decision making.

The two papers about the Disaster RM stream (Draghici, *et al.* 2011, Wedawatta and Ingirige 2016) deal only with the hazard risks: One is focused on the health and safety risk evaluation process, and the other one focuses on SMEs' prevention and adaptation to flood risks. The only article regarding the Engineering RM stream is from Kikuchi and Hirao (2010): It is a case study applied to a chemical processes industry, in which the impacts due to the use of cleansing agents on metal parts is analysed. Finally, a literature review (Verbano and Venturini 2013) considering all RM streams was found and inserted in the DB; its results will be further analysed and compared to the ones derived from the current analysis.

1.5 Discussion of the results

In the first period of analysis (1994-2006), the studies have two main focuses: one contemplates the financial risks and its management, while the other one regards the operational risks, including the specific subtypes of health and safety occupational risks and IT risks – although they are not studies considering the whole company in an integrated approach as in the ERM stream. The Project RM, the Enterprise RM and the strategic risks are also studied in the first period as topics in their early stages of development.

In the last 10 years, the main evidences highlighted by the analysis conducted are:

- The Enterprise RM and the operational risks in the industrial sector have become a central theme, even though the first one is still not completely developed, since usually not all types of risks are considered when it is adopted in the companies;
- The Project RM and the strategic risks also came to be a central theme, but still with an intermediate level of development, as it emerges from both the co-word analysis and the content analysis;
- Another theme significantly developed, but peripheral due to its specificity in the field of research, is the Financial RM, which is mainly adopted in the banking sector and is strictly related to the financial risks;
- The Supply Chain RM and the decision-making have merged in the same theme in this period, related mainly to a specific subtype of operational risks: health and safety occupational risks.
- Among the less-developed, but with an average level of importance, a new theme regarding IT risks in service companies and focusing on the preliminary phase of the RM process, that is, risk perception, can be found. Also, this theme represents an emerging area of study that comprises also the recent and growing cyber risks connected to all the activities performed on the web (Mukhopadhyay, *et al.* 2013).
- The outcomes obtained from the content analysis confirm that the most studied stream is the Enterprise RM, but Table 2 highlights that not all branches of the stream are developed, since it is more concentrated in the operational risks and not all the risk types are properly considered, as it is expected from a holistic Enterprise RM approach. The Financial RM stream is also quite developed, but it is very specialized: all papers consider the financial risks only, except in two cases where operational risks are also managed. However, the studies are not restricted to the financial industry, meaning that the companies, in general, are aware of the importance of the financial risks.

The content analysis confirmed that the most recent research streams – and, therefore, only slightly developed – are the Project RM, the Supply Chain RM and the Strategic RM. All the papers regarding

the Strategic RM focus on the strategic risks, but some of them study also the operational risks or the financial ones from a strategic perspective, considering them in investment opportunities.

The main risk type in the Supply Chain RM stream is the operational one, which was expected since most of the problems that may occur in supply chain management are related to the operations; so it is crucial for the whole supply chain to treat these risks. Notwithstanding, also is the fact that the occurrence of hazard, financial and strategic risks to one of the players could have a potential impact on all of them, interrupting the business continuity. Therefore, a wider RM approach in this stream is also desirable and expected in the future. Regarding the industries, most of the papers were applied in the manufacturing and in the automotive industries, whose companies are usually active actors of complex supply chains.

On the other hand, the Project RM Stream takes into account several risk types: Half of the studies contemplate all of them, indicating the application of a complete Project RM approach. In this case the weak point is represented by the limited application in different industrial sectors; for example, no paper devoted specifically to the manufacturing sector can be found.

1.5.1 Comparison with a previous literature review

In this section, a comparison of results obtained in this study with the ones of a previous literature review from Verbano and Venturini (2013), based on 33 papers published between 1999 and 2009, will be conducted. A comparison between the results from both literature reviews is displayed on the bar charts presented on Figure 15a (RM streams) and on Figure 15b (risk types).

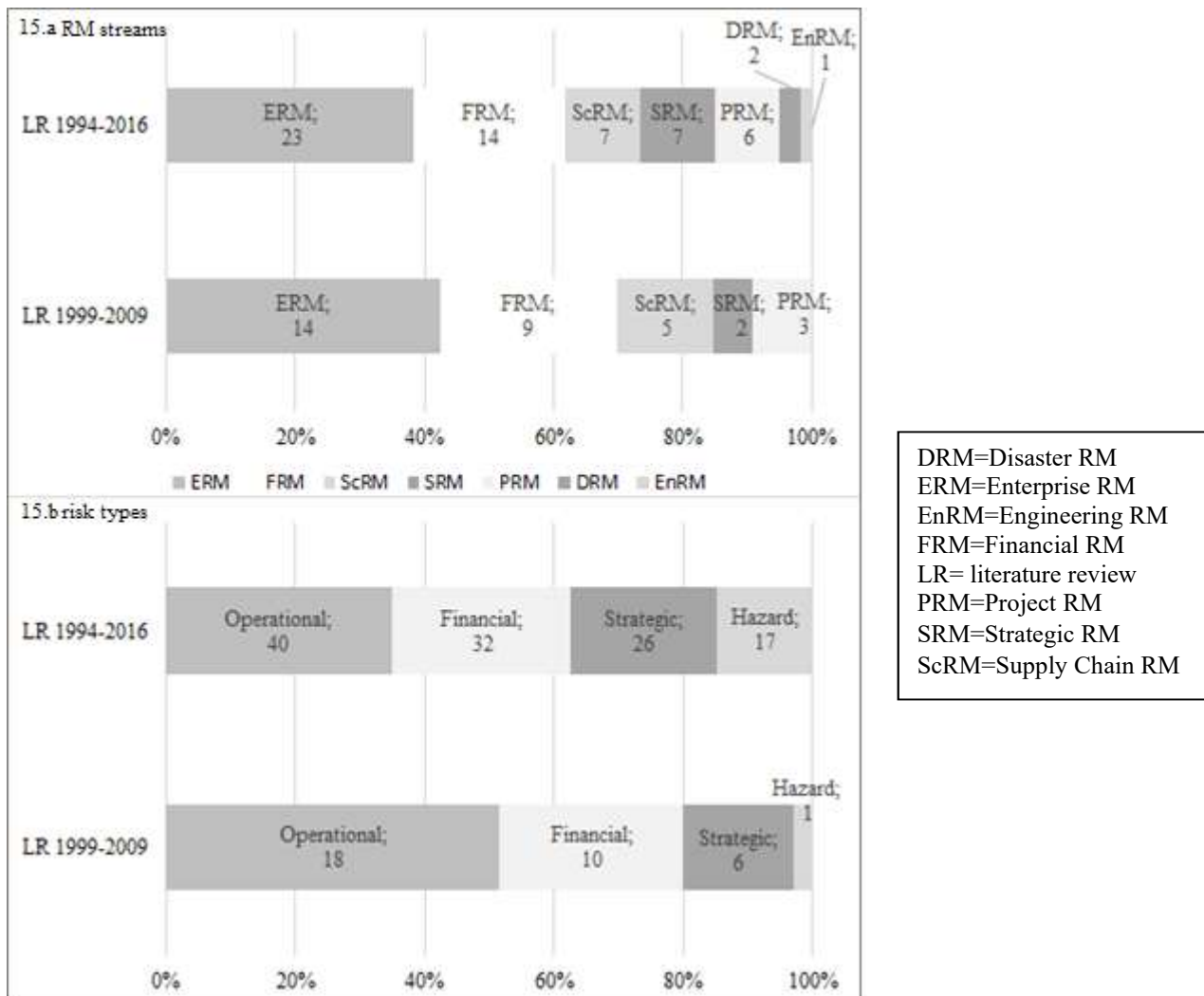


Figure 15: RM streams and risk types in the literature reviews

From Figure 15 and Tables 2 and 3, it can be observed that in both databases, the most studied risk types are the operational ones, especially in the Enterprise RM stream, and less frequently in the Project RM and in the Supply Chain RM streams. Financial risks are the second most studied ones, managed mainly in the Financial RM and, secondly, only in the newest database, in the Enterprise RM and Project RM streams. The interest in the management of the strategic risks is increasing, but less relevant, covered mainly in the Strategic RM stream and, only in the newest database, also in the Project RM one. Finally, hazard risks recently have been considered in more types of RM streams. Therefore, from this comparison, it can be concluded that the current analysis confirmed the prominence of operational and financial risks, especially in Enterprise RM and Financial RM stream, as reported in the previous literature review. On the other hand, the current literature review highlights

the emergence of all types of risks and of Project RM, Strategic RM and Supply Chain RM streams. Finally, in the current database, two RM streams arise: Disaster RM (2 papers) and Engineering RM (1 paper). However, these are not considered emerging themes and further developments are not expected in SMEs, since the Engineering RM is very complex and rarely applicable to SMEs, and the Disaster RM is mainly related to the management of a whole territory by the local authority. Concluding, although the RM in SMEs has been developing in recent years, there are still many research opportunities to deepen the knowledge of this topic.

1.5.2 Future research opportunities

Despite the growing interest in this research field, many gaps emerged (see Table 4), allowing the identification of several future research opportunities; these are detailed in the following table by research stream after considering the state of the art and the suggestions highlighted through the analysed literature review.

RM Stream	Papers	INDUSTRY											RESEARCH METHODOLOGY					RM PROCESS					RISK TYPE							
		manufacturing				service							action research	case study	conceptual model proposal	literature review	model proposal and testing	survey	0- context analysis					financial	hazard	operational	strategic	all	not available	
		agriculture	automotive/electronic/mechanic	other manufacturing	construction	auditing, consulting, training	commerce/e-commerce	financial	IT	logistics	other services	not available							1- identification	2- evaluation	3- treatment	4- monitor and report	all							
Enterprise RM	23	2	0	10	8	4	9	3	3	5	12	3	1	6	2	0	5	13	1	20	19	10	10	10	11	8	21	11	4	2
Financial RM	14	2	0	2	2	0	4	6	1	2	3	2	0	0	0	1	3	10	3	6	9	3	2	2	14	0	2	0	0	0
Supply Chain RM	7	0	2	2	0	0	0	0	0	0	2	1	0	4	1	0	1	2	1	4	4	4	1	1	1	2	7	2	1	0
Strategic RM	7	0	0	2	1	0	0	2	1	0	1	0	0	4	1	0	0	2	1	3	5	2	2	1	1	0	3	7	0	0
Project RM	6	0	1	1	2	1	0	0	1	0	2	0	0	3	0	0	3	0	0	6	6	3	3	3	4	3	5	6	3	0

Table 4: Gaps emerging in the main RM streams, by industry (manufacturing and construction, and services), research methodology, RM Process phase and risk type. Legend: dark background=high number of papers; light background=medium number of papers; blank background=no papers or small number of papers

There are 23 papers regarding the most studied stream, Enterprise RM, which is not a significant number considering the timeframe (1994-2016). In addition to that, most of the Enterprise RM applications are partial, not holistic as they should be. Therefore, further research about Enterprise RM

should consider all risk types and all risk phases of the RM process, as it was done in the study of Brustbauer (2016). Also Kim and Vonortas (2014) suggest that future analysis on specific procedures of risk identification, evaluation, treatment and monitoring may be more accurate. Also, in most of the Enterprise RM cases, the sample size was relatively small, so generalisations should be handled with caution (Love, *et al.* 2005, Wu and Olson 2009, Bajo, *et al.* 2012, Garg and Makukule 2015, Brustbauer 2016, Henschel and Durst 2016, Schönbohm and Juelich 2016). In the future, other cases are needed to support the results previously obtained, extending their generalisation.

In the Financial RM stream, future work could deepen the analysis of the financial risks considering all RM process phases, and also work in sectors different from the financial one. Work by Beck, Klapper and Mendoza (2010) suggests conducting surveys in different financial areas and using a more extensive data set to derive reliable and detailed results (Sohn and Jeon 2010). Moreover, Pennings and Garcia (2004) propose to analyse the way that risk attitudes are formed in different environments. One of the main financial issues for SMEs is related to their weaknesses in obtaining loans and managing their credit risks; future works are needed to suggest tools, techniques and practices to evaluate and treat financial risks in SMEs, in order to overcome these limitations.

Definitely, future qualitative and quantitative research regarding the Supply Chain RM and the Project RM streams are expected, as the analysis conducted reveals they are the emerging streams. The studies in the Supply Chain RM are concentrated in the management of operational risks, while the goal of Supply Chain RM is to minimise all risks among all the players; therefore, future studies could consider also financial, strategic and hazard risks connected to the supply chain. Another recommendation is to follow all phases of the RM process in the Supply Chain RM. Faisal (2016) identified the risks through literature review and affirms that, in the future, it would be useful to obtain them by conducting field studies regarding Supply Chain RM. Future work may be addressed both to service sectors and to other manufacturing sectors; Faisal and Shankar (2006), for instance, recommend the application of their proposed model for lean, agile or “leagile” supply chain entities.

Ellegaard (2008) states that future studies addressing other types of companies, such as bio-tech or trading, could reveal other findings, while Thun, Drüke and Hoenig (2011) believe that the inclusion of different industries could also highlight variations in the way SMEs apply RM in the supply chain context.

In the Project RM stream, all risk types, besides operational and strategic ones, and all risk phases should be analysed in order to assure the project's success. As for the context of application, a future challenge is to promote the application of the Project RM in companies organised mainly by processes (like generally in manufacturing), in which nevertheless innovation is developed through successful projects and then introduced into innovative processes. In the paper of Neves *et al.* (2014), one of the suggestions for future research is the demonstration of the real benefits of applying risk management in incubated technology-based firms and the ways of treating the identified risks given the firms' context. This concern is supported by Pereira *et al.* (2015) that suggest further research is needed to extend universally the evidence of a favourable integration of a tool to support innovative projects development by SMEs to all the goal-oriented issues. Other future works in Project RM can be related to strengthen the results obtained in previous research; for example. Work by Marcelino-Sádaba *et al.* (2014) suggests that the application of their proposed Project RM methodology in cultural environments different from Spain, in order to verify its applicability and generalisation.

In the Strategic RM stream, further research is advocated in the identification of strategic risks, which is of extreme importance since they directly affect the company's objectives. In the paper of Bayaga (2012), for instance, further research is suggested to measure the changing strategies related to ICT adoption. Studies by Pezderka and Sinkovics (2011) indicate that future work is required to operationalise and test the integrated e-risk framework proposed. Since most of the research methodologies adopted in the Strategic RM papers are case studies, many of the findings cannot be generalised (Portman-Smith and Harwood 2015); therefore, also in this case, given the recent emergence of this stream, other case studies should be conducted in the future (Poba-Nzaou, Raymond

and Fabi 2014) and quantitative research could also be performed to confirm the validity of the first studies and deepen the actual knowledge.

No further studies are suggested for Engineering RM nor for Disaster RM as these streams are significantly more suitable for large companies and usually not applicable for SMEs and, in the case of the disaster risks, are managed also by the Public Authority.

CHAPTER 2

DEVELOPMENT OF A FRAMEWORK TO ANALYSE PROJECT RISK MANAGEMENT IN SMES

The results obtained in the previous chapter have indicated the Project RM (PRM) stream as a relevant, not-well studied emerging stream, and the published papers about it suggest further research to extend the application of PRM in SMEs. So, the aim of the second part of the thesis is to contribute to fulfill this research opportunity by conducting multiple case studies to analyse the implementation of PRM in SMEs. To conduct the cases, it was necessary to build an empirical framework of analysis, which construction is explained in this chapter. In the following sections, the topic of PRM in SMEs is explained in detail (Section 2.1) and the objective and methodology of the second part of the thesis are presented (Section 2.2). In Section 2.3, the construction of the research protocol, built to analyse the adoption of PRM in SMEs, is presented together with the case selection criteria and the case analysis methodology. In Section 2.4 the research protocol is tested and Section 2.5 concludes the chapter.

2.1 Project Risk Management in SMEs

PRM is an integral part of Project Management (PM), where PM is the application of methods, knowledge, tools and techniques to a project, integrating the various phases of a project's lifecycle in order to achieve its goal (ISO21500 2012, PMI 2017). The PM process is divided into five phases (i.e., initiation, planning, execution, monitoring & control and closure) (ISO21500 2012), and its main purpose is to increase the organisational value (Dalcher 2012). Most companies are aware of the importance of a structured approach to PM (Miklosik 2015) and of the increased effectiveness and efficiency of human effort in the organisation that is obtained through PM (Fernando, et al. 2018), opting then for its adoption.

When a project is implemented in a company, it is essential to design all of the project's lifecycle and identify all the possible sources of risks that can be technical-operational, organisational, financial and strategic (Badri 2015). To ensure project success in today's competitive environment, an organisation must manage these project risks effectively, even though various difficulties are experienced (Shenhar, et al. 2007, Srivannaboon and Milosevic 2006). Through the identification of such risks, the managers are able to study the possible positive and negative outcomes and define the correct response to treat them in order to assure the success of the entire project. Commonly, in most types of organisations, many efforts of managers are expended on dealing with project risk-related issues (Fernando, et al. 2018). PRM activities, tools and techniques and organisational aspects offer an approach to manage these risks proactively in order to improve the projects' probability of success. PRM contributes to identify the project objectives, improve the project monitoring and control, improve communication among the project stakeholders, facilitate decision-making and increase the chances of project success (PMI 2013, Raz and Michael 2001). It is a subset of PM, both in the Project Management Institute (PMI) framework and in the ISO 21500 (ISO21500 2012, PMI 2013), composed of four phases: risk identification, risk analysis, risk treatment and risk monitor & control. The aim of PRM is to systematically identify, analyse, treat and monitor & control project-related risks by decreasing the probability and impact of occurrence of negative ones (threats) as well as increasing the probability and impact of occurrence of positive events (opportunities) during the project (Borge 2002, PMI 2013).

Given its importance, in the last years, many companies, from different types of industries, have adopted PRM. Using the appropriate tools, PRM provides an effective means for managing a complex project against time, cost and quality non-achievement (Dey 2012).

Also, Elkington and Smallman (2000) claim that PRM is essential for the project's success. They have identified that the most successful projects implemented more RM practices. In fact, the earlier RM is initiated, the more successful a project becomes.

RM process activities and the criteria for choosing among risk techniques have been extensively studied and implemented in both literature and practice. However, these criteria usually do not consider either the characteristics of the project and of its surrounding environment or the attitude of an organisation towards risk (Cagliano, Grimaldi and Rafele 2015).

Despite its strategical importance, PRM diffusion is limited mainly to large companies. The SMEs vulnerability, because of a combination of resource-related constraints (i.e., human, technical and financial constraints), low bargaining power and sensitiveness to business risk and competition, leads to an additional need of PRM adoption (Blanc Alquier and Lagasse Tignol 2006, Dallago, Guglielmetti and Rondinelli 2012).

For SMEs, PRM should be carried out at an early stage in the strategic selection of projects to be implemented, because their success has a great influence on its survival. However, as Vacik, et al. (2018) indicate in their study, only 4% of the companies studied used risk measurement methodologies in their decision making, carrying out the process in a qualitative way.

Moreover, different frameworks of RM are necessary, depending on the size of the project to facilitate the RM application in SMEs (Turner, Ledwith and Kelly 2010). According to Marcelino-Sádaba et al. (2014), SMEs need less bureaucratic PM models, with perhaps a different toolset to traditional versions designed for medium or large projects, which could facilitate the RM throughout the project lifecycle.

The analysis of the six papers about PRM in SMEs in the database revealed that all published papers are empirical studies (i.e., three case studies and three model proposal and testing). Three of these studies were applied in the industrial sector, two were applied in the service sector and one was applied in both sectors. Only half of the papers contemplated all project risk types and, as for the PRM phases, only in two of them all phases were applied, as it has emerged from the content and descriptive analyses. Despite its overmentioned importance, PRM is neither much studied nor

widespread in SMEs (Marcelino-Sádaba, et al. 2014) and, given the abovementioned results, it was possible to conclude that there is a significant gap to be fulfilled with new researches.

2.2 Objective and methodology

The objective of the second phase of this thesis is to understand how to adopt PRM in SMEs with a positive cost-benefit ratio, considering RM phases, activities, tools, instruments, procedures and other organisational aspects that enable the effective implementation of PRM in SMEs. Given the nature of the objective of this research, an exploratory and explanatory research through the multiple case studies methodology has been chosen, as it is the most appropriate one for this type of study (Yin 1994, Voss, Tsikriktsis and Frohlich 2002, Eisenhardt and Graebner 2007).

To achieve this objective, the following specific research questions were formulated:

RQ3. Which are the main RM phases, activities, tools and organizational aspects adopted by SMEs in the PRM process?

RQ4. What are the outcomes and evidences of the PRM adoption in SMEs?

RQ5. Which are the enabling and hindering factors to perform PRM in SMEs?

To conduct the multiple case study regarding the adoption of PRM in SMEs with a positive cost-benefit ratio, an empirical framework of analysis has been specifically developed, which was the objective of this Chapter. To test the validity of this empirical framework and improve it, a pilot case was conducted.

To build the research protocol, firstly, well-known books and significant articles about research methodologies were consulted. After that, consolidated manuals about PM and PRM, as well as empirical papers about the adoption of PRM by different types of companies, were analysed in order to collect the fundamental dimensions to be inserted in the theoretical framework. All the collected information was adapted to the SMEs context and summarised to support the questionnaire creation.

The steps of the methodology, their specific aims and the final questionnaire sections are presented in Figure 16.

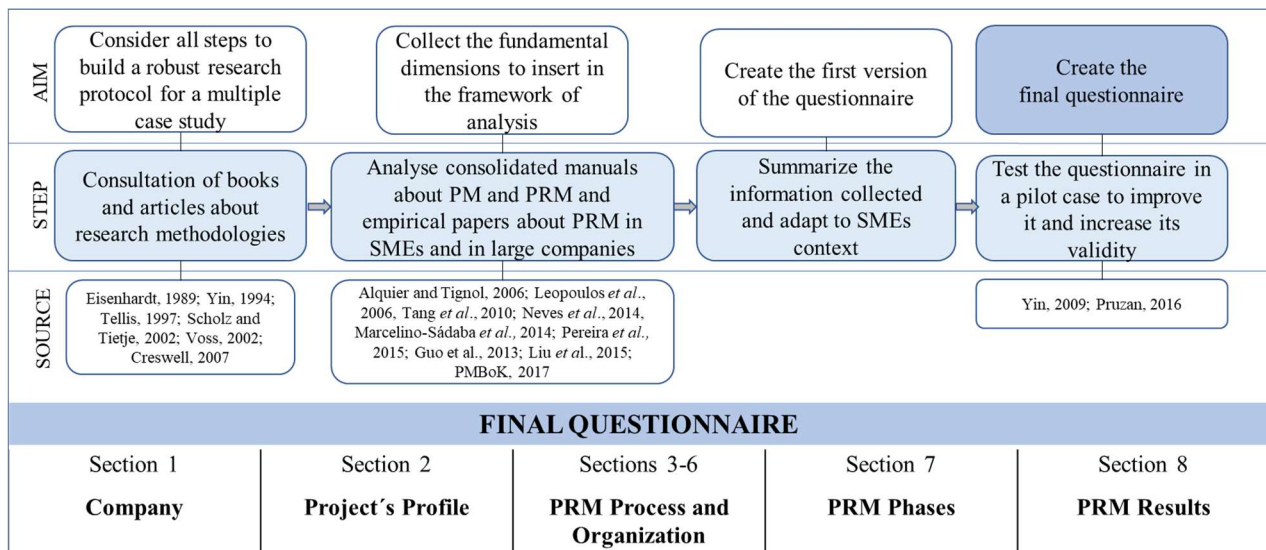


Figure 16: Construction of the research protocol

2.3 The framework for the empirical analysis

2.3.1 Definition of the research protocol and case selection criteria

The final questionnaire, with close-ended, open-ended and perception questions is structured in eight sections: (1) Company and respondents profile; (2) Project overview (i.e., the main characteristics, objectives, type of end-user, innovativeness, complexity and relevance level of the project); (3) PRM process and organisation; (4) PRM identification phase; (5) PRM analysis phase; (6) PRM treatment phase; (7) PRM monitor & control phase; (8) Evidences and outcomes of the PRM adoption (i.e., the benefits, time and costs of PRM implementation, hindering and enabling factors). In each of these sections, the activities performed, the tools and techniques used, the results obtained and the main difficulties encountered are also questioned. The semi-structured interviews, using this questionnaire, are the primary data source of data collection, supplemented with documents related to the project to ensure the construct validity and internal validity (Yin 2009).

The project is the unit of analysis of the research and three characteristics are necessary to fit the selection criteria:

- Project with PRM implementation;
- Cost-benefit ratio of PRM adoption higher than 1;
- Project developed in a European SME.

In order to obtain a broad sample and gain a deeper understanding of the topic of interest in different scenarios, heterogeneity among the cases is necessary. So, besides the requested project's features, projects from different industrial sectors and with different end-users (external or internal) will be selected, in order to guarantee the external validity of the research (Yin 2009).

2.3.2 Case analysis methodology definition

Following the research protocol and according to the specific research purpose and the state of the art of the area of interest, the approach to directed content analysis, which goal is to validate or extend conceptually a theoretical framework or theory (Hsieh and Shannon 2005) using deductive coding will be initially used in the cases analysis.

This approach consists in coding data before and during its analysis. After the initial coding through the semi-structured questionnaires, in order to refine the results, especially those that emerge from the open-ended questions, it is necessary to complete the coding process through a careful analysis of the interviews. As it is indicated by Hsieh & Shannon (2005), since the goal of the research is to identify and categorize all instances of a particular phenomenon, the interviews will be transcribed and inductively coded with descriptive coding and In Vivo coding methods.

All the coding process is done manually. Firstly, segments of data are initially summarized, and, in a second moment, pattern coding was applied. Once this process is completed, the within-case analyses, which will be presented in Section 3.2, are carried on. The main goal of a within-case analysis is to describe, understand and explain what has happened in the single case (Miles and Huberman 1994).

After understanding each case individually, the cross-case analysis (Section 3.3) is performed and, as supported by Myers (2000), partial generalizations to similar populations were made. Through the cross-case analysis it was possible to strengthen a theory, built through examination of similarities and differences across cases. Eisenhardt (1989) and Voss, Tsikriktsis and Frohlich (2002) state that analysing similarities and differences between pairs of cases is a powerful method to better understand the cases and obtain meaningful findings.

Replication strategy will be used during the cross-case analysis. In this strategy, a theoretical framework is applied to study one case in depth, and the successive cases are examined to see whether the pattern found matches that in previous cases (creating a cluster) or not (Yin 2009).

Therefore, both within-case and cross-case analysis of the data were carried on, as they are suitable for multiple case-studies (Eisenhardt 1989, Voss, Tsikriktsis and Frohlich 2002, Yin 2009)

2.4 Testing of the research protocol

The pilot project was selected based on the adoption of PRM by a SME, the type of industry in which it was implemented (i.e., ICT services) and the availability and knowledge of the project manager and other members of the project team. Furthermore, to ensure the project's internal validity through triangulation and to increase data reliability (Voss, Tsikriktsis and Frohlich 2002), the results of the in-depth interviews with multiple respondents were integrated with the analysis of documents related to the PRM plan and outcomes, which were delivered to the researchers.

The project analysed was successfully completed. From the analysis of the PRM, it was possible to grasp interesting evidences about how to successfully adopt PRM in a SME. Firstly, besides all the qualitative benefits obtained from the PRM, it is important to highlight the positive cost-benefit ratio between the RM outcomes and implementation costs, which can motivate the development of RM also in this type of company. Likewise, the study of Fernando et al. (2018) confirmed that PRM is positively related to PM performance.

In more details, the project manager devoted most of its efforts (i.e., in time and depth of the analysis) in identifying and dealing with the risks of project failure during the very early initiation phase of the project, in order to accept it only if project success is likely attended. This is realised in the preliminary analysis with a proactive approach, revealing the company knowledge and awareness that risks may lead to a complete project failure. Moreover, the project's success gave the company the important opportunity of captivating clients in a new market, which was identified and pursued because of the PRM. This result reinforced the affirmation of Carvalho and Rabechini (2015), who stated that PRM can use a mapping method of the threats and opportunities to develop new models. A summary of the main results is displayed in Fig. 17.

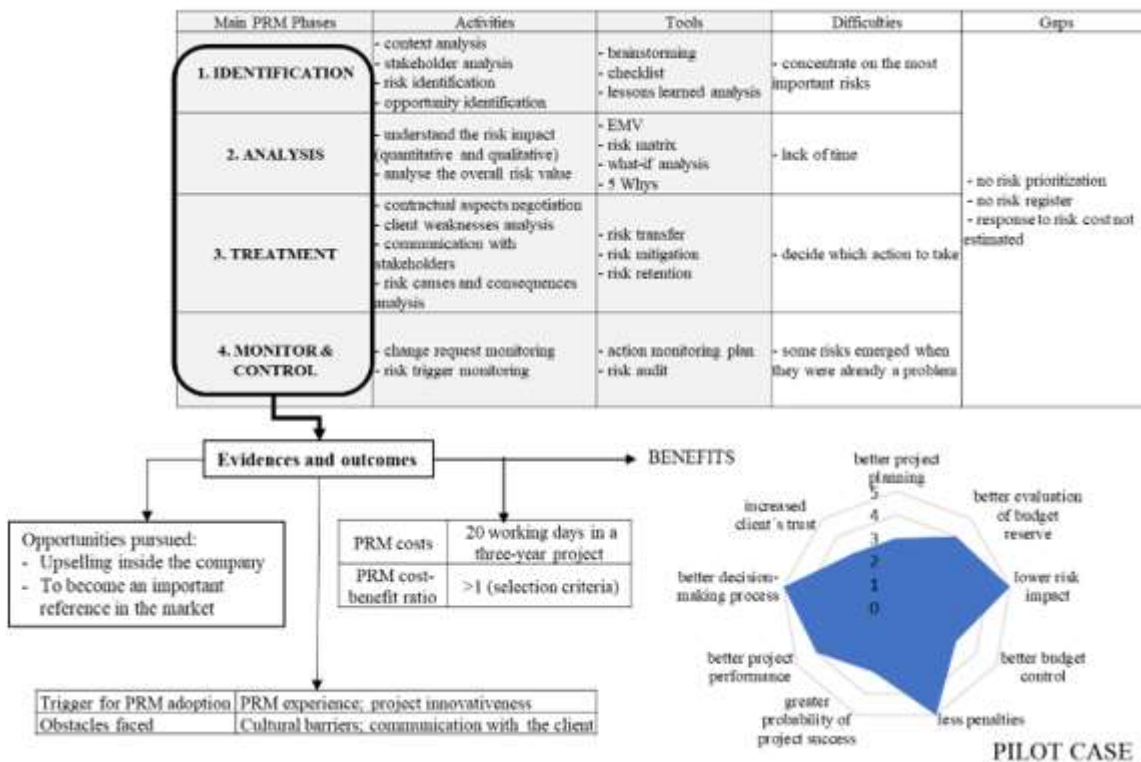


Figure 17: Pilot case results

The company concentrates its efforts in managing the risks of project failure to ensure the success of its projects, which is the main fundamental goal to be pursued through a PRM system, followed by optimising performance and extending a proactive approach to manage the other project risks that, if not carefully managed, often cause an increase in project costs and completion time.

This preliminary analysis also disclosed a positive characteristic of the company that was important for the project: a strategic vision. According to Carvalho and Rabechini (2015), PM needs to be embedded in strategic thinking on project risks to ensure the completion of the PM activities. The entire project team was involved in the PRM, which was also a positive result since, according to Radnor and Walley (2008), the entire staff should be involved and consulted in order to increase motivation and create conditions for a sustainable implementation.

The analysis also revealed that the main difficulties faced in the PRM process were the need of managing risks on the job, the unreliable information given by the client and the attempt to involve the client in the PRM process. Among the weak points, the following were highlighted: the lack of a risk register, the unstructured risk acceptance threshold definition (based on the consultants' feelings and experiences), the unwillingness of the top management to invest more time on PRM, the uncalculated cost of risk response and the absence of a document registering the lessons learned. Therefore, many decisions were purely based on the consultants' knowledge and experiences. When analysing the outcomes of the PRM adoption, the consultants presume that an improvement in the PRM process would significantly affect the benefits obtained.

2.5 Conclusion

In this chapter, the empirical framework has been defined. It was developed specifically for SMEs and successfully tested in the pilot case, allowing researchers to analyse the PRM main dimensions and to determine the cost-benefit ratio connected to its adoption in SMEs.

As it emerged in the literature review, one of the reasons for SMEs to not apply PRM is that CEOs may believe its costs are not justifiable. However, the positive cost-benefit ratio obtained in this project shows that the benefits obtained from the PRM adoption overcome the related costs.

Regarding the practical implications, the pilot case gives an example of an effective and efficient RM in the preliminary phase of project initiating, assuring project success; meanwhile, suggestions to

improve the PRM have been highlighted, in order to improve project performance and fully benefit from the PRM adoption. This initial study has also confirmed that PRM adoption in SMEs is still at early stages, as emerged from the literature (Kim and Vonortas 2014).

Although this is a pilot case, limited to a specific industrial sector, it provided first indications about the PRM adoption in SMEs and verified the validity of and refined the proposed empirical framework by adding the evaluation of the strategic relevance of the project for the company and by classifying the project into internal or external. The final version of the empirical framework was used to conduct the case studies of the next chapter.

CHAPTER 3

RESULTS FROM THE EMPIRICAL ANALYSIS OF PRM IN SMES

After the pilot case, which was explained in detail in Section 2.3.3, ten projects conducted in SMEs were analysed in order to grasp evidence about the adoption of PRM in SMEs. The definition of the sample of cases is presented in Section 3.1. The results from the within-case analyses (Section 3.2) and from the cross-case analysis (Section 3.3) are presented next, while the implications of the clusters identified in the cross-case analysis are discussed in Section 3.4.

3.1 Definition of the sample of cases

The project was the unit of analysis of the empirical research and were selected based on specific selection criteria defined in the empirical framework presented in Section 2.3.

To guarantee the heterogeneity among the cases and the external validity of the research (Yin 2009) and ensure the possibility of generalizations, the projects were screened considering the following characteristics:

- Developed by firms in two different countries;
- Had external or internal end-users;
- Developed in different industrial sectors;
- Conducted in companies with project or process production systems;
- Carried on in micro, small or medium-sized companies.

An overview of the ten selected cases with the main characteristics of the project are displayed on Table 5.

Case	COMPANY				PROJECT			
	Country	Size	Industrial sector	Production system	Client	Length (months)	Total cost	Team (number)
case 1	Italy	small	IT consultancy	project	external	7	€ 60.000,00	7
case 2	Italy	medium	engineering	process	external	18	€ 100.000,00	10
case 3	Italy	medium	IT consultancy	project	external	3	€ 33.500,00	6
case 4	Spain	micro	manufacturing (automotive)	project	internal	24	€ 300.000,00	5
case 5	Spain	small	manufacturing (machining)	process	internal	18	€ 240.000,00	5
case 6	Spain	medium	manufacturing (truck bodies)	process	internal	12	€ 330.000,00	6
case 7	Spain	micro	manufacturing (long boards)	process	external	12	€ 40.000,00	5
case 8	Spain	small	manufacturing (cellulose insulation)	process	internal	11	€ 95.000,00	4
case 9	Spain	medium	management consulting	project	internal	24	€ 500.000,00	3
case 10	Spain	medium	manufacturing (tower cranes)	process	internal	25	NA	15

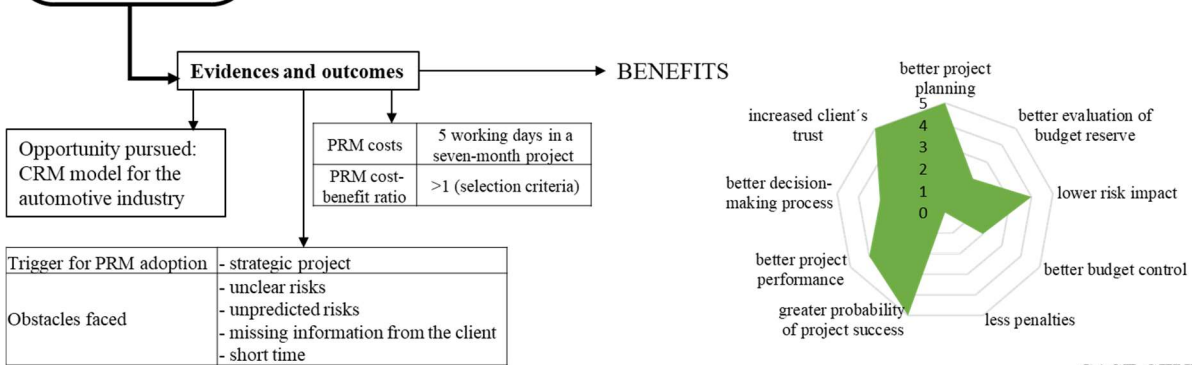
Table 5: Characteristics of the sample of cases

3.2 Results from the within-case analyses

All interviews were conducted on-site and, to avoid bias and ensure the construct's validity (Voss, Tsikriktsis and Frohlich 2002), at least two people who were highly involved in the project were the respondents. The interviews were about 90 minutes in length and were conducted in the respondents' native languages, which incentivized them to give more information about the project, since they felt more comfortable during the process. After a preliminary analysis of the collected data, integrative information was often requested by phone or email. The researchers have also analysed documents related to the project in order to increase data reliability and to ensure the project's internal validity through triangulation (Voss, Tsikriktsis and Frohlich 2002). The interviews were recorded and transcribed for the data analysis.

The within-case analyses allowed the researchers to answer the research questions proposed in Chapter 2. For each case, the results obtained from the questionnaire were carefully analysed. All information collected was organized into tables for the next phase of the data analysis. In addition, a figure with the PRM phases, the activities conducted, the tools used, the difficulties faced in each phase, the gaps in the process and the PRM results was created. Figures 18 to 27 display the results of the within-case analyses for each case study followed by a brief discussion, while the detailed description of all cases is presented in Appendix A.

Main PRM Phases	Activities	Tools	Difficulties	Gaps
1. IDENTIFICATION	- context analysis - stakeholder analysis - risk identification - opportunity identification	- brainstorming - interview with experts - SWOT analysis - 5 Whys	- understand the client's risk	- no risk register - no risk threshold - no response planning - response cost not calculated
2. ANALYSIS	- analyse the risk impact	- 5 Whys - cost-benefit Analysis	- client information not reliable - client expectation - analysis on the job need	
3. TREATMENT	- analysis "on the job" (at occurrence)	- risk transfer - risk Mitigation	- involve the client	
4. MONITOR & CONTROL	- risks are constantly controlled	- change request monitoring - risk trigger monitoring	- lack of time - unforeseen risks - lack of information	



CASE STUDY 1

Figure 18: Within-case analysis of case study 1

In case study 1, a new CRM model was built for an external client. Most of the project's efforts (i.e., in time and depth of the analysis) were devoted to identifying and dealing with the risks of project failure during the very early initiation phase of the project, in order to accept it only if project success is likely attended. This proactive approach revealed the company's knowledge and awareness that risks may lead to a complete project failure. Moreover, the project's success gave the company the important opportunity of captivating clients in a new market, an opportunity that was identified and pursued because of PRM.

Main PRM Phases	Activities	Tools	Difficulties	Gaps
1. IDENTIFICATION	- context analysis - risk Identification	- brainstorming - checklist	- dealing with the client - time constraints	- no risk prioritization - no risk register - response cost not calculated
2. ANALYSIS	- analyse the possible risk impact - based on the experience	- risk matrix	- understand the risk	
3. TREATMENT	- team meeting	- risk mitigation - risk elimination	- decide how to treat the risk - involve the client	
4. MONITOR & CONTROL	- monitoring meeting - risk reevaluation	- risk trigger monitoring	- not understand well the risk - some of the people involved	

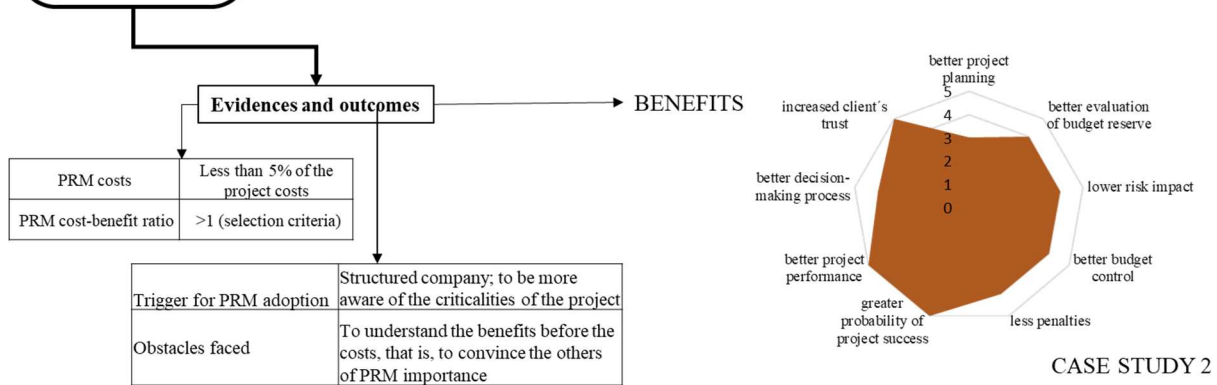
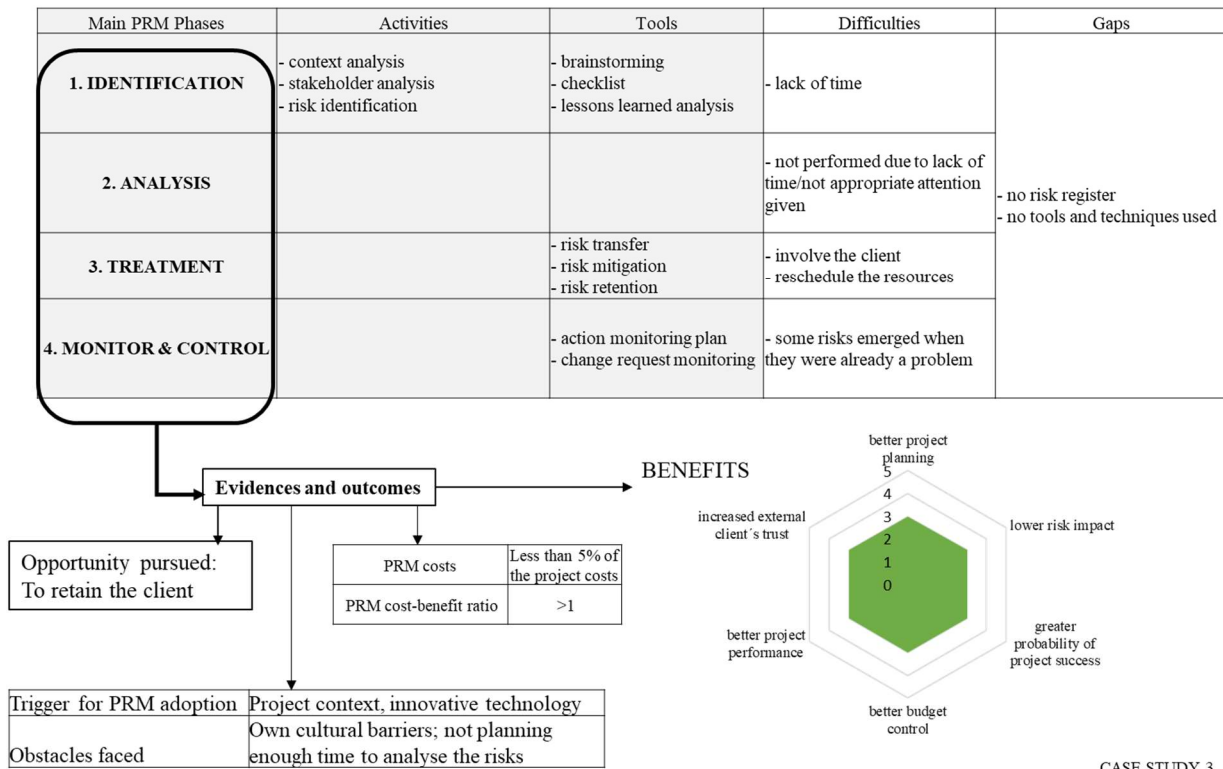


Figure 19: Within-case analysis of case study 2

The project of case study 2 was focused on the construction of a new telephone site. Notwithstanding the lack of a more structured PRM process organization, significant benefits were obtained through PRM adoption. The meetings held along the entire project lifecycle were essential for keeping track of the risks and avoiding problems. The interviewees stated that the difficulty of “well understanding the risks” was due to the number of managers from different areas involved in the PRM process who had different point of views about the risks and, consequently, different concerns regarding the same project milestones.

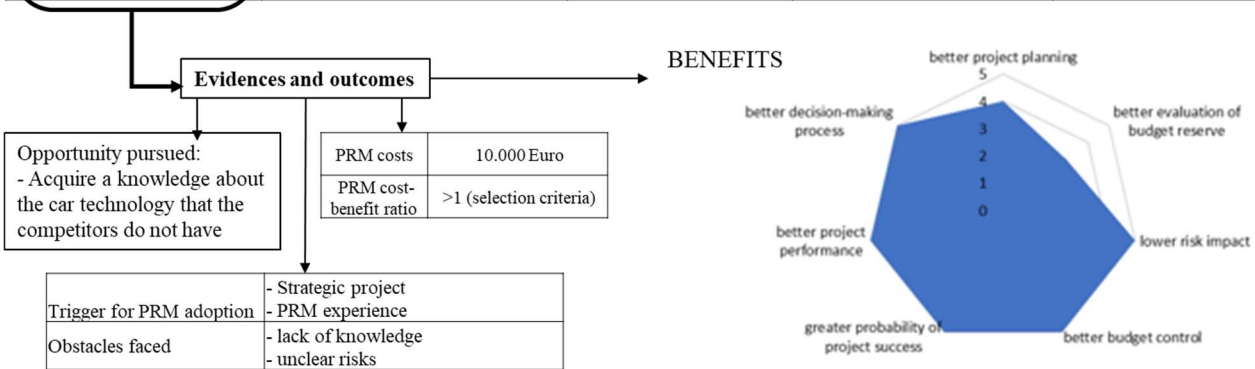


CASE STUDY 3

Figure 20: Within-case analysis of case study 3

The objective of case study 3 (CS3) was to update the technology of the business intelligence platform of an external client. It has emerged that the risk analysis phase was sketchy, reflecting on the project results and the relationship with this external client. The project manager stated that “if you want to do PRM, then you have to do it well, otherwise the time spent on it will be wasted”. The go-live of the project was problematic since the end-users encountered some issues and there were not enough technicians from CS3 company to support them. The difficulties faced during the go-live phase may have jeopardized the opportunity of retaining the client that was being pursued. The project manager stated that “the unpleasant 30-min phone call could have been avoided if a different risk treatment approach had been taken; I have learned the lesson of having more people of my team at the client’s office when the project is delivered.”

Main PRM Phases	Activities	Tools	Difficulties	Gaps
1. IDENTIFICATION	- context analysis - stakeholder analysis - risk identification	- checklist	- understand well the risk	- no risk register - no risk threshold - response cost not calculated
2. ANALYSIS	- meetings	- risk matrix - what-if analysis	- lack of knowledge	
3. TREATMENT	- decide to outsource or not	- risk avoidance - risk mitigation	- technology not well known	
4. MONITOR & CONTROL	- attempts to replicate the problem - periodic monitoring meeting	- risk reevaluation - risk trigger monitoring	- understand well the risk	

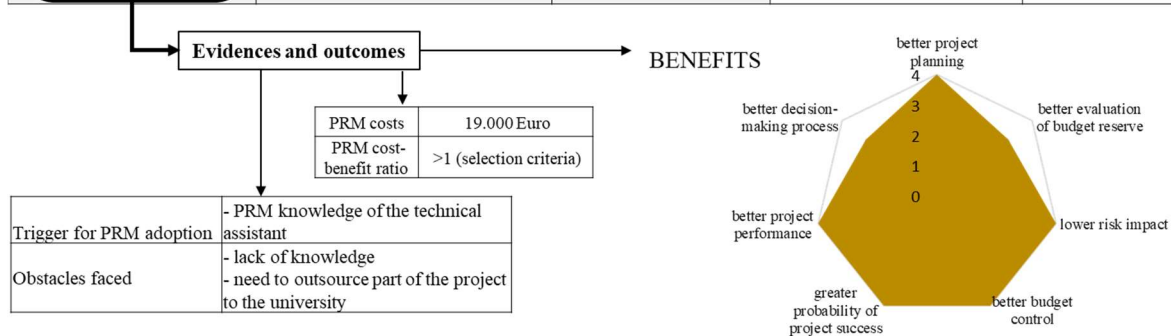


CASE STUDY 4

Figure 21: Within-case analysis of case study 4

In case study 4, a new racing car (EF10) was created. The main lesson learned from this case was to gather as much information as possible about the identified risks and opportunities. Through the execution of this project, the company has learned a new technology that places them in a privileged position in the market, since their competitors do not have the same deep knowledge of this technology as they do now. The communication with the client was the main difficulty faced. One of the interviewees stated that the pilot responsible for testing the car was not able to communicate the problem and the project manager had to perform the test himself in order to understand what the real issue with the engine was. To improve the PRM process in future projects, it is important to define who is accountable for the tests and, moreover, who has the capacity of testing the engine, understand what is affecting its performance and what could be done to improve it.

Main PRM Phases	Activities	Tools	Difficulties	Gaps
1. IDENTIFICATION	- context analysis - stakeholder analysis - risk identification - opportunity identification	- brainstorming - checklist - interview with experts - FMEA - risk register - SWOT - analysis of the root causes	- decide if partially outsource the project or not - deal with technical risks related to the prototype	- no risk owner identified - no risk threshold - response cost not calculated
2. ANALYSIS	- meetings	- risk matrix - risk register - risk ranking	- lack of knowledge	
3. TREATMENT	- plan evaluation activities - changes in the design	- risk avoidance - risk mitigation - risk transfer - risk retention		
4. MONITOR & CONTROL	- action monitoring plan - periodic monitoring meeting	- risk reevaluation - risk trigger monitoring	- lack of knowledge	

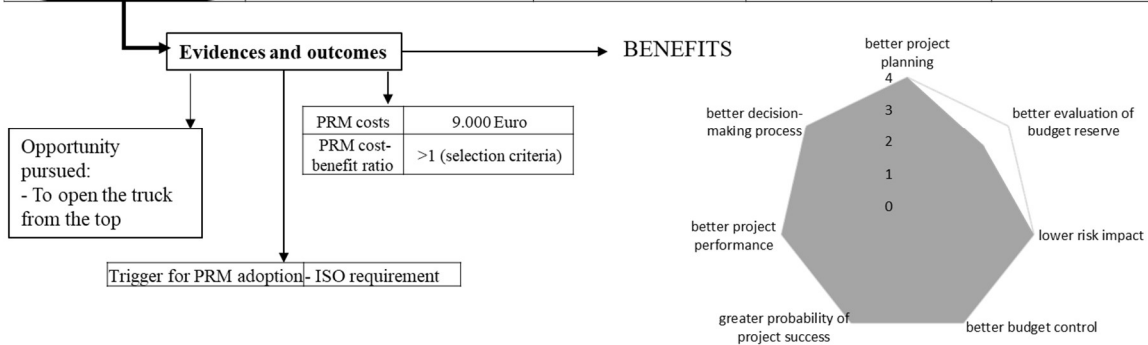


CASE STUDY 5

Figure 22: Within-case analysis of case study 5

A technology for a specific type of axis of big dimensions was developed in case study 5. The main decision faced during the project was related to the outsourcing of the engine’s design to the local university. Based on the risks and the costs, the project manager decided for the outsourcing and, given the positive results obtained, it has proven to be the right decision. In this project, PRM was considered an important decision-making tool to support the team when facing unknown situations. It was also noted that a significant number of PRM tools was used along the process, indicating that since the team did not have much experience on PRM, they tried to use different tools in order to identify all possible risks and evaluate the different possibilities to deal with them.

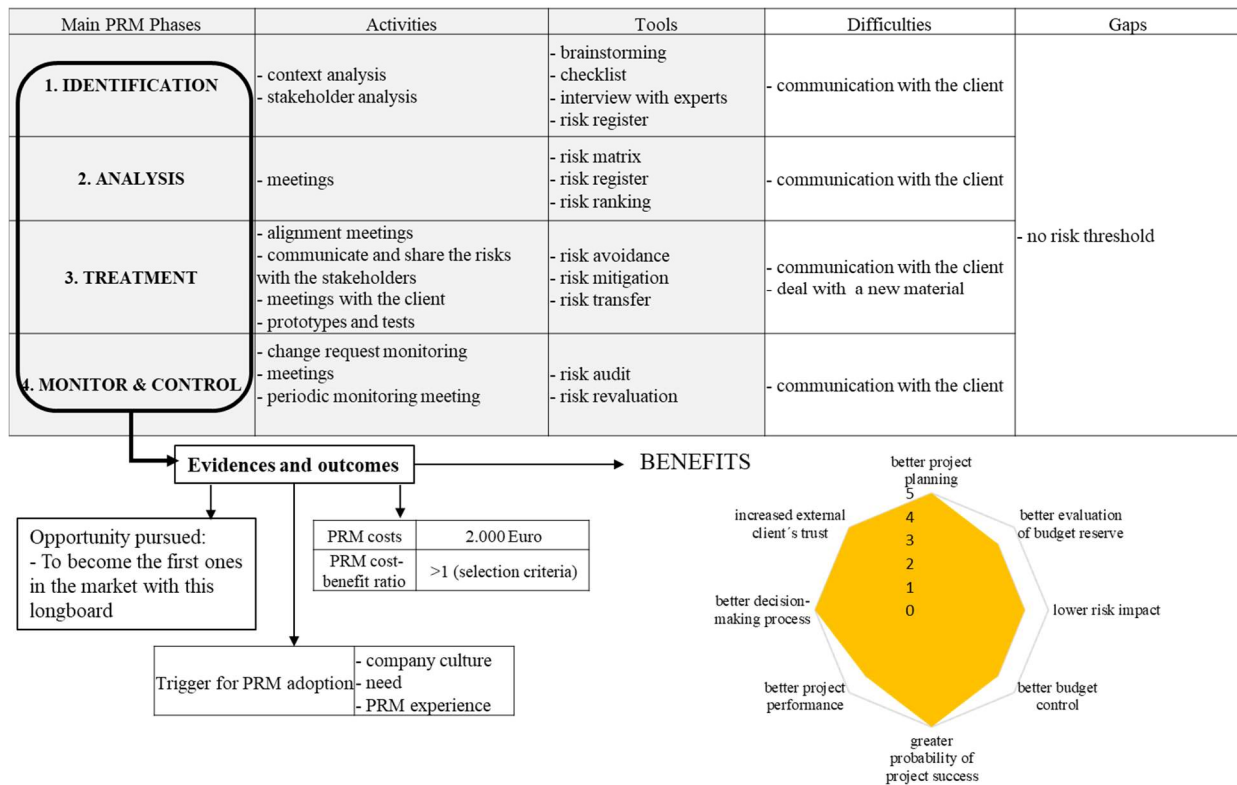
Main PRM Phases	Activities	Tools	Difficulties	Gaps
1. IDENTIFICATION	- context analysis - stakeholder analysis - risk identification - opportunity identification	- brainstorming - checklist - risk register	- lack of technical knowledge	- no risk prioritization - no risk threshold - no risk treatment planning - response cost not calculated
2. ANALYSIS	- meetings	- risk matrix - risk register - risk ranking	- not being able to predict how the risk would most likely occur	
3. TREATMENT	- changes in the design - communicate and share the risks with the stakeholders - prototypes and tests	- risk avoidance - risk mitigation		
4. MONITOR & CONTROL	- periodic monitoring meeting	- risk audit - risk reevaluation		



CASE STUDY 6

Figure 23: Within-case analysis of case study 6

Case study 6 involved the construction of a truck body to transport cattle. Before this project, the company had never built truck bodies to transport live animals. The main risk faced was related to the construction of the ramp for the animals to enter the truck. Regardless all the ramp prototypes that were built, the animals were not able to enter the truck without sliding, so additional readjustments had to be carried on in order to build a safe ramp. The project manager stated that additional attention must be paid when dealing with animals.

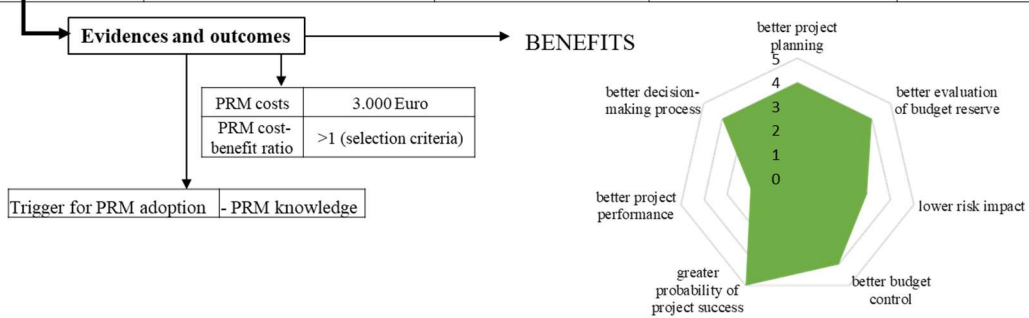


CASE STUDY 7

Figure 24: Within-case analysis of case study 7

A new longboard, with different specifications from those that exist in the market, was the objective of the project of case study 7. The specifications of the client, a world-famous longboard rider, were not very clear and his feedback after testing the prototypes was not always precise, becoming a difficulty during the project. This case has shown that when dealing with an external client, the communication becomes a crucial factor for the project's success. Several times, the project team had to guess what the client really wanted or expected from the product. PRM was very useful to deal with this situation, which was all documented. The project manager believes that "everything that is not documented does not turn out well".

Main PRM Phases	Activities	Tools	Difficulties	Gaps
1. IDENTIFICATION	- context analysis - risk identification - stakeholder analysis	- brainstorming	- lack of technical knowledge	- no risk register - no risk threshold - roles in PRM not clearly assigned
2. ANALYSIS	- activities to prevent any anomalies/criticities that may occur - meetings - tests	- risk matrix - risk ranking	- lack of knowledge	
3. TREATMENT	- root cause analysis - what-if analysis	- risk mitigation - risk transfer	- deal with a new material	
4. MONITOR & CONTROL	- meetings - periodic monitoring meeting	- risk reevaluation	- lack of information/knowledge	



CASE STUDY 8

Figure 25: Within-case analysis of case study 8

The objective of the project of case study 8 was to fabricate white insulation. This was an innovative project for the company, since it has always produced grey insulation using recycled newspaper as raw material. The team had no knowledge about the materials and products to use in order to obtain the white insulation, but initially they thought this information could be easily acquired, which turned out to be a wrong assumption. After many tests and benchmarking, the project was successfully completed, but the project manager stated that in a next innovative project, he would like to know better the details of the process before starting it.

Main PRM Phases	Activities	Tools	Difficulties	Gaps
1. IDENTIFICATION	- context analysis - risk identification - stakeholder analysis	- brainstorming - checklist - risk register	- find the appropriate SW supplier - lack of technical knowledge - understand well the risk	- no risk threshold
2. ANALYSIS	- meetings	- risk matrix - risk ranking - risk register		
3. TREATMENT	- redefine specifications - control the team - choose company to transfer the risk to	- risk avoidance - risk mitigation - risk transfer	- communication with the supplier	
4. MONITOR & CONTROL	- action monitoring plan - change request monitoring - periodic monitoring meeting	- risk audit - risk reevaluation	- lack of time - lack of knowledge regarding the ERP system	

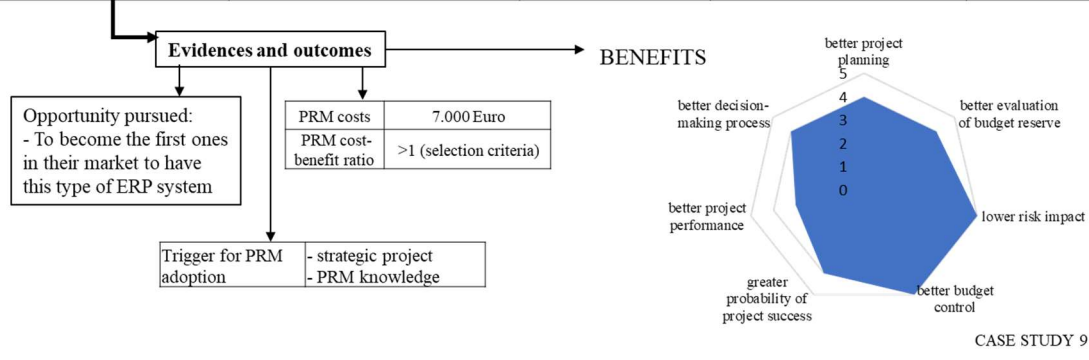
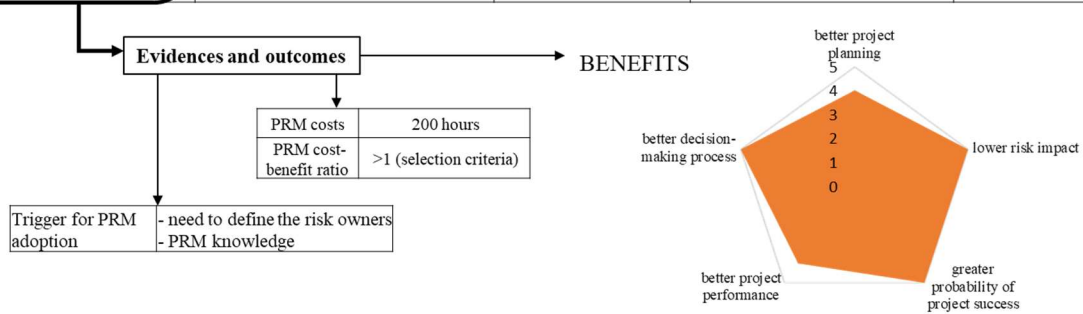


Figure 26: Within-case analysis of case study 9

Case study 9 consisted of developing a new ERP tool to manage the company’s projects and activities. The particularity of this case is related to the change in the scope that occurred 12 months after the beginning of the project, which lasted 24 months. The uncertainties related to the ERP software and its development by a supplier led to a request of a budget increase. The project had turned out to be difficult both for company and for the supplier, but the constant control of the risks and activities performed led to the project’s success.

Main PRM Phases	Activities	Tools	Difficulties	Gaps
1. IDENTIFICATION	- risk identification	- interview with experts - risk register	- availability of the experts from other areas - time negotiation between the PM and the directors regarding the deliverables	- no budget control - no opportunities considered - no risk threshold
2. ANALYSIS	- meetings - to understand the real risk impact and probability of occurrence	- risk matrix - risk register	- to understand the details of the information provided by different areas and put them together	
3. TREATMENT	- alignment meetings	- risk avoidance - risk mitigation - risk retention - risk transfer	- lack of time	
4. MONITOR & CONTROL	- action monitoring plan	- risk reevaluation		



CASE STUDY 10

Figure 27: Within-case analysis of case study 10

The project of the last case study was the construction of a tower crane with a new PLC system control. At the beginning of the project, the project manager gathered information from different sectors about the project risks and created a risk register which he was constantly updating. According to him, the identification of the risk owner was crucial for the project's success, since to each person specific responsibilities were assigned. The constant update of the risk register was important for the project to be delivered on time and be successful.

Based on the outcomes of the within-case analyses, the main activities performed and the main tools used in each phase of the PRM process were individuated as it follows:

- Phase 1: the main activities are context analysis, risk identification, stakeholder analysis and opportunity identification, and the main tools are brainstorming, checklist, risk register, interview with experts, SWOT analysis, FMEA, 5 Whys and root-cause analysis;
- Phase 2: the main activities are meetings, design-relates activities and tests, and the main tools are risk matrix, risk register, risk ranking, 5 Why and EMV (expected money value);

- Phase 3: the main activities are communication/meetings, design/specification changes, outsourcing decisions, prototypes testing, team monitoring and analysis on the job, and the main tools are risk mitigation, risk transfer, risk avoidance and risk retention;
- Phase 4: the main activities are risk reevaluation, periodic monitoring meeting, action monitoring plan, meetings and problem replication, and the main tools are change request monitoring, risk trigger monitoring and risk audit.

These results are summarized in Figure 28.

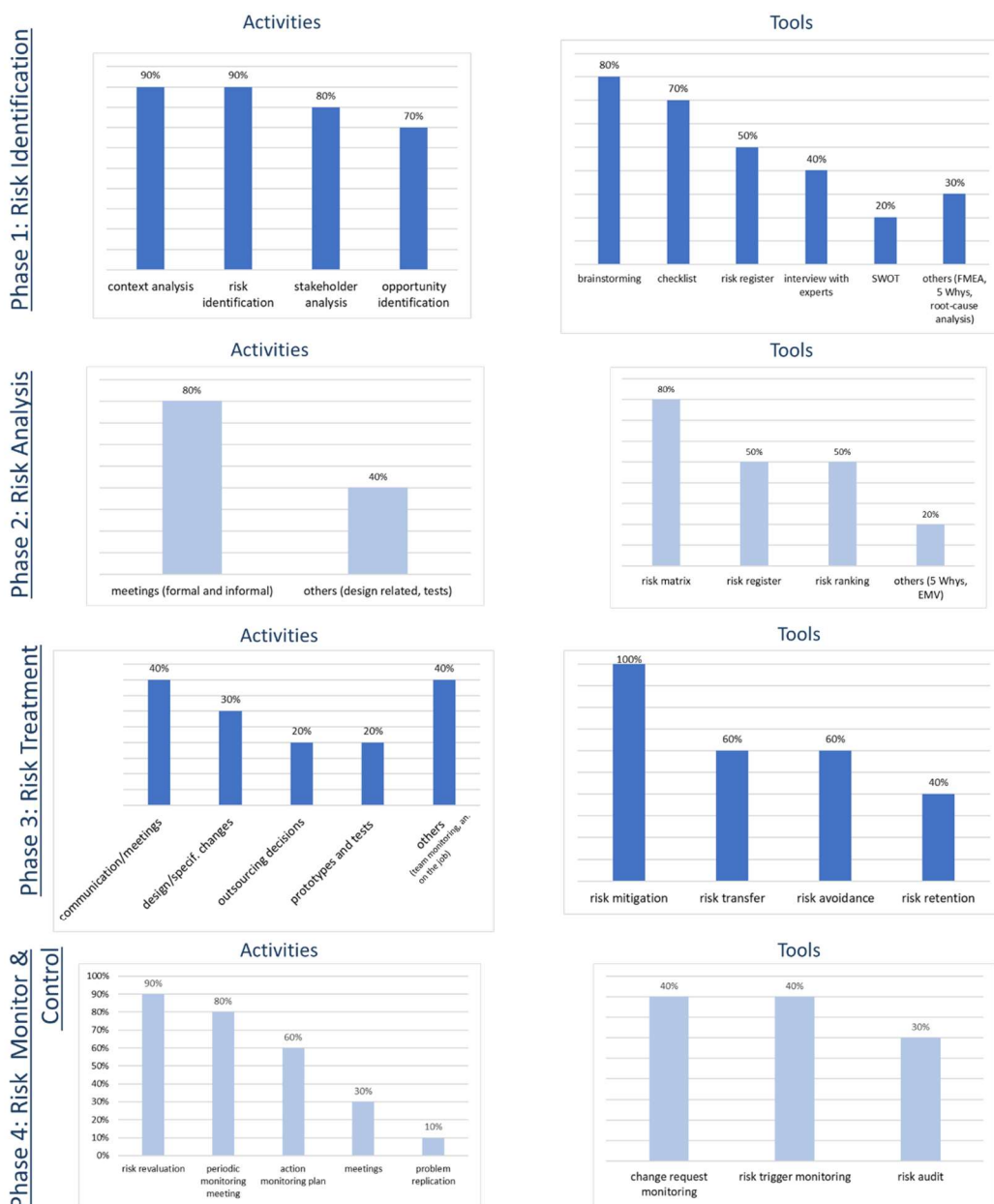


Figure 28: PRM Phases, activities and tools

As for the organizational aspects related to PRM adoption, the following descriptive variables were analysed:

- Responsible for PRM implementation (who)
- People involved in the PRM process (which roles)
- Roles in PRM clearly assigned (yes/no)
- Internal PRM procedures adopted in the project (yes/no)
- PRM training plan for the people involved in the project (yes/no)

In all cases, the project manager was the responsible for the PRM implementation process. In some of the cases, members of the team or a PM consultant or function manager was involved. In eight cases, the roles in the PRM process were clearly assigned, and in seven cases, the internal PRM procedures were followed, while PRM training was conducted in only two cases. Table 6 presents the organizational aspects in detail.

Organizational Aspects	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Case 10
Responsible for PRM	PM	PM	PM	PM	PM	PM	PM	PM	PM	PM
People involved in the PRM process	PM and his assistant in all phases, and the sales rep. in phases 1,2 and 4 also	PM and area managers	PM, project architect and PM consultant	CEO and PM consultant	CEO and PM consultant	technical director and PM consultant	team and PM consultant	CEO and PM consultant	PM and innovation manager	PM
Roles in PRM clearly assigned	yes	yes	no	yes	yes	yes	yes	no	yes	yes
Internal PRM procedures adopted in the project	yes	no	no	yes	yes	yes	yes	no	yes	yes
PRM training plan for the people involved in the project	yes	no	no	no	no	no	yes	no	no	no

Table 6: Organizational aspects

The innovation, complexity and relevance of the projects were also assessed. Using a 5-point Likert scale, the interviewees were questioned about the project's technologic innovativeness, innovativeness for the market, project management complexity and strategic relevance. On average, the innovativeness for the market and the PM complexity were medium-high, while the project technologic innovativeness was high and the strategic relevance of the projects was even higher. The detailed results indicating a high level of innovativeness and complexity in the projects are shown on Table 7.

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Case 10	average
project technologic innovativeness	5	2	4	5	4	4	5	4	5	3	4,1
innovativeness for the market	2	2	2	5	4	4	5	4	5	3	3,6
project management complexity	3	5	4	4	4	3	3	3	4	2	3,5
strategic relevance	5	5	5	5	5	4	5	3	5	4	4,6
average	3,8	3,5	3,8	4,8	4,3	3,8	4,5	3,5	4,8	3,0	4,0

Table 7: Project innovativeness, complexity and relevance

In the final section of the interview, the main outcomes and evidence of the PRM process were discussed. A list of benefits than can be obtained through the implementation of PRM was created by the researchers. Using a 5-point Likert scale once again, the interviewees were asked about their perception regarding the achievement of these seven benefits (eight in the cases with an external end-user) through PRM adoption. Their perception was very satisfactory, as it can be depicted from Table 8.

Perceived benefits (1 to 5)	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Case 10	avg
greater probability of project success	5	5	3	5	4	4	5	5	4	5	4,5
increased external client's trust	5	5	3	-	-	-	5	-	-	-	4,5
better decision-making process	3	4	-	5	3	4	5	4	4	5	4,1
lower risk impact	4	4	3	5	4	4	4	3	5	5	4,1
better project planning	5	3	3	4	4	4	5	4	4	4	4,0
better budget control	2	4	3	5	4	4	4	4	5	-	3,9
better project performance	4	5	3	5	4	4	4	2	3	4	3,8
better evaluation of budget reserve	2	4	-	3	3	3	4	-	4	-	3,3
average	3,8	4,3	3,0	4,6	3,7	3,9	4,5	3,7	4,1	4,6	4,0

Table 8: Benefits obtained through PRM adoption

In addition to the benefits obtained through PRM, other important evidence emerged from the results. In all cases, PRM was considered useful, and the time/cost spent on its implementation was justified by the benefits, as required by the selection criteria. The interviewees of six projects believe that PRM should be adopted in all of the company's projects. In another two interviews, the respondents stated that PRM should be implemented in all innovative projects, while in the other two cases, the interviewees affirmed that the PRM process should be carried on in the strategic projects. Table 9 displays the evidences from the results for each case.

Evidences from the results	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6	Case 7	Case 8	Case 9	Case 10
PRM implementation time/cost	€ 3.000	€ 4.000	€ 3.000	€ 10.000	€ 19.000	€ 9.000	€ 2.000	€ 3.000	€ 7.000	25 man-days
Time/cost justified by the benefits	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
PRM useful in the project	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Types of projects to adopt PRM	all	all	new clients; high visibility projects with innovative technology	possible generation of strategic risks for the company	all innovative projects	involvement of new product design with significant outsourcing activities	all	all	all; if not possible, at least the strategic projects	all
Opportunities considered	yes	yes	yes	yes	no	yes	yes	no	yes	no

Table 9: Evidences from PRM adoption

The last research question concerned the enabling and hindering factors for companies to adopt PRM. The respondents have pointed out the following as the enabling factors: previous PRM experience; support of a PM consultant with PRM experience; having a strategic/innovative project (which stimulates PRM adoption); a PRM report requested by the government/project financier; and stakeholder support. In terms of the hindering factors, it has emerged that difficulties in the communication with the external client, lack of support from CEO/stakeholders (i.e., no recognition of PRM importance for the project's success) and PRM being seen as a "waste of time" by some of the people involved in the project are the most significant issues.

3.3 Results from the cross-case analysis

After performing the within-case analysis for each of the selected cases, the cross-case analysis was conducted. Considering the level of benefits that the projects have achieved through the PRM implementation and the project characteristics, the projects were clustered into three different groups identifying different patterns:

- Group 1: very high level of benefits (cases 4, 7 and 10)
- Group 2a: high level of benefits – manufacturing (cases 1, 2 and 9)
- Group 2b: high level of benefits – services (cases 5, 6 and 8)

Case 3 is the only one that has obtained a medium level of benefits and therefore was excluded from the clusters.

In group 1 (very high benefits achieved), similarities in the project context and PRM organization were acknowledged, and the same project risk types were identified, using common tools and performing the same activities. The risks were constantly measured during the projects, and the project manager was responsible for PRM. A consultant with PRM experience in the micro and small company, and a project manager with significant PRM experience, were crucial for achieving very high benefits.

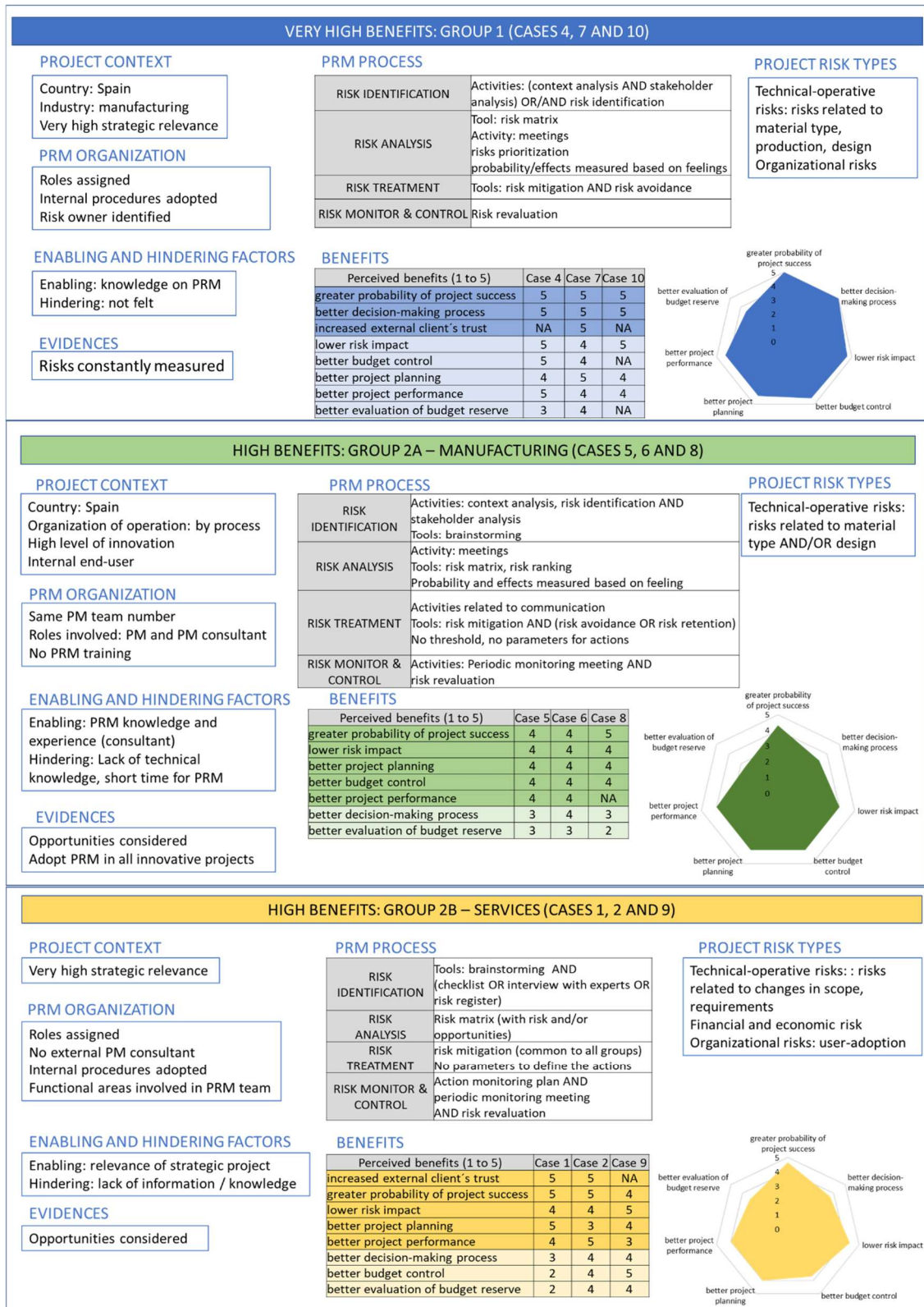
Six other cases have reached a high level of benefits and, based on the project context characteristics, were split into two groups: manufacturing (group 2a) and services (group 2b).

In the first group, composed of the manufacturing cases, projects have a very high level of innovation and complexity, and the contexts in which they exist are extremely similar. The roles involved in the projects were the same (project manager and project manager consultant), and the same project risks were identified. Several common activities were conducted, and common tools were used in the first three PRM phases.

The project risk manager's knowledge and experience enabled the team to adopt PRM, notwithstanding the fact that in all cases, difficulties were faced due to the lack of knowledge about some project details at the outset. Interesting evidence has emerged in these cases, with opportunities considered and pursued, and the risk register being constantly updated, as the most significant pieces of evidence.

The third group is formed by three services companies with a very high standard of PRM organization. In contrast to the previous groups, more project risk types were considered in these cases (three in total), which led to the individuation of specific risks in all projects. Similarities are identified in the PRM process, which was slightly adapted in each of the cases. Their strategic relevance has triggered the project managers to adopt PRM, regardless their lack of information or

knowledge about the difficulties to be faced. While identifying the risks, the opportunities were also considered in all cases. Figure 29 summarizes the characteristics of the clusters.



The project studied in case 3 reached a mid-range level of benefits. Regardless of the project's high level of innovativeness and medium-high level of project management complexity, no PRM roles were assigned, no internal procedures were followed and no PRM training was conducted, indicating a poor level of organization in both cases. The risk analysis was performed sketchily, and there were issues during the "go-live" phase of the project. According to the project manager, "PRM has to be well implemented, otherwise the time dedicated to it will be a waste". Therefore, in this case, PRM was adopted, and the results were positive, but it is likely that with a better PRM approach, the project would have obtained higher benefits. Given the specific characteristics of the case and the impossibility of replicating the results, this project was not clustered.

3.4 Discussion

According to Myers (2000), partial generalizations can be made to similar populations.

In particular, in all ten cases, characterized for the selection criteria adopted by time/cost spent on PRM justified by the benefits obtained, the following common features emerged:

- the project manager was responsible for the PRM implementation;
- all PRM phases were followed, but in two cases the risk analysis phase was not fully implemented;
- only technical-operative risks were considered and identified in all projects;
- the risk matrix and risk mitigation tools were used in the risk analysis and in the risk treatment phases, respectively, and the risk revaluation activity was performed during the risk monitor and control phase; and
- when analysing the context in which the projects existed, it emerged that all the projects have either a very high strategic relevance or a high level of innovation.

At the end of all projects, PRM was considered useful for the project's success.

Comparing the clusters, the following conclusions can be drawn. Either internal PRM procedures were adopted, or a PM consultant with PRM experience was involved in the process, assuring the success of its adoption and high levels of benefits. The cases confirm what was pointed out in the literature review – that PRM is usually carried out in person by the project manager.

As for the PRM organization, the combination of assigning roles in the PRM process, adopting internal procedures and identifying the risk owner is a distinctive feature of the first cluster, in which all projects have achieved very high benefits. In cluster 2a, the roles were not assigned, and no internal procedures were adopted, but there was a consultant with PRM experience, which led these projects to obtain a high level of benefits. Therefore, the identification of the risk owner and the identification of internal PRM procedures, or the involvement of a PM consultant with PRM experience, seem to be necessary aspects to ensuring PRM adoption. In the cases in which there was not a minimum level of knowledge about PRM, the project managers have asked for external support. However, the best option is still to have the knowledge inside the company: in cluster 1, the PRM knowledge was internal; in cluster 2a, it was external; and in cluster 2b, it was internal but less consolidated than in the cases of the first cluster.

Regarding cluster 2b, the collaboration of other functional areas with the PRM team led to the consideration of more project risk types. In particular, three types of risk were considered in these projects, indicating a more comprehensive approach of the project context, since more functional areas were involved in the PRM team in these cases. It can also be assumed that the service industry, in which all projects of this cluster exist, is more aware of the context of the project than the manufacturing industries, due to the higher involvement of the project stakeholders.

In manufacturing projects in which the strategic relevance was not very high (cluster 2a), only technical-operative risks were considered, while in cluster 1 (manufacturing cases with very high strategic relevance), the organizational risk types were also taken into consideration. Therefore, in

manufacturing projects, technical operative risks are the primary risks, but if they are strategically relevant, organizational risks must also be considered.

Another positive result from the PRM process is that in clusters 2a and 2b, the opportunities are also being considered, indicating a more holistic approach towards risks.

Several differences were identified among the clusters when analysing the PRM process phases. The studied literature indicates that PRM must be systematic and continuous throughout the project's lifecycle in order to be successful, which is confirmed in the cases.

During the risk identification phase of the Spanish projects' implementation (clusters 1 and 2a), many meetings were held, and the risks were constantly measured. In most of these cases, PRM was stimulated by the government, which has facilitated its adoption, since the project managers had to deliver to the government a report about the project evolution every six months. During this phase, cluster 2a was the one in which the projects had more activities in common among them (context analysis, risk identification and stakeholder analysis).

Meetings and measurement of risk probability of occurrence, as well as effects based on feelings, were adopted by the manufacturing clusters (1 and 2a) during the risk analysis phase. Risk prioritization and the constant measurement of risks were important to achieving the highest level of benefits (cluster 1). The risk matrix was used in this phase in all cases and served as a basis for risk prioritization in cluster 1.

During the risk treatment phase, two tools were used in the manufacturing clusters: risk mitigation and risk avoidance. In some cases, instead of risk avoidance, the risk retention tool was used. In cluster 2b, only the risk mitigation tool was adopted. Except for the risk revaluation activity in the risk monitor and control phase, in the projects of clusters 2a and 2b, additional activities common to all projects inside the cluster were followed.

The interviewees reported they intend to adopt PRM in the future projects of the company; in cluster 2a in particular, project innovativeness will be the trigger for PRM adoption in future projects.

Regarding the hindering and enabling factors for PRM adoption, the support inside the company to conduct the PRM process and the client cooperation – when needed – are considered crucial factors for successful PRM implementation. In the projects of cluster 1, the company's higher-level management did not interfere in the project managers' decisions about PRM, so the interviewees have not felt any hindering factors during the PRM adoption. Significant hindering factors include the lack of information about the service to be provided or about the technical specifications of the process that are needed to develop a product.

Figure 30 presents a comparison between the clusters according to the variables related to PRM and the benefits obtained.

VERY HIGH BENEFITS GROUP 1	HIGH BENEFITS GROUP 2A – MANUFACTURING	HIGH BENEFITS GROUP 2B – SERVICES
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PROJECT CONTEXT			PRM ORGANIZATION		
Spain Very high strategic relevance Manufacturing Ind.	Spain Organization: by process High level of innovation Internal end-user	Italy and Spain Very high strategic relevance	Roles assigned Int. procedures adopted Risk owner identified	Same PM team number Roles involved: PM and PM consultant No PRM training	Roles assigned Int. procedures adopted No ext. PM consultant Functional areas involved in PRM team
PM responsible for PRM					

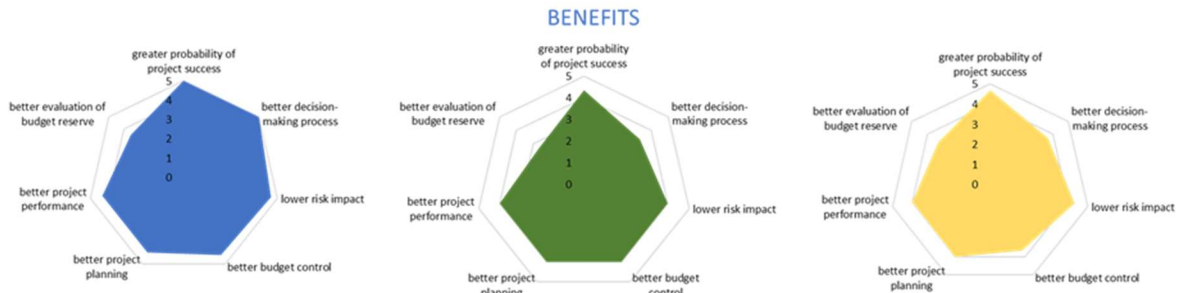
PROJECT RISK TYPES CONSIDERED AND IDENTIFIED		
Technical-operative risks: risks related to material type, design, production Organizational risks	Technical-operative risks: risks related to material type AND/OR design	Technical-operative risks: risks related to changes in scope, requirements Organizational risks: user-adoption Financial and economic risks
Technical-operative risks considered No political, no contract risks considered		

ENABLING AND HINDERING FACTORS		
Enabling: PRM knowledge Hindering: not felt	Enabling: PRM knowledge and experience (consultant) Hindering: Lack of technical knowledge, short time for PRM	Enabling: relevance of strategic project Hindering: lack of information/ knowledge

PRM PROCESS			
RISK IDENTIFICATION	Activities: (context analysis AND stakeholder analysis) OR/AND risk identification	Activities: context analysis AND risk identification AND stakeholder analysis	
		Tool: brainstorming	Tools: brainstorming AND (checklist OR interview w/ experts OR risk register)
RISK ANALYSIS	Activity: meetings	Activity: meetings	
	Tool: risk matrix*	Tools: risk matrix* AND risk ranking	Tool: risk matrix* (with risk and/or opportunities)
	Risks prioritization Probability/effects measured based on feelings	Probability/effects measured based on feelings	
RISK TREATMENT		Activities related to communication	
	Tools: risk mitigation* AND risk avoidance	Tools: risk mitigation* AND (risk avoidance OR risk retention)	Tool: risk mitigation*
		No threshold, no parameters for actions	No parameters for actions
RISK MONITOR & CONTROL	Activity: risk reevaluation*	Activities: periodic monitoring meeting AND risk reevaluation*	Activities: Action monitoring plan AND periodic monitoring meeting AND risk reevaluation*

* Common element

EVIDENCES		
Risks constantly measured	Opportunities considered Adopt PRM in all innovative projects	Opportunities considered



*The benefit of increasing the external client's trust through PRM is not displayed in the graphs since not all projects had an external end-user. Nevertheless, it is important to highlight that in all cases with an external end-user, this benefit was rated as 5.

Figure 30: Comparison of PRM implementation between the clusters

CHAPTER 4

DISCUSSION AND CONTRIBUTION

In Chapter 4, a final discussion of the findings obtained is presented, starting from and the answers to the research questions (Section 4.1); validity, reliability and limitations of the research are reported in Section 4.2, the academic and managerial contribution are presented in Section 4.3 and the future research opportunities conclude the chapter in Section 4.4.

4.1 Findings from the analyses

The findings confirmed what had emerged from the literature. In the study of Vacík et al. (2018), 96% of the analysed companies carried out the RM process in a qualitative way, which indicates that usually no quantitative methods are used. This tendency was confirmed in this thesis, since in all the studied cases the risk analysis was only qualitative.

Many studies about PRM in SMEs, as the ones of Sharif and Rozan (2010) and of Pereira et al. (2015), state that RM is generally carried out in person by the project manager due to the high cost of the tool and the need for qualified staff to perform it. Also this statement was confirmed, as in all ten cases, the project manager was responsible for the PRM implementation and simple tools were used.

According to Pellerin and Perrier (2019), one of the biggest issues in performing PRM is the lack of systematic risk identification methods for specific project types based on lessons learned from similar projects. In most of the cases considered in this study, no meetings to discuss the lessons learned were held, and therefore no methods for systematic risk analysis were created. Nevertheless, it is expected that the indications that emerged from this study – about tools and activities to be performed during the risk identification phase and the following PRM phases – can be relevant for developing structured and efficient PRM implementation in SMEs.

In the following subsections, all the research questions that were answered in the previous chapters will be recalled in order to summarize the results obtained through the different analyses conducted.

4.1.1 The development of RM in SMEs (RQ1)

Through the systematic literature review developed in Chapter 1, it was possible to map the development of RM in SMEs comparing two periods: from 1994 until 2006 and from 2007 until 2016. The analyses have shown that the interest for the theme has grown along the years, but it is still not well deepened. More specifically, in the first period, the studies were focused on financial and operational risks, and first studies about strategic risks, ERM stream and PRM stream were conducted. In the second period, the ERM stream has become a central theme, while PRM, SCRM and SRM streams were the emerging ones, with more opportunities for future research.

4.1.2 The state of the art in RM for SMEs, the conceptual structures and the key research streams of RM in SMEs (RQ2)

There are still many gaps in the literature of RM in SMEs, despite the importance of the theme.

The most studied stream is the ERM one, but it is still not completely developed, since it is more concentrated on the operational risks, and not on all of them as it should be expected. The FRM stream is significantly developed, but mainly restricted to the banking sector and, in addition to that, only the financial risks tend to be considered when it is implemented.

The PRM stream and the strategic risks also came to be a central theme along time, but still with an intermediate level of development. Together with the SCRM and the SRM streams, the PRM stream is pointed out as an emerging field. The SCRM is more focused on the operational risks and the SRM considers mainly the strategic ones. On the other hand, in three studies about the PRM stream all risk types were analysed, which is a significant result since it is a particularly important stream and an integral part of PM processes.

4.1.3 The main RM phases, activities, tools and organizational aspects adopted in the PRM process in SMEs (RQ3)

Using the selection criteria presented in Chapter 2 (project developed in a SME in which PRM was adopted with a positive cost-benefit ratio) and thanks to the heterogeneity among the cases based on the variables defined in Chapter 2 (different countries, internal or external end-users, different industrial sectors, project or process production systems, different company size), it was possible to replicate and generalise the results obtained. The generalisation of these results have led to the answer of the third research question.

The main activities performed in each PRM phase were:

- Risk identification phase: context analysis, risk identification, stakeholder analysis and opportunity identification;
- Risk analysis phase: meeting, design-relates activities and tests;
- Risk treatment phase: communication/meetings, design/specification changes, outsourcing decisions, prototypes testing, team monitoring and analysis on the job;
- Risk monitor & control phase: risk reevaluation, periodic monitoring meeting, action monitoring plan, meetings and problem replication.

As for the tools, the main ones used in each phase were:

- Risk identification phase: brainstorming, checklist, risk register, interview with experts, SWOT analysis, FMEA, 5 Whys and root-cause analysis;
- Risk analysis phase: risk matrix, risk register, risk ranking, 5 Why and expected money value;
- Risk treatment phase: risk mitigation, risk transfer, risk avoidance and risk retention;
- Risk monitor & control phase: change request monitoring, risk trigger monitoring and risk audit.

SMEs manage project risks using simple tools and carrying on well known activities in most of the cases.

Regarding the second part of the third research question, the organizational aspects related to the adoption of PRM in SMEs were:

- the project manager was the responsible for PRM implementation in all cases;
- Besides the project manager, the roles of the other people involved in the PRM process were area manager, project manager consultant, innovation manager, project architect, CEO and sales representative.

4.1.4 The outcomes and evidences of the PRM adoption in SMEs (RQ4)

The perception of the interviewees about the benefits obtained through the implementation of PRM was very satisfactory. Using a 5-point Likert scale, most benefits reached an average between 3,8 and 4,5 points. The only benefit that had a lower score, of 3,3 points, was 'better evaluation of budget reserve', therefore PRM seems not generally used in order to define the budget reserve. Not every project has obtained all types of benefits, but most of them have. Also, the benefit of increasing the external client's trust, was applicable only to the projects with an external end-user and, in those cases, it was always considered to be very high (5 points). Among the benefits achieved in all projects, 'Greater probability of project success' was the one with the highest average rate (4,5 points).

Regarding the second part of the fourth research question, the main evidences related to the PRM adoption in SMEs are:

- PRM was considered useful in all cases;
- All interviewees believe that PRM should be adopted in future projects of the company, and most of them would like to adopt it in all projects and not only in strategic and/or innovative ones;
- The opportunities were considered in seven cases (out of ten).

The results related to the benefits are based on the perception of the interviewees, who have all worked with project management for many years. Moreover, in all cases at least one of these professionals

had large experience in project risk management. These characteristics, together with the triangulation that was ensured in all cases, guarantee the reliability of the results obtained.

4.1.5 The enabling and hindering factors to perform PRM in SMEs (RQ5)

The last research question's objective was to understand what encourages SMEs to adopt PRM in their projects and what dissuades them. The analyses of the results indicate that the main enabling factors for companies to adopt PRM are:

- Previous PRM experience;
- Support of a PM consultant with PRM experience;
- Strategic or innovative project;
- PRM report requested by the government or the project financier;
- Stakeholders support.

It is clear that the support inside the company and the knowledge of the people involved in the process are the main motivators for the PRM implementation. All interviewees would like to adopt PRM in their future projects.

Finally, the hindering factors to perform PRM in SMEs are:

- Difficulties in the communication with the external client;
- Lack of support from CEO/stakeholders;
- PRM seen as a "waste of time" by some of the people involved in the project.

The project managers who have faced one or more of the abovementioned difficulties during the project believe that, given the positive results obtained, these factors should be considered and overcome in future. The benefits obtained through PRM in the project confirm its relevance for the project's success and the need of implementing it in future projects.

4.2 Validity and reliability of the research

The quality of the case studies conducted in this research was assured by testing the construct validity, internal validity, external validity and reliability (Yin 2009). The construct validity was guaranteed by the multiple sources of evidences (Yin 2009). In this research, semi-structured interviews with more than one person were conducted in person by at least one of the researchers. All information obtained was integrated with documents related to the project and, generally, phone calls between the researchers and the interviewees. This approach has also guaranteed the internal validity of the analyses through triangulation (Yin, 2009).

The multiple cases have increased the external validity of the research, since it was possible to make generalizations from the findings as it is suggested by Voss, Tsikriktsis and Frohlich (2002). Finally, the last quality test, that regards the reliability of the study, was also achieved through the research protocol constructed and the creation of the database with the interviews and the documents related to the cases, so that other researchers could have the same conclusions when analysing the data. Reliability assure to avoid possible errors and biases in the study (Yin 2009).

4.3 Academic and managerial contribution

4.3.1 Academic contribution

From an academic point of view, the first part of this research contributes to structure the RM themes developed in the literature for SMEs using an original research methodology approach. This approach provides a contribution to the development of a methodology combining bibliometric and content analysis for conducting literature reviews and investigating the state of the art of a research topic.

The presentation of the state of the art of RM in SMEs and the analysis of the key research streams contribute to the literature about this theme and gives indications to researchers about important topics of RM in SMEs that need to be developed.

The second part of the thesis contributes with the proposal of an empirical framework for analysing the adoption of PRM in SMEs, which could not be found in the literature, and that can be used in future studies in this field. The cases presented are also significant for the literature, since the results add ten cases to the only three papers with cases that were previously published. The ten cases analysed in the thesis contribute to the development of the PRM stream, as they give relevant indications about how to adopt PRM in SMEs, considering different variables that influence the PRM process.

4.3.2 Managerial contribution

Thanks to the findings obtained in the first part of this thesis, managers of SMEs can identify the RM streams they are managing and refer to the related literature. Each RM stream has specific characteristics and objectives, thus the importance of referring to the correct one. With this approach, practitioners could improve their knowledge about RM, identifying new types of risks they need to manage, discovering new tools and techniques to be used and understanding the value offered by RM in SMEs.

The second part of this research offers a new contribution to the diffusion of PRM in SMEs, giving practical indications for managers to adopt PRM in SMEs. In particular, organizational risks should always be considered and not only the technical-operative ones. Moreover, in the services industry, financial and economic risks should also be taken into consideration in order to achieve higher benefits. The specific activities to be performed, tools to be used and organizational aspects for a successful PRM implementation in SMEs with a positive cost-benefit ratio in different scenarios are also indicated. The clusters present the different levels of benefits that can be obtained through different procedures.

4.4 Limitations and further development

In the first part of the research, one of the limitations regards the number of the papers selected and included in the analysed database, as it is not a high one (61 papers), showing the potential for further

development of RM in SMEs. However, all papers presented are of high quality and this is an emerging topic, so other papers should be in progress. Moreover, the co-word analysis applied at a not-so-large database could lead to a limited reliability and generalisability, but its results have been supported and verified by the ones obtained through the content analysis, which confirms its reliability.

The second part of the research has its limitations related to the small number of cases and the fact that they were all conducted only in Italy or in Spain. Moreover, most of the Spanish cases were supported by the government, which led to the PRM adoption. It would be interesting to apply the same research protocol in other countries to analyse if the profile of the PRM adoption is similar or not. Regarding the types of industries, services companies different from engineering and consultancy areas were not analysed and no manufacturing cases were carried on in Italy; future studies fulfilling this gap would enrich the results and give the possibility of proposing further generalisations. Another limitation concerns the fact that the results related to the benefits obtained in the cases were based on the perceptions of the interviewees. Further research could implement a more objective evaluation of the benefits deriving from PRM, which would increase the reliability of the final outcomes.

SMEs need and deserve new RM methods, tools and approaches to take advantage of managing risks and leveraging their business value. Several research opportunities were identified in the different RM streams in SMEs, except the EnRM and the DRM ones, since EnRM is very complex and rarely applicable to SMEs, and DRM is mainly related to the management of a whole territory by the local authority. Following, the main opportunities for the other RM streams are summarized, ending with the PRM stream, as it was the topic of the second part of the thesis and, for this reason, it was more deeply analysed.

- ERM stream: most of its applications are partial, and not holistic as they should be. Therefore, future works about ERM considering all risk types and all risk phases of the RM process are expected, as it was done in the study of Brustbauer (2016). Also, other cases are needed to support the results obtained in previous studies, extending their generalisation;

- FRM stream: further research could deepen the analysis of the financial risks considering all RM process phases, and also applications in sectors different from the financial one, since most of the empirical papers found were developed in the banking sector. Future works are needed to suggest tools, techniques and practices to evaluate and treatment of financial risks in SMEs, in order to overcome their difficulties in obtaining loans and managing credit risks;
- SCRМ stream: it is concentrated in the management of operational risks, so future studies could consider also the financial, strategic and hazard risk types. Moreover, future research could consider all phases of the RM process and be addressed both to service sectors and to different manufacturing sectors;
- SRM stream: further research is needed to identify other strategic risks. Also, most of the papers about SRM are case studies, so many of the findings cannot be generalized. Therefore, given the emergence of this stream, quantitative research could also be performed to confirm the validity of the first studies and deepen the actual knowledge;
- PRM stream: it is an emerging stream and with very few publications. A study like the one presented in this research was missing in the literature. Future studies could use the empirical framework constructed in this thesis and apply it in different countries from Italy and Spain and industrial contexts that were not analysed, considering different sizes of the SMEs companies, the company's production organization and the type of end-user. Moreover, it would be useful to test the indications obtained through the patterns identification and verify if the same level of benefits can be achieved once the same procedure is applied in other industrial contexts and in other countries.

CONCLUSION

The increasing competitiveness and unpredictability of the business in all industrial sectors have promoted RM to be one of the main approaches to overcome uncertainties and support companies into reaching their objectives and ensuring their survival. Given the importance of SMEs in the European Union economy and the need of SMEs to manage risks appropriately, the research aimed at investigating the state of the art of RM in SMEs and contributing to the development of an important emerging stream, the PRM. More specifically, the thesis had two main objectives, which were pursued in two different phases with specific research questions.

The first objective was to outline the development, the state of the art and the possible future research directions of RM in SMEs. To reach this goal, the following research questions were formulated:

RQ1. How has RM been developing in SMEs?

RQ2. What is the state of the art in RM for SMEs? What are the conceptual structures and the key research streams of RM in SMEs?

Through a systematic literature review in which all significant papers about RM in SMEs were analysed, the literature was mapped, the main RM streams were identified and the research questions were answered. It has emerged that the interest for the topic has increased in the last decade, but there are still many gaps to be fulfilled. Among the research opportunities, it came to light that the PRM stream has recently become relevant, and the few papers published about it indicate a poor consideration of all risk types and an incomplete application of the PRM process limited to specific industrial sectors.

To pursue this research opportunity, the objective of the second phase of the thesis was to understand how to adopt PRM in SMEs with a positive cost-benefit ratio considering RM phases, activities, tools and organizational aspects that enable the effective implementation of PRM in SMEs. In order to achieve it, the following research questions were developed:

RQ3. Which are the main RM phases, activities, tools and organizational aspects adopted in the PRM process in SMEs?

RQ4. What are the outcomes and evidences of the PRM adoption in SMEs?

RQ5. Which are the enabling and hindering factors to perform PRM in SMEs?

The questions were answered and the objective was successfully achieved through the performance of multiple case studies. After a cross-case analysis of the ten cases, three clusters were built and indications about how to implement PRM in SMEs with a positive cost-benefit ratio considering different project characteristics to achieve a high/very high level of benefits were presented.

Thanks to this research, a complete literature review using a new combined methodology of bibliometric and content analysis was offered and a precise result about the state of the art of RM in SMEs and its evolution was provided. This is not only an academic contribution, but also a managerial one, since practitioners can refer to these results to decide to which RM stream they should address the RM implementation in their company.

The empirical framework developed for analysing the cases is an important contribution to the development of the PRM stream, together with the ten analysed cases added to the literature. From a managerial point of view, the results of the second part of the thesis give practical indications about PRM phases and PRM organizational aspects to be considered in different types of industries for its successful implementation.

Thanks to this thesis, it is possible to increase the diffusion of PRM in SMEs, since the indications provided for its implementation with a positive cost-benefit ratio can be useful in other projects. Further research in RM in SMEs and in PRM in SMEs are expected as the topics are new and emerging. Particularly for PRM in SMEs, new studies could be conducted starting from the limitations of this research: the sample could be increased so that statistical analysis could be performed, and other heterogeneity variables could be added to the sample, allowing these indications

to be useful in other types of projects as well. Moreover, further research could be conducted in other countries and in other industrial contexts to expand the results.

In conclusion, this research constitutes a significant study for the fields of RM in SMEs and PRM in SMEs. Its academic and managerial contributions are relevant for the development of these topics and the sustainability of economic growth, given the importance of RM and PRM for SMEs and the importance of SMEs for many countries' economy.

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APPENDIX A

CASES DESCRIPTION

1. PILOT CASE STUDY

For the pilot case study, a small-sized consultancy company, organised in matrix by projects was selected. The company employs six people, has a turnover of 1 million Euro and its main activity is project management consultancy. The analysed project consisted of implementing a cost estimating system for a client from the Engineering and Construction sector. The project costed 300,000 Euros and involved seven people for thirty months. Two members of the project team were interviewed: the project manager and, after him, the sales manager, who verified and integrated the previously collected data.

In order to understand the main characteristics of the project, the interviewees were asked to classify the project's innovativeness and complexity on a Likert-type scale, from 1 (very low) to 5 (very high). Both the technologic innovativeness and the client's market innovativeness were considered to be high. When evaluating these aspects, the project manager used the expression "I would say that", meaning that he was not absolutely sure about the given score. As for the PM complexity, in the beginning of the project it was rated as low, but during the project the project manager realized that it was actually high. This came out as a "surprise" (in his words) since, regardless their experience, they have misjudged the project's complexity. While talking to them, it was decided to add the evaluation of the project's relevance for the company's strategy to the questionnaire, as it has emerged as an important evaluation aspect. In this case it was considered very high since both the project manager and the sales manager believed that having success in this project would allow the organisation to enter into a new market. The average score obtained from the project's innovativeness and complexity is 4,5 (as displayed in Figure 1), highlighting a potential high level of risk that is usually associated with the abovementioned characteristics.

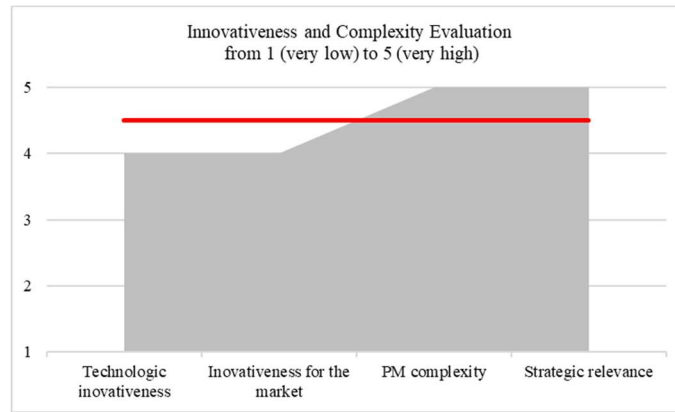


Figure 1: Project's innovativeness and complexity evaluation

PRM process and organisation

The project manager was responsible for the PRM process. The sales manager helped him throughout the process and, during the risk analysis phase, a lawyer was also involved since the contract to be signed with the external client was evaluated at this phase. Table 1 displays the general information about the PRM process and the organisation adopted in the project.

PRM overview	
Implemented PRM phases	identification, analysis, treatment, monitor & control
PM phases with PRM adoption	initiation, planning, execution, closure
Responsible for PRM	project manager
PRM team	project manager sales manager lawyer (in the risk analysis phase)
Risk owners identified	yes

Table 1: PRM overview in the analysed case

Risk identification

The activities carried on during the identification phase were context analysis, stakeholder analysis and risk identification, while the adopted tools were brainstorming, checklist (using the draft of the contract as a source) and the lessons learned from the previous similar projects. The project risk types considered were technical-operative, contractual and financial and economic ones. The organizational risks were also considered, but only partially. According to the project manager, this was a weak

point of the project as he believes that these risks should have been taken into more consideration. The identified risk projects were anticipated project termination by the client, change of requirements/scope/objectives, modifications in the client's project team, risks related to the outsourcing and insolvency. During this phase, the opportunities were also considered and these two were identified and pursued: upselling inside the company and to become an important reference in the Italian market of consultancy services.

The main difficulty faced was to concentrate on the risks that could have a bigger impact/probability of occurrence. No risk register was created.

Risk analysis

The main activities performed during this phase were analyse the risk impact (quantitatively and qualitatively) and the overall risk value, and the main tools used were expected money value (EMV), risk matrix and what-if analysis. The probability of risk occurrence and of risk consequences were evaluated in 4 different levels (zero, low, medium and high), being the risk consequences also measured in two different dimensions (economic and project margin).

The monetary consequences that could be caused by the risks identified in the previous phase were estimated through a what-if analysis and specific measures were taken in the contract to try to protect the company from these risks.

The risks were not prioritized, and the main difficulty faced was the time constraint to perform the analysis (since it was all done during the contractual phase), which obliged the people involved to work extra hours at the beginning of the project. The project manager stated that "the issues of lack of time and extra-working hours always emerge in the projects".

Risk treatment

The definition of risk acceptance threshold was based on the contract's value (this is the company's policy for all projects). During the risk treatment phase, the activities carried on were: contractual

aspects negotiation, client weaknesses analysis, communication with stakeholders, what-if analysis and 5 Whys. As for the techniques applied, risk mitigation was used, mainly in the contractual phase, risk transfer and risk retention (if they had enough financial resources available). Some risks were accepted, even without the required condition, because of strategic reasons. Certain risks had to be accepted in order not to lose the project. Some of the risks were rejected through the contract. It is important to highlight that the user acceptance test also served as a tool in the risk treatment phase.

To determine which action to take against a risk, the project manager and his team evaluated the risk occurrence probability in a scale from 1 (low) to 4 (high). If the result were 1 or 2, the risk was not going to be taken into consideration; if the result were 3 or 4, the team would evaluate how could they mitigate or transfer the risk.

The risk response cost was calculated for some risks and, given the results, some clauses in the contract were modified and other risks were transferred to a supplier (even if the implementation costs increased in that case).

To plan the risk response, the risk owners had the critical parameters under control and were constantly in contact with the main stakeholders to understand their perception of the project (communication with the stakeholders).

According to the project manager, the main difficulty faced during the risk treatment phase is the fact that they were never sure about the effect of the action taken to mitigate/eliminate a risk. If the action did not cause the expected effect, it could even make things worse and cause chaos.

Risk monitoring & control

During this phase, the main two activities carried on were risk audit and monitoring meeting, while the main tools used were action monitoring plan, change request monitoring and risk trigger monitoring. The risks were identified only at the beginning of the project and there was not a constant

monitoring of them. The main difficulty faced was the fact that some risks emerged when they were already a problem and thus there was not much time to solve the situation and avoid losses.

PRM outcomes

According to the consultants, the use of PRM in this project had a medium impact on improving the project planning, better controlling the budget, increasing the probability of project success and on improving the client's trust. However, both the interviewees believe that if the PRM process were improved, all these benefits could increase from medium to high.

Another benefit obtained from the PRM adoption was the budget reserve evaluation: PRM had a high contribution on its improvement according to the consultants' opinion and to the measurements made. Moreover, PRM helped to reduce the penalties and to improve the projects' performance.

The highest contributions of PRM regard the diminution of the risk impact and its support in the decision-making process.

The project manager and the sales manager are sure that the PRM benefits obtained overcame the implementation costs (i.e., approximately 10,000 Euros) and the time spent in its analysis (i.e., 20 working days in a 30-month project).

The main reasons for having adopted PRM in this project were the fact that it was an innovative project (new supplier, new project) for a strategic client and the experience and knowledge that they have about PRM.

They believe that the context analysis of PRM should be implemented in all types of projects and, depending on the results, all the PRM process should be adopted in the project or not. Among the main obstacles faced during the PRM implementation were:

- The frequency in which one of the members of the team perceived PRM as a useless cost;
- The cultural obstacle of many people believing that the risks must simply be accepted, and nothing should/can be done about it.

2. CASE STUDY 1 – CS1

This case study took place in a small-sized consultancy company organised by projects that employs 48 people and has a turnover of five million Euros. Moreover, its main activity is the development of Customer Relationship Management (CRM) systems that focus on user adoption (i.e., the spontaneous and profitable utilisation of CRM by its users).

The analysed project consisted of implementing a new CRM system to an external client that belonged to the automotive industry and had the ambitious objective of increasing its annual income by 30%. The project costed 60,000 Euros and involved seven people for seven months. Two members of the project team were interviewed: firstly, the project manager and, secondly, the manager's assistant, who played an important role in verifying and integrating the previously collected data.

In order to understand the main characteristics of the project, the interviewees were asked to classify the project's innovativeness and complexity on a Likert-type scale, from 1 (very low) to 5 (very high). The technological innovativeness was considered to be very high, while the client's market innovativeness was considered to be low. The complexity of the PM was rated as 'medium', while the project's relevance for the company's strategy was considered very high since both the project manager and the assistant believed that having success in this project may allow the organisation to enter into a new market. The average score obtained from the project's innovativeness and complexity is 3,75 (as displayed in Figure 2), highlighting a potential medium-high level of risk that is usually associated with the abovementioned characteristics.

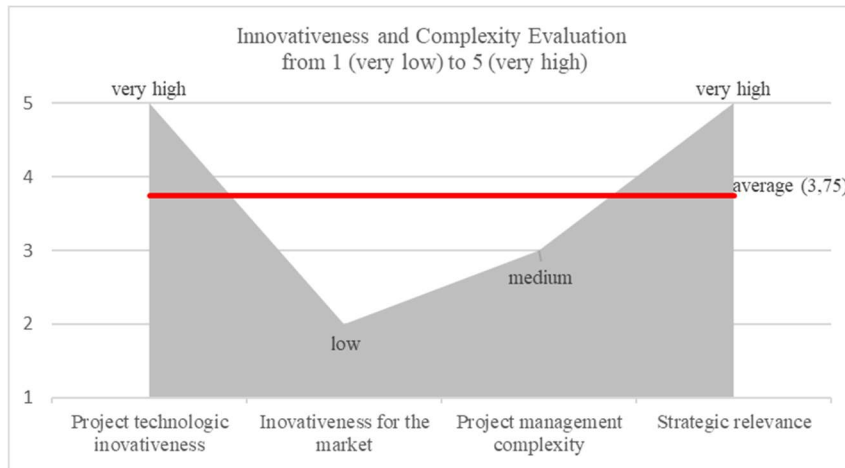


Figure 2: Project's innovativeness and complexity evaluation

PRM process and organisation

The project manager was responsible for the PRM. The assistant helped him throughout the process, and the sales manager was involved during the identification, the analysis and the monitor & control phases. Table 2 displays the general information about the PRM process and the organisation adopted in the project.

PRM overview	
Implemented PRM phases	identification, analysis, treatment, monitor & control
PM phases with PRM adoption	initiation, planning, execution, closure
Responsible for PRM	project manager (supported by his assistant)
PRM team	project manager (PRM responsible) project manager assistant sales manager
Risk owners identified	yes

Table 2: PRM overview in the analysed case

Risk identification and analysis

In this project, as in all other projects of this company, a preliminary analysis was performed. The analysis consisted of a three-day evaluation, with the aim of defining the actual picture of the client's company's infrastructure and understanding the possible interactions between the client's information

system and the CRM system to be implemented. Thus, the outcomes of this analysis served as an input for the project planning.

During this preliminary analysis, the activities to be performed were ordered by importance in a matrix (deriving from a cost-benefit analysis), and the possible risks that may be faced during the project were identified and analysed. Therefore, the first two phases of the PRM process, risk identification and risk analysis, were proactively performed in this first PM phase (i.e., initiation).

In particular for the risk identification, the activities performed – mainly to check the project feasibility – were context analysis, stakeholder analysis and risks and opportunities identification, while the main tools used were brainstorming, interviews with experts, SWOT Analysis and the 5 Whys technique. No relevant, technical-operational risks were identified; however, if there were any identified in this preliminary analysis, the company would not have accepted the project. In addition to that, as a mitigating action, a clause in the contract signed by the client allows the company to interrupt the project if any risks related to the IT structure emerges.

Strategic risks, however, were identified (e.g., the possible issues impeding an effective user adoption), in addition to few organisational risks (i.e., the operational risks); for example, there was a risk of assigning part of the project to an inexperienced or low-skilled software engineer, which, in turn, could open the risk of not delivering the project in time. From a financial point of view, the client was considered to be reliable, thus no relevant financial risks were considered.

Besides the risks, an opportunity was also identified: to turn this project into a model for future clients in the automotive industry. For this reason, the project manager devoted all his effort towards obtaining a specific CRM model for this industry by the end of the project.

The main obstacle encountered in this phase was understanding what the main risks for the client were. The project manager and the assistant, who were responsible for the PRM, were very concerned about the risk of not satisfying the client because of the potential difficulties that could be faced during

the CRM user adoption. Such difficulties could not only jeopardise the project but also threaten the opportunities of making the project a successful case and attracting new clients in the market.

During the risk analysis, the project team focused on analysing the consequences of the risks identified as well as the risks that could arise during the execution of the project. The tools and techniques adopted in this phase were the 5 Whys technique and the cost-benefit analysis, obtaining a qualitative evaluation of the identified risks. No risk prioritisation was done in the project. The risk related to the user adoption and the eventual lack of skills of a team member were analysed. For example, the user adoption was considered a risk with a significant negative impact for the company's strategy in case it occurred, while the lack of knowledge of one of the software engineers could incur into extra working days, which means a loss of money.

Despite all the analysis conducted, they did not create a risk register and, because of a CEO's decision, the risks were not reported in any document. Several difficulties were faced during the risk analysis, and the main ones were the possible unreliable information given by the client and the need to deal with unexpected risks. Given the activities and connected risks, the project manager approved the preliminary analysis and officially started the project. During the project lifecycle, the project manager had the responsibility of having these initially identified risks under control.

Risk treatment

The definition of a risk acceptance threshold was based on the consultants' feelings and knowledge, without any type of objective or quantitative analysis threshold.

Firstly, risk treatment was performed in the preliminary analysis. With the aim to assure the project's success, every source of technical impediments related to the client infrastructure was accurately considered and, if detected, the project would have been excluded to avoid the risks. Moreover, to transfer other potential technical risks emerging during the project, a clause in the contract allowed the company to interrupt the project if any risk related to the IT structure, and not initially individuated, emerged.

Two specific techniques were used to complete the risk treatment during the project implementation: risk mitigation and, more widely, risk transfer. Both the project manager and the assistant recognised that these actions should be planned in advance; nevertheless, as in most of the company's projects, they managed both the risk mitigation and the risk transfer 'live' (i.e., following a reactive approach). For example, in this project, an SMS alert system was implemented in the CRM with a particular template and a timer. While this SMS system was being built, one of the client's managers was replaced by another one, who was not satisfied with the final template nor with the timer configuration and asked for modifications. These changes imply extra working hours for the engineers who were working in the project; therefore, the company managed to transfer the risk of extra costs to the client since the specifications of the user requirements were different from what was specified in the contract. As a result, the sales manager created a change request, and the client paid for it.

Another risk that occurred in the project was related to the lack of skills of one of the software engineers. During the second day of the project, a software engineer – as a member of the project team – asked the project manager to leave the project because he was not capable of developing all the required activities. Since this was an expected risk, the project manager had already considered another person and made a substitution in the project team; however, this replacement could not be done immediately so, in the end, two working-days were lost (i.e., approximately 1.500 Euros). In this case the risk was partially mitigated but not completely avoided.

A significant difficulty faced in this phase was to involve the client, given his poor availability.

Risk monitoring & control

During this phase, the main two activities carried on were change request monitoring and risk trigger monitoring. To this extent, a risk tracking tool, called 'JIRA', was developed by the software engineers using an Agile logic. Through 'JIRA', the project team was able to keep track of any change request and the eventual problems that emerged during the project execution. This tool was also useful to support the project manager to discuss with the client and decide which treatment action to take

when needed. The main difficulties faced during this phase were the lack of time, the need of dealing with non-calculated risks and the lack of information provided by the client.

Once the project finished, a meeting involving all the project members was held, during which they discussed and reported the lessons learned about how to avoid in the future the same difficulties and problems encountered in this project; these results were not documented.

PRM outcomes

According to the consultants, the use of PRM in this project had a very high impact on improving the project planning, increasing the probability of project success and increasing the client's trust. Moreover, the project manager and the assistant also affirmed that PRM has highly contributed in reducing the risk impact and improving the project's performance. Through PRM application, the main risks were avoided, and a significant strategic opportunity was identified; thus, pursuing this opportunity gave extra motivation for the project team. Besides that, both interviewees affirmed that PRM supported them in the decision-making process, but it was not very significant because there was no risk register, and risk evaluation was not performed in a systematic way. However, the project manager believes that, if the PRM process were more structured and the risk analysis were deeper, the project team would have more reliable information about the project that could considerably contribute in the decision-making process; therefore, potential PRM benefits are even higher than the actual ones.

The adoption of PRM had a low impact on improving the evaluation of the budget reserve and on the budget controlling, since there was not a quantitative risk evaluation; however, both respondents believed that these outcomes could benefit from an improved application of PRM.

The project manager and the assistant believed the PRM benefits obtained overcame the implementation costs (i.e., approximately 3.000 Euros) and the time spent in its analysis (i.e., 5 working days). They also believed that it should be implemented in all types of projects. They further pointed out that the strategic nature of the project gave a strong motivation for the PRM adoption.

Among the main obstacles faced during the PRM implementation were: risks not clearly identified at the beginning of the project, difficult communications with the client and time constraints. Nevertheless, the opportunity identified in the preliminary analysis was successfully achieved; thus, by the time of the project's closure, the main structure of a specific CRM model for the automotive industry had been developed.

3. CASE STUDY 2 – CS2

The third company of the research was a medium-sized engineering company with 187 workers and a 7 million Euro annual turnover. The project consisted of building a new area for a TLC type telephone system for an external client and costed 100,000 Euros. During the 18 months in which the project was carried on, 10 people from different sectors worked on it. For this case study, the project managers who has managed the project during all its lifecycle and a project manager who was part of the team in the initial phases were interviewed.

The interviewees classified the project's innovativeness and complexity on a Likert-type scale, from 1 (very low) to 5 (very high). Both the technologic innovativeness and the client's market innovativeness were considered to be very low; while the PM complexity and the project's relevance for the company's strategy were rated as very high leading to an average score of these four aspects of 3,5 (as displayed in Figure 3), highlighting, also in this case, a potential medium-high level of risk that is usually associated with the abovementioned characteristics.

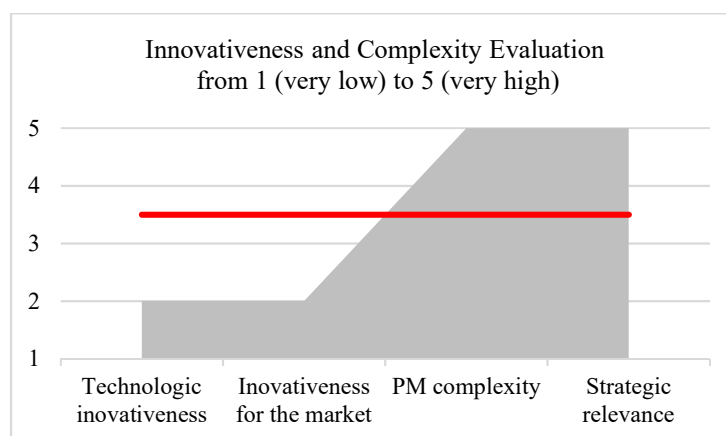


Figure 3: Project's innovativeness and complexity evaluation

PRM process and organisation

The project manager was the only one in charge of the PRM. Table 3 displays an overview of the PRM process and its organisation along the project.

PRM overview	
Implemented PRM phases	identification, analysis, treatment, monitor & control
PM phases with PRM adoption	initiation and execution
Responsible for PRM	project manager
PRM team	area managers
Risk owners identified	yes

Table 3: PRM overview in the analysed case

Risk identification

During the risk identification phase, context analysis and risk identification activities were carried on, and the brainstorming and checklist tools were used. All project risk types were considered: technical-operative, organizational, contractual, political and financial and economic. After careful consideration, only the technical-operative risks of changing the scope of the project and changing the project requirements were identified. The opportunity of improvements in the process was also considered. As for the difficulties faced during this phase, the main ones were lack of time and negotiations/communication between the project manager and the client.

Risk analysis

The risk analysis was based on the team's experience and a safety plan of the construction site with risk matrix was designed, but without any prioritization of risks. One of the difficulties faced in this phase was to organize all the information provided by the different specialized sectors that were involved in the project in order to decide how to proceed with the work and avoid the possible risks identified.

Risk treatment

Meetings to share and align the information among the team members and, when necessary, with the client took place periodically. Regarding the PRM process, these meetings allowed the team to analyse the risks that could emerge and try to mitigate or eliminate them considering the other variables involved in the project.

No risk acceptance threshold was officially defined, since the activities were carried on based on the feelings and experience of the team members. Risk mitigation and risk elimination tools were used during this phase. However, the answer to the risks was not systematically planned: when an unconformity in the system that could be a risk trigger was identified, the team reacted to it.

The main difficulty faced during this phase was that, since the risk treatment process was not well structured, the team had difficulties to decide how to react to the risk trigger and to the risk itself when it emerged.

Risk monitoring & control

During the last PRM phase, the risk trigger monitoring tool was used and action monitoring plan, periodic monitoring meetings and risk revaluation activities were occasionally performed. Once the project finished, there was no meeting to discuss the lessons learned, notwithstanding the project manager had indicated that the main issue faced during the risk monitoring and control was the difficulty that the project team members have into “understanding well the risks and the importance of avoiding them”.

PRM outcomes

The interviewees were asked to rate some of the benefits provided by the PRM adoption in the project in a Likert-scale from 1 to 5. According to them, the use of PRM has allowed them to better plan the project, but they believed that the PRM implementation could have been better and, in that case, the project planning would have been improved even more. The PRM had a very high contribution to

both the project performance and the probability of project's success. As for the budget control, the budget reserve evaluation and the decision-making process, the consultants believed that they were highly benefited by the PRM adoption, but the benefit could have been even a little higher if the PRM adoption had been more structured than it was. PRM has played a very important role in decreasing the risk impact and the penalties, and into increasing the client's trust in the company.

The cost to implement PRM in this project was around 5.000 Euro, which corresponds to 5% of the project cost. Both interviewees believe that it was useful to use PRM since the time and cost spent on it were justified by the benefits provided by its adoption.

The main factors that have motivated them to adopt PRM were the company's structure and flexibility and its attention devoted to project's critical points. The consultants believed that the main obstacle faced during all PRM process cycle was to convince the team that the benefits provided by PRM would justify the costs of its implementation and that, given the positive results obtained in this project, that the PRM should be adopted in all future projects of the company.

4. CASE STUDY 3 – CS3

The last Italian case was a project carried on by a medium-sized consultancy company with a matrix by projects organizational structure. The company, which main activity is project management consultancy, employs 110 people and its turnover is of 15 million Euro. An external company hired them to update their Business Intelligence platform technology. The project costed 33.500 Euros and involved six people for three months. Two members of the project team were interviewed: the project manager and one of the software engineers who worked in the project.

To analyse the main characteristics of the project, the interviewees were asked to classify the project's innovativeness and complexity on a Likert-type scale, from 1 (very low) to 5 (very high). The technological innovativeness and the PM complexity were considered to be high, while the client's market innovativeness was considered to be low. The project's relevance for the company's strategy was considered very high. The average score obtained from the project's innovativeness and

complexity was 3,75 (as displayed in Figure 4), highlighting, a potential medium-high level of risk that is usually associated with the abovementioned characteristics.

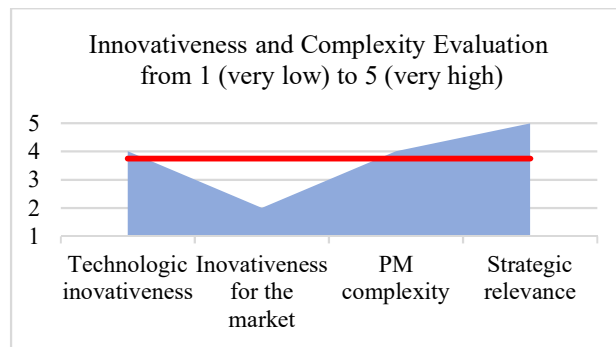


Figure 4: Project’s innovativeness and complexity evaluation

PRM process and organisation

Both the project manager and one of the software engineers were responsible for the PRM implementation along the project. Table 4 displays the general information about the PRM process and the organisation adopted in the project.

PRM overview	
Implemented PRM phases	identification, analysis, monitor & control
PM phases with PRM adoption	initiation and planning
Responsible for PRM	project manager software engineer
PRM team	project manager software engineer project management consultant
Risk owners identified	yes, indirectly

Table 4: PRM overview in the analysed case

Risk identification

During the risk identification phase, context analysis, stakeholder analysis and risk identification activities were developed. Only the technical-operative risks were considered and identified, since the consultants considered them to be the most relevant ones in this specific project. The user adoption was the risk that they had to dedicate most of their attention to, in order to avoid problems by the time

of delivering the project and therefore receiving a negative feedback from the client. The following tools were used during this phase: brainstorming, checklist and analysis of similar past projects in order to verify the lessons learned. The main difficulty encountered by the team was the lack of time. As for the possible opportunities, the project team was hoping to have other projects with this client in the future, thus the critical importance of delivering this project in the best possible way in order to satisfy and retain the client.

Risk analysis

No structured risk analysis was performed. The only study performed regarding the risk analysis was to have a contingency/buffer of time and be aware of the possibility of having to perform extra activities if one of the risks emerged.

Risk treatment

During the risk treatment phase, three tools were used: risk mitigation, risk transfer and risk retention. The estimation of the risk answer cost was also calculated, but since the actions were taken only after the risk presented itself, it was actually the cost to answer to the problem (caused by the risk) that was calculated. The risk threshold was defined as 20% of the project cost. At this phase, the risk owner was responsible for planning the answer to the risk implementation and the number of working days needed to solve the issues were estimated.

The difficulties encountered during the risk treatment phase were to involve the client and reschedule the activities of the team due to the occurrence of unexpected problems.

Risk monitoring & control

In the last PRM phase, risk monitoring & control, the change requests were monitored and the action monitoring plan was carried on. The risks were identified only at the beginning of the project, but the project manager continued monitoring them along the project lifecycle.

During the project's closure, a meeting between the team and the client was held in order to discuss the lessons learned and, according to the project manager, the main lesson learned was that once there is an innovative technical release, the team's presence in the client must be continuous during the first days, as important risks in this project emerged when they were already a problem.

PRM outcomes

Once the project was completed, the main outcomes were evaluated. When classifying in a Likert-scale from 1 to 5 the benefits obtained from the PRM adoption in the project, the project manager rated the impact on almost all benefits as medium (level 3). Since the PRM process implementation was poor in certain aspects, the interviewees believed that some benefits could have been higher if the PRM adoption had been more structured, so that the impact on risk reduction would have been high (level 4) and the project planning, the budget control, the probability of project success, the project performance and the client's trust would have been very high (level 5).

The context in which the project was inserted and the innovative technology that was used in it were the main reasons for adopting PRM. The obstacles faced were related to the lack of time and the idea of not needing to dedicate more time into PRM, which led to a shortage of activities devoted to the risk analysis and, consequently, the emergence of problems that could have been avoided.

The interviewees see the aforementioned facts as a lesson learned for the next projects, affirming that the PRM must be well done in order to obtain all the benefits that it can offer, otherwise it may end up being a waste of time. They also believe that PRM should be mainly adopted in projects with new clients, projects with high visibility and projects that use innovative technology in its implementation.

Nevertheless, the PRM was applied with a positive cost-benefit ratio since only a couple of days were spent in the process, meaning an average cost of 3.000 Euro on a 33.500 Euro project.

5. CASE STUDY 4 - CS4

The fourth project analysed was the first case study that was carried on in Spain. It was conducted in a micro-sized automotive company organised by projects with five workers and a 267.000 Euro turnover. Its core activity is the creation and development of racing cars, being the development of a new racing car called EF-10 the project that was the object of this study. The owner of the company, who was interviewed together with a project management consultant, informed that the project costed 300,000 Euro (subsidied by the government) and involved all employees for 24 months.

In a Likert-scale from 1 (very low) to 5 (very high), the interviewees classified the project's technologic innovativeness, innovativeness for the market and strategic relevance as very high, while the PM complexity was rated as high, leading to an average score of 4,75 (Figure 5). The result highlights a potential very high level of risk that is usually associated with the abovementioned characteristics.

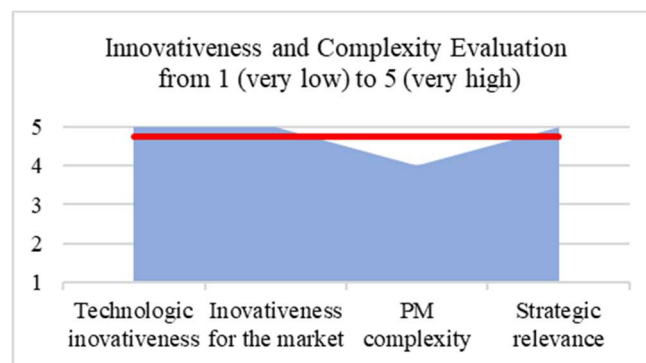


Figure 5: Project's innovativeness and complexity evaluation

PRM process and organisation

Given the micro-size of the company, the owner (CEO) was the project manager and responsible for the PRM process implementation. Since the project was subsidied by the Government of Navarre and due to the need of having to deliver periodic reports about the project evolution, a PM consultant with PRM experience supported him along the project lifecycle. During the meeting, which lasted around 80 minutes, the researcher visited the manufacturing area of the company, talked to one of the

employees about the process and saw the documents related to the project plan. Table 5 presents an overview of the PRM process and the organisation adopted in the project.

PRM overview	
Implemented PRM phases	all
PM phases with PRM adoption	all
Responsible for PRM	project manager (supported by an external assistant)
PRM team	project manager project management consultant
Risk owners identified	yes

Table 5: PRM overview in the analysed case

Risk identification

To identify the risks, context analysis, stakeholder analysis and risk identification activities were carried on and the checklist tool was used. Technical-operative, organizational and contract risks were considered, and the following specific risks were identified: risks related to the supplier (in terms of reliability), to the selection of technology to be used in the car, to the material type, to the prototype production, and to the “lack of knowledge”. The interviewees stated that the team did not have enough knowledge about the performance characteristics of the engine that they were initially planning to use in the project.

The particular difficulty faced was the fact that the team “did not know well the risks” (said the respondents), that is, the team was aware of the fact that using this particular engine in the project could be problematic as the car could not achieve the expected performance, but they were not able to predict which components of the engine could fail and how these failures could impact on the car’s performance. On the other hand, the team knew that this difficulty had to be faced and decided to learn as much as possible about this specific engine and the other ones available in the market. So, this fact has encouraged them to pursue the opportunity of developing a specific internal knowledge that could be useful for other projects in the future.

Risk analysis

Risk matrix and what-if analysis tools were used during the many meetings that took place to discuss how to deal with the identified risks. Only the qualitative analysis was carried on, as the probability of risk occurrence and the effects were both measured based on the team experience and their awareness about the fact that the probability of occurrence of some of the risks were directly related to their supplier, so it was hard for the team to evaluate it quantitatively. The risk prioritization was based on the results of this qualitative analysis. The main risk they could have in terms of money was related to the cost of the engine, that would have to be substituted if it were not the most suitable one for this new car. After some tests, the project manager decided to adapt the engine that was being tested.

During this phase, the team continued facing the aforementioned difficulty of not knowing all the characteristics of the engine, finding hard to analyse the possible impacts of the different levels in which it could fail.

Risk treatment

Risk mitigation and risk avoidance were the two techniques used at this phase. As it was previously mentioned, some of the risks were related to the engine, so tests had to be carried on verifying if the engine was meeting the requirements. The tests took place in the company and in a racing area, being the car driven by an expert pilot who was responsible for giving a precise feedback of his perceptions about the car to the team.

Risk monitoring & control

In the last phase of the PRM process, risk trigger monitoring, risk revaluation and periodic monitoring meeting activities were carried on. In addition to those, the team has attempted to replicate the problems that emerged during the engine tests to decide if they had to adapt the engine, which was

the final decision, or contact a supplier and use another engine in the project. The risks were constantly measured and reported during meetings that took place at least once per month.

PRM outcomes

The PM consultant affirmed that PRM was important to support the development of the project and to have the time, the quality and the costs under control. He believes the PRM benefits obtained overcame the implementation costs (i.e., approximately 10,000 Euro) and the time spent in its analysis (i.e., 20 working days).

The PRM adoption was motivated by the fact that this was a strategic project for the company and that the PM consultant had experience in PRM. Given the positive results obtained, the CEO believes that PRM should be implemented in all projects that present strategic risks for the company. The lack of knowledge regarding the engine and some of the materials were the main risks faced, as they were not able to fully understand the impact of every decision taken related to the engine and the materials on the project's success.

6. CASE STUDY 5 - CS5

The data for the fifth case study (CS5) was collected in a small-sized manufacturing company organised by process with 21 employees and a 3.000.000 Euro turnover. With the company's machines (lathes, rectifiers and milling cutters), different types of manufacturing engines are fabricated. In this project a unique engine for a specific type of axys of big dimensions was developed at the cost of 240.000 Euro and involving 5 people for 18 months.

According to the CEO, who was the project manager, the project's strategic relevance was very high, while its technological innovativeness, innovativeness for the market and management complexity were high. Based on these results, the level of risk of the project was ranked as 4,25 on a scale from 1 to 5, pointing out a potential high level of risk in the project (Figure 6). Given the project's

complexity and relevance, the project manager had the support of a PM consultant for the PRM implementation.

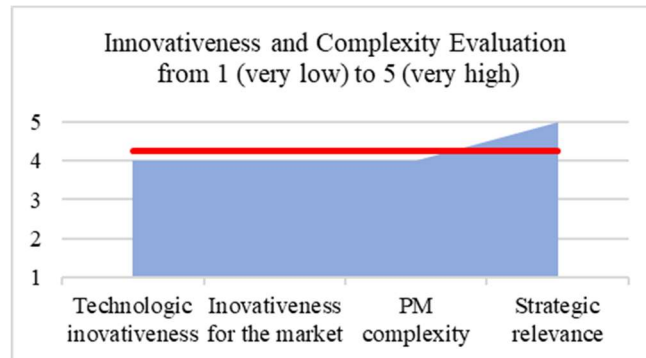


Figure 6: Project’s innovativeness and complexity evaluation

PRM process and organisation

The project manager was responsible for the PRM process together with the PM consultant. The roles in the PRM process were clearly assigned. Table 6 displays an overview of the PRM process and the organisation adopted in the project.

PRM overview	
Implemented PRM phases	all
PM phases with PRM adoption	all
Responsible for PRM	project manager
PRM team	project manager project management consultant
Risk owners identified	yes

Table 6: PRM overview in the analysed case

Risk identification

Activities of context analysis, stakeholder analysis, risk identification and opportunity identification were carried on during the first PRM phase with the support of brainstorming, checklist, interview with experts, FMEA (in the design), risk register, SWOT analysis and analysis of the root-causes tools. Technical-operative and organizational risks were considered, being the risks related to changes in scope/objectives of the project, risks related to the selection of technology and selection of the material type, to the design and to the lack of knowledge the identified ones. Despite the activities conducted, no opportunity was identified at this phase.

The main difficulties faced were related to the decision of outsourcing or not the design of the engine, which could incur into the technical risk of having to change the prototype. After careful consideration, the project manager has outsourced the design activities to the Public University of Navarre.

Risk analysis

During the several meetings that took place in the risk analysis phase, discussions about how to deal with the identified risks using risk matrix, risk ranking and risk register tools were conducted. The probability of risk occurrence and the effects were measured qualitatively, based on the team's experience and "on their gut feelings", and served as a base for the risk prioritization. The monetary consequence of the risk was not evaluated, being the only costs considered the ones related to the design outsourcing. The team's lack of knowledge regarding the development of the engine was the main difficulty faced, as they "did not know exactly what to expect" during the project execution.

Risk treatment

To treat the risks, the overall situation was evaluated, and the project manager decided to slightly redesign the product together with a professor from the Public University of Navarre who was in charge of the design. Different risk treatment tools were implemented (risk mitigation, risk retention, risk transfer and risk avoidance) based on the project plan. According to the interviewees, no particular difficulty was faced. The costs related to the engine design were calculated based on the price charged by the University.

Risk monitoring & control

During the risk monitoring & control phase, many meetings were held to reevaluate the risks, monitor the risk triggers and update the risk register, while periodic monitoring meeting and action monitoring plan activities were carried on. Due to the lack of knowledge related to the specifications and characteristics of the raw materials used in the project, the team considered the possibility of facing

a potential risk related to these materials, but no problem has emerged and the project was successfully completed.

PRM outcomes

According to the project manager, PRM was important for the project's success as it has supported the decision of outsourcing part of the activities and the benefits obtained through its adoption justified the implementation costs (i.e., approximately 19.000 Euro) and the time spent in its analysis (i.e., approximately 8% of the time of the project duration).

The PRM implementation was moved by the high level of innovation of the project and the initiative of the PM consultant to do it. Regardless the difficulties faced (i.e., lack of knowledge, uncertainties related to the actions to take during the process), the project was successful, and the project manager would like to implement PRM in all their future innovative projects.

7. CASE STUDY 6 – CS6

The third case took place in a medium-sized manufacturing enterprise which main activity is to build truck bodies. The company is organised by process, employs 78 people and has a turnover of 6.000.000 Euro. The project presented to the researchers was the construction of a truck body to transport cattle, which was never previously built. It costed 330.000 Euro and involved a team of six people for 12 months.

The technical director, who was also the project manager, was interviewed together with his consultant. The project technologic innovativeness, its innovativeness for the market and its strategic relevance were considered to be high, while the PM complexity was rated as medium by the interviewees. This classification, based on a Likert-scale from 1 to 5, led to a 3,75 (medium-high) potential level of risk in the project (Figure 7).

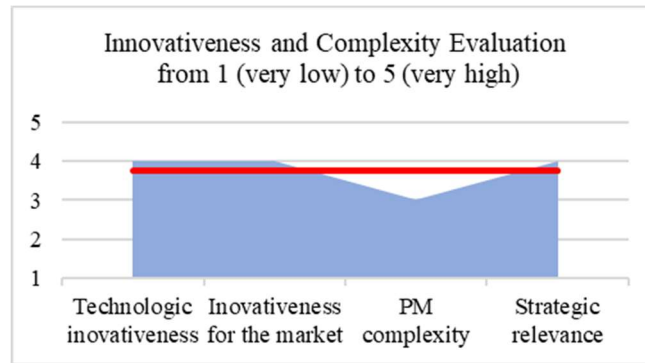


Figure 7: Project’s innovativeness and complexity evaluation

PRM process and organisation

The project manager was responsible for the PRM process. The project was subsidized by the Government of Navarre, so a project management consultant with PRM experience was part of the team, to support the project manager to assess the project risks and follow the requirements made by the ISO certification, which the company wanted to obtain. Table 7 presents an overview of the PRM process and the organisation adopted in the project.

PRM overview	
Implemented PRM phases	All
PM phases with PRM adoption	All
Responsible for PRM	project manager (supported by an external assistant)
PRM team	project manager project management consultant
Risk owners identified	yes

Table 7: PRM overview in the analysed case

Risk identification

During this first PRM phase, context analysis, stakeholder analysis, risk identification and opportunity identification activities were carried on together with the use of brainstorming, checklist and risk register tools. The risks considered were the technical-operative and the organizational ones, being the risks related to the material type, to the design, and to the lack of knowledge the ones identified.

The difficulty faced was the team's lack of technical knowledge regarding mainly the truck body's ramp, through which the animals enter the truck, and the sides of the structure that needed to be built in a specific way that allowed the animals to breathe without jeopardizing the truck's stability.

Risk analysis

The main activities that took place during the risk analysis were the meetings organized by the project manager with the project team at least once per month. During these meetings, the team has analysed the risks with the support of risk matrix and risk ranking tools and updated the risk register. There was no risk prioritization and the monetary consequence of the risks was not measured.

The probability of risk occurrence and its effects were both measured based mainly on the project manager's experience, without the use of any quantitative tools. The main difficulty the team has faced was related to the impossibility of predicting exactly how the risk could present itself and decide how to manage the possible triggers.

Risk treatment

The techniques used at this phase were risk mitigation and risk avoidance, which results were constantly communicated by the project manager to the stakeholders.

The response implementation was not planned. Basically, there were redesigns and tests of the different components of the truck body. Since one of the main risks was related to the ramp, many ramp prototypes were built, and several changes in its design were made in order to finally achieve a model of the ramp that would allow the cattle to enter the truck without any problems.

The risk of having problems to open the truck was turned into an opportunity: the project manager decided to use a well-known model of truck bodies that opens also from the top for this project. This model would allow the cattle to breathe well and there were no indications against its use under these circumstances.

Risk monitoring & control

Finally, during the risk monitoring & control phase, risk audit and risk revaluation tools were used, and period monitoring meeting activities were carried on. The risks were constantly measured, and the risk register was frequently updated by the risk owner. However, regardless all the monitoring, the risk related to the ramp emerged when it was already a problem: the animals were not able to enter the truck without sliding, which led to some readjustments in the project that were not initially predicted. The interviewees stated that the difficulties that can emerge when leading with animals must be better considered at the beginning of the project and that the team has learned the lesson of trying to gather as much information as possible regarding the project before it starts.

PRM outcomes

The cost-benefit ratio of the PRM implementation was positive: approximately 9.000 Euro were spent and 5% of the total time of the project was dedicated to PRM. The PRM adoption was necessary since the company was getting a new ISO certification and had to show the auditors their PRM procedures in order to obtain the certificate. In addition to that, the project was financed by the government, that requires trimestral reports on the project development which were written by the project manager with the support of the previously mentioned PM consultant.

Given the positive results generated by the PRM implementation, the interviewees believe that all projects involving a new design to develop a new product and the projects with a significant outsourcing should adopt PRM.

8. CASE STUDY 7 – CS7

The project of case study number 7 was executed in a micro-sized manufacturing enterprise, with 5 workers, a 175.000 Euro turnover and which main activity is the fabrication of long boards for different riding styles. The project was developed on request of one of the most famous longboard

riders in the world, who wanted a new longboard, with different specifications from those that exist in the market. The three owners of the company, together with a PM consultant, wrote the project and managed to receive a subsidy from the government to carry it on. The project costed around 40.000 Euro, but these are mainly the costs of material and production, since the three partners and the PM consultant did not receive any money for it. All the company was involved in the project for a period of 12 months.

Both the technical director, who was the project manager, and the PM consultant were interviewed. According to them, the strategic relevance of the project was very high, as it would put them at a new level among the competitors. The project technologic innovativeness and its innovativeness for the market were also very high, since they were creating a new longboard model, while the project management complexity was rated as medium. These ratings resulted on a potential high level of risk (4,5) in the project (Figure 8).

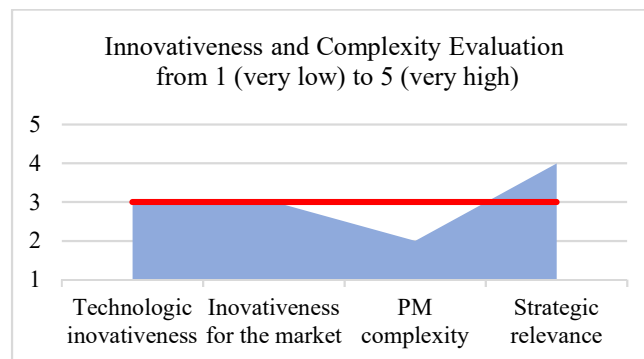


Figure 8: Project's innovativeness and complexity evaluation

PRM process and organisation

The technical director was the project manager and also the responsible for the PRM process, which involved all the team. Table 8 presents an overview of the PRM process and the organisation adopted in the project.

PRM overview	
Implemented PRM phases	all
PM phases with PRM adoption	all
Responsible for PRM	project manager
PRM team	all the company
Risk owners identified	yes

Table 8: PRM overview in the analysed case

Risk identification

To identify the risks, context analysis and stakeholder analysis activities were carried on and brainstorming, checklist, interview with experts and risk register tools were used. The team evaluated the possible technical-operative and organizational risks that could occur in the project, and the identified risks were those related to user adoption, to the material type and to the design. This project was seen as an opportunity for the company to become more relevant in the market, as it would make it the only one with this specific longboard, which, in case of a successful project, would have been approved by one of the champions in the longboards riding competitions.

The main difficulty faced was the communication with the client. His specifications were not very clear, and sometimes he was not able to express exactly his positive and negative impressions while testing the product.

Risk analysis

The team had weekly meetings to discuss the project and the project manager had everything documented, as she believes that is crucial for the project success to have all the information written down and organized. One of the team's main concerns was to "understand well the risks" that were identified in order to keep track of them.

Risk matrix, risk register and risk ranking tools were used, and the risks were prioritized based on the results of the risk matrix and on the team's experience. The project manager did some estimation regarding the monetary consequence of the risk: extra activities and extra material. No particular difficulty was faced during this phase.

Risk treatment

During the risk treatment, many tests were performed, and 19 prototypes were built. The client was responsible for testing the product and relating what were the problems perceived, so that the project team could make the necessary adjustments. This communication with the client continued to be the main difficulty of the project as the client was usually not clear and the team had to guess sometimes what he really wanted or expected from the product. The team continued organizing alignment meetings and sharing the risks among them (shareholders and PM consultant).

The parameters to decide the actions were based on the team's experience and feelings while they were trying to mitigate, transfer or avoid the risks.

Risk monitoring & control

In the risk monitoring & control phase, risk audit and risk revaluation tools were used. The main activities developed were change request monitoring, meetings and periodic monitoring meeting. The risk register continued to be updated.

Since the company is very small and the project's importance was very high, the shareholders were aware of the risks and managed them efficiently, regardless the difficulty of communication with the client, who was very satisfied with the final product once the project was concluded.

PRM outcomes

The interviewees considered that the benefits obtained through PRM were all high or very high, so the cost-benefit ratio was positive. According to them, about 5% of the time spent in the project was dedicated to PRM and the PRM costs summed up to 2.000 Euro.

The factors that have enabled the PRM adoption were the company culture, their market knowledge and their awareness regarding the need of having everything documented. According to the project manager, PRM should be implemented in all projects and be precisely documented: “everything that is not documented does not turn out well”.

9. CASE STUDY 8 – CS8

Company number 8 is a small-sized manufacturing enterprise organized by process which core activity is the fabrication of insulation using recycled newspaper as raw material. However, this project consisted of fabricating decorative insulation, that is, white insulation, which differs from the grey ones that is usually produced, requiring another procedure. The company employs 15 people and has a 375.000 Euro turnover. For 11 months, 4 people were involved in this project that was financed by the government of Navarre.

The CEO and a PM consultant, who supported the project team along the project, were interviewed. Regarding the project technologic innovativeness and innovativeness for the market, they were rated as high, while the management complexity and the strategic relevance were rated as medium in a Likert-scale from 1 to 5. Given these results, the project had a potential medium-high level of risk (3,5) as depicted on Figure 9.

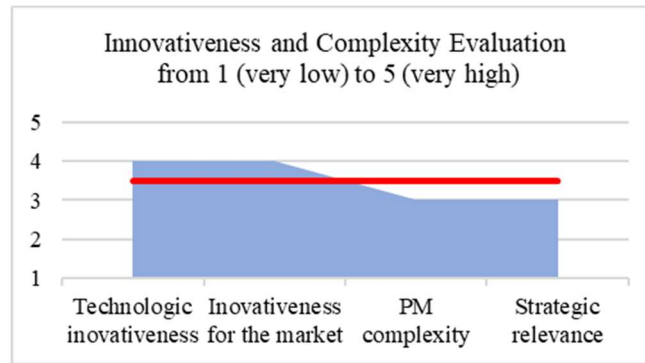


Figure 9: Project's innovativeness and complexity evaluation

PRM process and organisation

The CEO was the project manager and responsible for the PRM process and he was supported by the project management consultant. The roles in PRM were not clearly assigned, but the interviewee believes that the people were involved in the process regardless this fact. Table 9 displays an overview of the PRM process and the organisation adopted in the project.

PRM overview	
Implemented PRM phases	all
PM phases with PRM adoption	all
Responsible for PRM	project manager (supported by a consultant)
PRM team	project manager project management consultant
Risk owners identified	yes

Table 9: PRM overview in the analysed case

Risk identification

During the first PRM phase, risk identification, the brainstorming tool was used along context analysis, stakeholder analysis and risk identification activities were carried on. The considered risks were the technical-operative, contract and financial-economic ones and, from these, the specific risks identified were the ones related to the team's lack of knowledge about the characteristics of the materials to be used in the project and about how to fabricate this specific insulation. No opportunity was identified.

The lack of knowledge of the team regarding the materials and products to use in order to obtain the white insulation was the main difficulty faced. The team tried to imagine possible risks making different assumptions, but they could not be sure about what to expect.

Risk analysis

During the risk analysis phase many meetings were held and risk matrix and risk ranking tools were used to support the risk prioritization. Several tests were performed with different materials attempting to obtain the desired colour of the product. The probability of risk occurrence was measured based only on the team's experience and the results of the risk matrix.

The team did not know the process of fabricating white insulation neither the repercussions that the different choices of materials would cause. The project manager talked to suppliers and other people who are inserted in the same market, but the uncertainties regarding which would be the best material to use and how to process it have remained.

Risk treatment

What-if analysis and root cause analysis activities were carried on, along with the use of risk mitigation and risk retention tools. The team has applied these techniques without any structured planning. Moreover, the team was conscious about the impossibility of reaching the desired results at the first shot, but the only option they had was to try different products until they could obtain the desired results.

Risk monitoring & control

During the risk monitoring & control, many general meetings and periodic monitoring meetings took place. The risks were constantly reevaluated, especially since, also in this case, the team had difficulties to "understand well the risks" given their lack of knowledge related to the materials used in the process. The project manager stated that in a next project of this type, he would like to know better the process before starting the project.

PRM outcomes

According to the interviewees, the time (5% of the project) and money (3.000 Euro) spent on PRM implementation were justified by the benefits obtained. Given this positive experience, the project manager would like to apply PRM in all the company projects, and if not possible, at least on the ones subsidized by the government since this was the factor that enabled the PRM adoption. PRM has helped the team to control the development of the project and achieve good results in terms of quality, time and scope.

10. CASE STUDY 9 - CS9

A medium-sized consultancy company organized by projects was the next case analysed. With 230 employees, it is one of the most important consultancy companies in Spain. A few years ago, the need of developing a new ERP tool to manage the company's projects and activities has emerged. To perform this project, three people have worked on it full-time for 24 months. It was financially supported by the public administration and costed around 500,000 Euro.

The project manager and an innovation manager who was highly involved in the project were interviewed. According to them, the project strategic relevance and innovativeness were very high, and the PM complexity was high. The average score of the innovation and complexity evaluation was 4,75 in a scale from 1 to 5, highlighting a potential very high level of risk for the project (Figure 10).

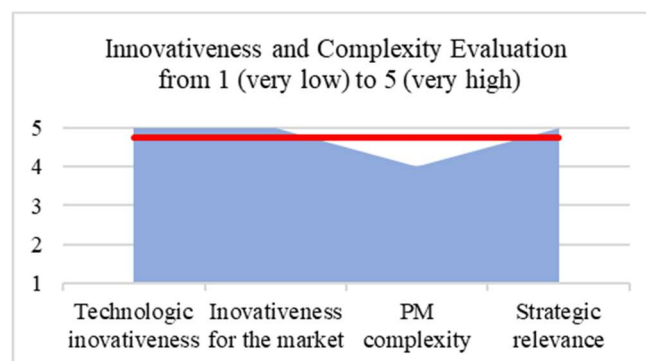


Figure 10: Project's innovativeness and complexity evaluation

PRM process and organisation

The project manager was the responsible for the PRM implementation, and the innovation manager has supported her along the entire project lifecycle. Table 10 presents an overview of the PRM process and the organisation adopted in the project.

PRM overview	
Implemented PRM phases	all
PM phases with PRM adoption	all
Responsible for PRM	project manager
PRM team	project manager innovation manager
Risk owners identified	yes

Table 10: PRM overview in the analysed case

Risk identification

The activities carried on during the first phase were context analysis, stakeholder analysis and risk identification. During these activities, the following project risk types were considered: technical-operative, organizational and financial/economic risks. With the support of brainstorming, checklist and risk register tools, the identified risks were the ones related to the user adoption, to changes in the scope/requirements as the project develops, to the knowledge of the providers of the outsourced service, to the reliability of the supplier and to the selection of technology.

During this phase, there were some difficulties for the team (i.e., understanding exactly the risks and finding the appropriate ERP supplier given their lack of technical knowledge).

Risk analysis

The project manager and the innovation manager were constantly discussing the risks related to the project. Many meetings took place during the risk analysis phase to discuss how to deal with the identified risks. Risk register, risk ranking and risk matrix tools were used to support the analysis, being the latter one the basis for the risks prioritization.

During this phase, the project manager asked the CEO for a budget increase, since there were many uncertainties related to the ERP software characteristics. Moreover, when the project was entering its second year, some change requests were made since company had started to grow more and other necessities emerged. No other difficulties were faced during the risk analysis, as the project manager had autonomy to conduct the project without any interference from the CEO.

Risk treatment

The risk treatment tools used in this project were risk mitigation, risk transfer and risk avoidance. An activity that was crucial for the project success was to choose the company to transfer the risks to, that is, the ERP company that would keep developing the software as some changes were made in the specifications and they were not sure if they should continue working with that supplier (which they did) or not. The project manager was constantly controlling the team to check if the responses to the risks were advancing according to the plan or not.

The project had turned out to be difficult both for the company and for the supplier. The new requirements that emerged during the project were difficult to be implemented and no one knew how to do it at first. Initially the system would be used only in the headquarters of the company in Pamplona, but eventually they have realized that it was necessary for the consultants in other plants to use it as well. The project manager saw it as an opportunity for the firm to be better than its competitors and decided to pursue it.

Risk monitoring & control

In the risk monitoring & control phase, risk audit and risk revaluation tools were used to support the activities of change request monitoring, action monitoring plan and periodic monitoring meeting. The risk register was also updated during this phase, as the risks were reassessed every two weeks. The main difficulties faced were the lack of time and the lack of knowledge of the company and the supplier to execute the project.

According to the project manager, once the project had finished, she wanted the users to start using the new system immediately, and this was a mistake. The user adoption is an activity that takes time and cannot be implemented from one day to another as it takes time for people to learn a new system at a satisfactory level. Both interviewees consider this to be the main lesson learned from this project.

PRM outcomes

The consultants could not estimate exactly the cost of the PRM implementation, but they believe it was around 7.000 Euro. Moreover, around 10% of the time spent by the directors in the project was dedicated to PRM.

The team did not face any difficulties during the PRM implementation as they had total support from the directors. It was a strategic project of high relevance so it was absolutely necessary to manage the risks and guarantee the project's success, otherwise the company could no longer exist. Both the project manager and the innovation manager believe that PRM should be implemented in all projects but, if that is not possible, it should be at least adopted in the strategic ones.

11. CASE STUDY 10 – CS10

The last company of this multiple case study is a medium-sized manufacturing company organized by process. The company builds tower cranes and this project consisted of constructing a tower crane with a new PLC system control. The project manager and the engineer who was responsible for the design of the project were interviewed.

The project lasted 25 months and 15 people were involved in it. It was not considered a very innovative project: according to the interviewees, the project technologic innovativeness and the innovativeness for the market were medium and the project management complexity was low. Nevertheless, the strategic relevance of the project was high, thus the importance of adopting PRM even if the risk for the project was potentially medium (3 in a Likert-scale from 1 to 5). Figure 11 displays the results.

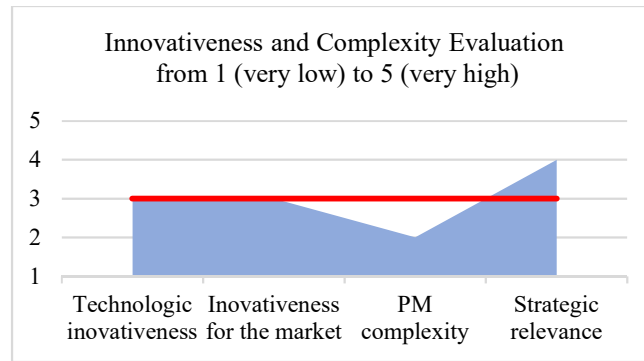


Figure 11: Project’s innovativeness and complexity evaluation

PRM process and organisation

The project manager was responsible for the PRM implementation. He was responsible for gathering information from different sectors about the project risks. Table 11 displays an overview of the PRM process, and the organization adopted in the project.

PRM overview	
Implemented PRM phases	all
PM phases with PRM adoption	all
Responsible for PRM	project manager
PRM team	project manager
Risk owners identified	yes

Table 11: PRM overview in the analysed case

Risk identification

The risk identification phase was conducted by the project manager. He interviewed experts from other areas involved in the project and created a risk register. The activities carried on during the first phase were context analysis, stakeholder analysis and risk identification. Technical-operative and organizational risks were considered. At this company, the project managers do not have any control of the budget neither do they have any information regarding the financial aspects of the project.

The main identified risks were the risks related to receiving the components in time, to the production and to personnel skills and lack of time. The project manager faced some difficulties to negotiate the deadlines of the project deliverables and to set up the meetings with the experts from the other areas.

Risk analysis

To analyse the risks, many meetings involving different people from different areas were organized. The project manager has always tried to understand the real risk impact and the real probability of risk occurrence using risk register and risk matrix tools. Both the probability and effects of risk occurrence were measured through the risk matrix, estimating the number of weeks that the project would be delayed in case of occurrence of any of those risks. The risk matrix was the main tool used during all PRM process and was constantly updated by the project manager, who shared it with the risk owners and the responsables for the different areas involved in the project.

The main difficulty faced by the project manager was to understand the information gathered with the experts of the different areas, put them together and assign responsibilities.

Risk treatment

Every two weeks there were alignment meetings, in which the risks were also discussed. Based on the results of the risk matrix, different actions to treat the risks were carried on: risk mitigation, risk transfer, risk retention and risk avoidance. For each risk, the project manager and the risk owner decided together which of the four actions to take and when to take it. The risk treatment was very successful in the project, being the lack of time the only difficulty faced.

Risk monitoring & control

During the last PRM phase, action monitoring plan activities were conducted, and the risks were once again reevaluated. The interviewees believe that the constant update of the risk register was very good for the PRM process, as it points out who is the risk owner and when that person is expected to complete the actions that they are in charge of. According to them, with this procedure, people take more action and problems are avoided.

PRM Outcomes

Approximately 200 hours (25 working days) in a 25-month project were spent in PRM, which can be considered a low value. Both interviewees stated that the costs to adopt PRM in the project were completely justified by the benefits obtained. It was not a complex project, but the application of PRM was important to keep the project deliverables in time and to assign responsibilities for the risks.

A few years ago, the project manager felt the need of managing better the risks in the project and took a course about PRM, so his knowledge and the need to define the risk owners were the enabling factors to adopt PRM. He currently adopts PRM in all his projects and intends to keep doing so.