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Risks in Enterprise Resource Planning Projects: Towards Understanding the Vendor's Perspective

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Preface

In May 2009 I had coffee with Michael Schermann, who had just completed his Ph.D on risk service engineering and was about to start a new research group at the Chair for Information Systems at the Technische Universität München. With his unrivalled optimism, Michael soon convinced me to join him in his research and to write my dissertation about information systems project risks. Today, almost four years later, I do not regret this decision. Although my expectations of academia were somewhat different, the last years turned out to be some of the most fascinating years in my life.

This dissertation would not have been possible without the help of many committed and selfless supporters. Special thanks to my doctoral advisor Professor Helmut Krcmar for the possibility to be part of a great research community with many diverse people and for his continuous guidance during the last four years. My time at the Chair for Information Systems was enriching in every way. I had the opportunity to work autonomously on a topic of my choice, to develop new methodological skills, to meet the most interesting people and to see the most interesting places. For all this I am deeply grateful. I also thank his wife Carol Krcmar who did her best to improve our sometimes very German use of the English language. I am sure that without her editing services quite a few of our publications would not have achieved the current degree of sophistication. I also owe thanks to Professor Burton Swanson who hosted my stay at the University of California Los Angeles towards the end of this dissertation. He came up with many great ideas for future research.

I am particularly indebted to my research group manager Michael Schermann. Despite his tight schedule he was always on hand with help and advice. His enthusiasm was a constant source of motivation for me. Through the sometimes strenuous but always fruitful discussions, Michael shaped many of our publications embedded in this thesis. I would also like to say a big thank you to my fellow doctoral students and friends at the Chair for Information Systems, in particular Manuel Wiesche and Konrad Dongus, whose acute sense of humor made my Ph.D. experience a very enjoyable one. Konrad is also one of my co-authors, whose contributions to this cumulative thesis cannot be emphasized strongly enough. I also thank my students and co-authors Tobias Hlavka, Marco Aust, Matthias Lenk and Melanie Langermeier. I'm grateful for their valuable research support. Much of this thesis builds on their data collection and data preparation efforts.

Besides my supervisors, colleagues, and students, my family and my friends have a large share in this dissertation. They all helped creating a unique social ecosystem that provided me with the necessary balance between work and life. Among the many who are part of this ecosystem, the following deserve special thanks: My father, Axel Hörmann, who always encouraged me to be the best possible version of myself. He led by example. My girlfriend, Daniela Strobl and my long-term friends from Tegernsee, Leonie Fresenius, Christin Conrad, Kristina Würz, Carolin Mayer, Sara Sottanelli, Max Kuhn, Franz Reiffenstuel, Ludwig Jaskolla, Josef Bichler, Willy Nowak, Max Knauer and Sebastian Obermüller, with whom I had many joyous moments, not only in the last four years. And, last but not least, my soccer teammates from Kreuth, who provided a very valuable contrast to academia. I dedicate this dissertation to them.

Tegernsee, July 2013 Stefan Hoermann

Abstract

Problem Statement: Despite years of experience in Information Systems (IS) project risk management, IS projects frequently fail with severe consequences for organizations. This thesis argues that our understanding of risks in IS projects is incomplete because of four challenges that are not addressed in extant research: (1) the overgeneralization of IS projects, (2) the focus on the client's perspective, (3) the reliance on primary data, and (4) the reliance on cross-sectional data. By investigating risks specifically in Enterprise Resources Planning (ERP) projects from a vendor's perspective with longitudinal archival data, this thesis contributes to a more nuanced understanding of IS project risks as the basis for more successful IS projects.

Research Design: Following a pragmatic epistemological position, we combine quantitative and qualitative strategies of inquiry to address the above mentioned challenges and the research questions that follow from them. Mixed strategies tend to provide stronger inferences and generate a richer understanding of the phenomenon of interest than either a quantitative or a qualitative strategy on its own.

Results: The results of this thesis comprise differences in risk profiles between different kinds of IS projects, an overview on risk and success factors in ERP projects, a ranking of risk factors in ERP projects from a vendor's perspective, temporal characteristics of risks in ERP projects from a vendor's perspective, determinants of the vendor's overall risk estimation in ERP projects, risk scenarios affecting the vendor's project profitability in ERP projects, and determinants of vendor profitability in ERP projects.

Contribution: In general, this thesis contributes to theory and practice by addressing the four challenges mentioned above, i.e., by (1) specifically investigating ERP projects instead of IS projects in general, by (2) focusing on the vendor's perspective instead of the client's perspective, by (3) leveraging secondary instead of primary data, and by (4) leveraging longitudinal instead of cross-sectional data. The contribution to theory relates to an improved understanding of variables, relationships, reasoning, and boundary conditions relating to ERP projects risks. The contribution to practice comprises a set of guidelines for ERP project risk management.

Study Limitations: This thesis is subject to several limitations. Threats to internal validity mainly result from our use of archival data. When using archival data, researchers do not have control over events and cannot rule out all rival explanations that may also lead to the obtained results. However, the overall plausibility of our explanations and the recurrent discussions with our industry partners give us some confidence in the internal validity of our results. Threats to external validity mainly result from the limited number of organizations our data is collected from. Due to specific characteristics of our industry partners, our findings have to be treated with care when generalizing to other organizations or industries.

Future Research: Given the results and the limitations of this thesis, we see several avenues for future research. In general, as many of our analyses are based on data from one company only, the validity of our results would benefit from replicating our studies in different settings, i.e., for different vendors and in different industries. More specific avenues for future research include: Deriving a typology of IS projects, comparing client and vendor perspectives on risk in IS projects, demonstrating the benefits of IS project risk management, investigating interrelationships between risks and IS project outcome, analyzing the effect of contract characteristics on IS project outcome, broadening the definition of vendor risks in IS projects, and analyzing further contractual regimes underlying IS projects.

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List of Abbreviations

A	Assumption
AMICS	Americas Conference on Information Systems
BLUE	Best Linear Unbiased Estimator
C	Challenge
CON	Conference
CRM	Continuous Risk Management
ECCS	Expeditionary Combat Support System
ECIS	European Conference on Information Systems
ERP	Enterprise Resource Planning
FP	Fixed Price
ICIS	International Conference on Information Systems
IJITPM	International Journal of Information Technology Project Management
IS	Information Systems
ISD	Individual Software Development
ISO	International Organization for Standardization
JIT	Journal of Information Technology
JNL	Journal
KBV	Knowledge Based View
M	Method
MIS	Management Information Systems
NR	Not Ranked
O	Outcome
OLS	Ordinary Least Squares
P	Publication
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PSI	Packaged Software Implementation
RQ	Research Question
SEI	Software Engineering Institute
TM	Time and Material
VHB	Verband der Hochschullehrer für Betriebswirtschaft
VIF	Variance Inflation Factor

Part A

1 Introduction

1.1 Problem Statement

Information systems (IS) have gained increasing importance in public and private organizations. They are involved in almost every organizational activity, whether they only play a supporting role or are critical elements in an organization's business model (McFarlan/McKenny/Pyburn, 1983). Research institutes estimate the worldwide spending on devices, data center systems, enterprise software, IS services, and telecommunication services to amount to 3,737 billion USD (Gartner Research, 2012).

There exists a wide range of benefits organizations expect to achieve from the use of IS (DeLone/McLean, 1992), ranging from individual benefits, such as increased task productivity or increased task innovation (Torkzadeh/Doll, 1999), to organizational ones, such as increased profitability or increased stock market valuation (Brynjolfsson/Hitt, 2003). Though sometimes discussed controversially (Carr, 2003), there is substantial empirical evidence that investment in IS actually results in benefits on both, the individual level (Bailey/Pearson, 1983; Clemons/Reddi/Row, 1993) and the organizational level (Brynjolfsson/Hitt, 1998; Hitt/Wu/Zhou, 2002; Brynjolfsson/Hitt, 2003).

Realizing these benefits, however, turns out to be difficult. IS projects – temporary organizations to which resources are assigned to do work to bring about beneficial change (Turner, 2006c) – are notorious for bearing a high risk of failure. Two prominent examples of failed IS projects highlight this issue: In 2008, Levi Strauss, a multinational apparel manufacturer, faced technical issues in an enterprise resource planning (ERP) project which was meant to consolidate the existing IS landscape. As a consequence, the company's internal control processes malfunctioned, preventing Levi Strauss from fulfilling orders for one week and causing a drop in quarterly net income of 192.5 million USD (Flyvbjerg/Budzier, 2011). Another recent example is provided by the US Air Force, which, in 2012, decided to cancel its expeditionary combat support system (ECSS) project. The ECSS project aimed at replacing legacy applications for financial reporting and incurred costs of approximately 1 billion USD (Kanaracus, 2012). Table 1 provides a selection of prominent IS project failures in the last decade.

Given this high risk of failure and its severe consequences, information systems project risk management (ISPRM) has gained considerable importance in recent years among researchers and practitioners. There are various streams of research in the discipline of ISPRM. Above all, researchers have analyzed dimensions of IS project success (Atkinson, 1999; Baccarini, 1999; Shenhar et al., 2001; Bannerman/Thorogood, 2012), risks to these success dimensions (Boehm, 1991; Schmidt et al., 2001; Liu et al., 2010), and approaches how to best manage these risks (Charette, 1996; Heemstra/Kusters, 1996; Powell/Klein, 1996).

Year	Organization	Project	Consequences	Source
2012	Avantor	Upgrade of the ERP platform	The project caused severe disruptions in customer service processes and was eventually cancelled; IBM got sued for several millions of USD.	Frost (2012)
2012	American Air Force	Implementation of an ERP system to replace over 200 different legacy systems	After six years and additional costs of over two billion USD, the expeditionary combat support system (ECSS) project was cancelled.	Kanaracus (2012)
2011	British National Health Service	Implementation of an electronic patient record system	The NPfIT project was cancelled after nine years of development and costs of around twelve billion GBP.	Randell (2007)
2010	German Federal Armed Forces	Modernization of the IS infrastructure	The Herkules project faced delays and budget overruns of more than 600 million EUR. At the same time user evaluations suggest low system performance, frequent system failures and consequently a low user satisfaction.	Schulzki-Haddouti (2010)
2008	Levi Strauss	Implementation of an ERP system to replace several legacy systems	The new system caused issues with internal financial controls and order fulfillments, eventually resulting in a drop in quarterly net income of 193 million USD.	Flyvbjerg/Budzier (2011) and Buhl (2012)
2005	German Ministry of Transport	Development and implementation of a distance-based toll system	Project delays of sixteen months are estimated to have cost the German government revenue losses of ten billion USD; arbitration in the Toll Collect case is still ongoing.	Foti (2004) and Flyvbjerg/Budzier (2011)
2004	Ford	Implementation of a procurement system	The project was cancelled after four years of development and incurring costs of several million USD.	Songini (2004)

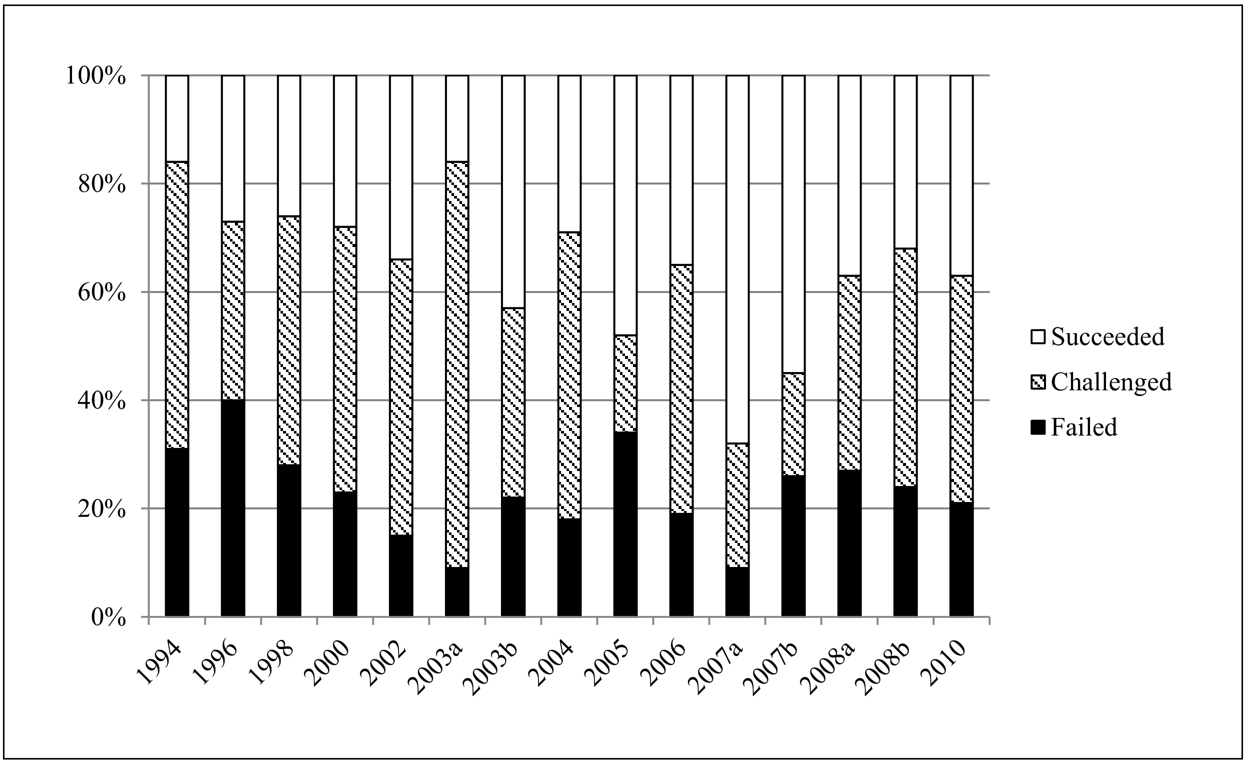
Table 1. Selection of Prominent IS Project Failures

Despite a fast growing body of knowledge and more than two decades of experience in ISPRM, there still seem to exist many IS projects that face budget or schedule overruns or do not result in the expected beneficial change: The well-known and widely cited CHAOS reports on IS project success/failure state an average failure rate of 25% over the last 16 years (with a maximum of 40% in 1996 and a minimum of 15% in 2002)[1]. In the 2010, 68% of the sample projects were considered failed (24%) or challenged (44%) concerning budget, schedule, or scope (The Standish Group, 2010).

Even though many researchers raise concerns about the CHAOS report's validity (Glass, 2006; Jorgensen/Molokken, 2006; Eveleens/Verhoef, 2010), failure rates in academic studies tend to be high as well: Cuthbertson/Sauer (2003) found that 75% of the IS projects in their sample are challenged with regard to budget, schedule, or scope. Two replication studies in South Africa by Sonnekus/Labuschagne (2004) and Labuschagne/Marnewick/Jakovljevic (2008) suggest that failure rates are as high as 22% and 27% respectively. Sauer/Gemino/Reich (2007) analyzed 412 IS projects in the UK and found that about 32% were either abandoned or considerably challenged with respect to their budget, schedule, or scope. El Emam/Koru (2008) asked mid- and senior level IS project managers to report on multiple dimensions of project success in two consecutive surveys in 2005 and 2007. Their results suggest that between 34% and 26% were unsuccessful, i.e., failed or challenged, with no significant improvement in cancellation rates from 2005 to 2007. A more recent study by Flyvbjerg/Budzier (2011) suggests an average budget overrun in IS projects of 27%. More importantly, however, the authors pointed out that these overruns do not follow a normal distribution but rather exhibit "fat tails", i.e., massive overruns occurred much more often than expected. In fact, every sixth project exceeded its budget by on average 200% and its schedule by 70%. As Flyvbjerg/Budzier (2011) illustrate, not only do IS projects fail quite often, but some IS projects do so with rather extreme budget and schedule overruns. These "black swan" projects often have severe consequences, sometimes even causing whole companies to fail (Buhl, 2012).

In sum, industry reports and academic studies both still point to considerable failure rates in IS projects. Figure 1 aggregates the results of various studies on IS project failure rates from 1994 to 2010. Though it is hard to compare these studies due to heterogeneous definitions of IS project success and failure, it becomes clear that IS projects have considerable potential for improvement.

[1] The CHAOS report considers a project successful if it is completed on-time and on-budget, with all features and functions as initially specified. A project is considered challenged if it is completed and operational but exceeded initial budget or schedule objectives or falls short of initial scope objectives. A project is considered failed if the project is cancelled at some point during the development cycle. We applied this definition of failed and challenged IS projects when compiling Figure 1.



1994: The Standish Group (1994); 1996: The Standish Group (1996); 1998: The Standish Group (1998); 2000: The Standish Group (2000); 2002: The Standish Group (2002); 2003a: Cuthbertson/Sauer (2003); 2003b: Sonnekus/Labuschagne (2004); 2004: The Standish Group (2004); 2005: El Emam/Koru (2008); 2006: The Standish Group (2006); 2007a: Sauer/Gemino/Reich (2007); 2007b: El Emam/Koru (2008); 2008a: Labuschagne/Marnewick/Jakovljevic (2008); 2008b: The Standish Group (2008); 2010: The Standish Group (2010).

Figure 1. Failure Rates in IS Projects From 1994 to 2010

With these high failure rates in mind, we argue that the understanding of risks in IS projects may be limited. We identify four fundamental challenges (C) that have not been addressed in extant IS research:

– **C1: Overgeneralization.** Studies on IS project risks seldom differentiate between different types of IS projects. However, researchers suggest that there exist fundamental differences between IS projects, which makes it difficult to generalize findings (McFarlan, 1981; Sherer/Alter, 2004; Bannerman/Thorogood, 2012; Keil/Rai/Liu, 2012). For instance, Markus/Tanis (2000) point out distinct characteristics of ERP projects, such as the integration of company-wide information, the use of off-the-shelf packages, or the frequently required change of business processes. These characteristics seem to result in specific risk profiles for ERP projects (Sumner, 2000; Aloini/Dulmin/Mininno, 2007). A study by Appari/Benaroch (2010) confirms that different IS projects are likely to exhibit different sensitivities to risks. Lacking a commonly accepted typology of IS projects that would help avoid overgeneralization, the papers in this thesis instead focus on projects that are concerned with the installation, parameterization, integration, testing, and upgrading pre-packaged ERP software as one specific type of IS projects. ERP software is the largest segment of the software market (Gartner Research, 2012) and one of the most imperative enterprise technologies in recent years (Markus/Tanis, 2000; Shah/Goldstein/Ward, 2002). Furthermore, because ERP projects tend to be particularly prone to failure (Sumner, 2000) and tend to feature particularly intense client-vendor relationships (Markus/Tanis, 2000) they provide fertile ground for analyzing project risk from a vendor's perspective (see C2).

- **C2: Focus on the client's perspective.** Much of the existing literature focuses on the client's perspective on risks in IS projects (Levina/Ross, 2003; Dibbern et al., 2004; Savolainen/Ahonen/Richardson, 2012). In recent years, however, companies have reduced their share of in-house IS activities, giving rise to an IS industry with a global turnover of approximately 2,700 billion USD in 2012 (Hess et al., 2012). Today, most IS projects are conducted with the help of external service providers or vendors that bring specific expertise and capabilities to the process and considerably influence project value creation (Swanson, 2010). Research has made only tentative attempts to systematically analyze risk from a vendor's perspective. It is suggested though that vendors and clients have different perceptions of success and consequently also face different risks (Markus/Tanis, 2000; Gopal/Koka, 2012; Savolainen/Ahonen/Richardson, 2012). This thesis presumes that, in order to deliver more successful IS projects, it is necessary to understand both, the client's and the vendor's perspective on risks. Five papers in this thesis therefore focus specifically on the vendor's perspective.

- **C3: Reliance on primary data.** Researchers in the field of IS project risk management tend to rely on primary data, i.e., data that is explicitly collected for research purposes via instruments, such as surveys or interviews. Collecting primary data allows the researcher to tailor the data collection process to the specific research problem. However, related to the fact that the researcher interacts with the phenomenon under investigation, analysis of primary data may also be subject to several biases. Podsakoff et al. (2003) provide an extensive discussion on the sources of so called common method bias, i.e., bias that "is attributable to the measurement method rather than to the constructs the measures represent" (Podsakoff et al., 2003, 879). Potential biases related to a study's respondents may result from consistency motives, implicit theories, social desirability, leniency, acquiescence, positive and negative affectivity, transient mood states or recall issues. For instance, Du et al. (2007) acknowledge that project managers that are currently involved in a project may be subject to social desirability bias, i.e., respond to a researcher's questions in a manner they think is expected from them and that presents themselves in a favorable light. This tendency might result in an underreporting of inconvenient facts, an issue which is particularly problematic when researching risks. Employing different data sources is an intuitive remedy for common method bias (Podsakoff et al., 2003; Chang/van Witteloostuijn/Eden, 2010). In this thesis, six papers are based on archival data. Though being subject to different forms of biases, archival data offer a complementary perspective on extant research results that mainly rely on primary data.

- **C4: Reliance on cross-sectional data.** Closely related to the above mentioned focus on primary data is the fact that studies in the field of ISPRM are oftentimes cross-sectional in nature. Cross-sectional studies provide a snapshot of the phenomenon of interest at one point in time. In contrast, longitudinal studies collect and analyze data at several points in time, enabling the researcher to investigate aspects of organizational change and learning that are inherently linked to the concept of time and, thus, might not be visible from cross-sectional data (Pettigrew, 1990; Van de Ven/Huber, 1990; Shultz/Hoffman/Reiter-Palmon, 2005). Temporal precedence that can be observed from longitudinal data is also one of the requirements for inferring from correlation to causality (Miles/Huberman, 1994). In that way, longitudinal data are particularly apt for investigating causes and effects. Given the lack of guiding theory in the field of ISPRM, researchers have repeatedly called for a longitudinal perspective in order to determine interdependencies between risks (Yetton et al., 2000; Wallace/Keil/Rai, 2004a; Gemino/Reich/Sauer, 2008). Two papers in this thesis follow this call and provide a detailed temporal account of how risks evolve in ERP projects.

1.2 Research Questions

The overall objective of this thesis is to advance the understanding of risks in IS projects by tackling selected research gaps in the discipline of ISPRM that follow from the above mentioned challenges. Below, we briefly illustrate the research questions (RQ) that will be addressed in this thesis.

The prioritization of IS project risks likely depends on the type of IS project under investigation. While extant studies tend to investigate IS projects in general, a detailed analysis of how the risk profiles of different types of IS projects vary does not exist. Differentiating between IS project types might result in more specific risk profiles which again may provide the basis for more effective risk management.

- **RQ1:** What differences exist between individual software development (ISD) and packaged software implementation (PSI) projects, such as ERP projects, with regard to their risk profiles?

There are two main streams of research, which aim at increasing the success rate of ERP projects: Research on risk factors and research on success factors. Efforts to integrate and compare these two fields are rare. Integration promises mutual benefits by highlighting synergies and complementary aspects between these two streams of research.

- **RQ2:** What risk and success factors to ERP project outcome can be found in the IS literature and how do these two streams of research differ?

Researchers have devised various checklists of risks. These prioritized lists of risks are frequently used in practice in order to guide project managers in risk identification and risk assessment. The underlying mechanisms that lead to this prioritization are, however, not explicitly stated. Providing a vendor's perspective might yield new insights with regard to the relative importance of ERP project risks and illustrate underlying mechanisms.

- **RQ3:** What are mechanisms that explain rankings of risk factors in ERP projects from a vendor's perspective?

In addition to knowing what risks are important in IS projects and what mechanisms drive the prioritization of risks, knowing when to manage risks is also crucial for risk management to be effective and efficient. While researchers have acknowledged that IS project risks vary over time (e.g., Wallace/Keil/Rai, 2004a; Gemino/Reich/Sauer, 2008) the predominant perspective on risks in IS projects is a static one. Analyzing temporal variations in the importance of risks promises useful insights for risk managers when to manage which risks during the project life cycle.

- **RQ4:** How do ERP project risks evolve over time?

A vendor's estimation of the overall project risk prior to project start affects many subsequent managerial decisions, such as the design of contractual provisions or the project governance. Transaction characteristics, such as the project size or the contract type, may provide the vendor with early indicators of the project's overall risk. To date, however, little is known whether transaction characteristics affect the vendor's risk estimation.

- **RQ5:** Do vendors include transaction characteristics in their risk estimation when estimating overall ERP project risk?

While acknowledging that IS project risks are interrelated, extant research most often assumes that risks work in isolation. It is unclear what interrelations between risks exist and how vendor profitability is affected. Identifying interrelations between risks may help project managers in addressing root causes of project failure early in the project life cycle.

- **RQ6:** How do risk factors affect vendor profitability in ERP projects?

Structural project risks such as the size or the contract type of the project, and knowledge risks, such as a lack of client or industry knowledge, are suggested to be important determinants of vendor profitability in ERP projects. Empirical evidence of the significance and the effect sizes of these relationships, however, is missing. Estimating these effect sizes provides vendors with useful information with regard to their expected project profitability.

- **RQ7:** What is the effect of structural and knowledge related risks on vendor profitability in ERP projects in fixed price (FP) and time and materials (TM) contracts?

These research questions and the according publications address the challenges mentioned above as illustrated in Table 2.

	RQ1	RQ2	RQ3	RQ4	RQ5	RQ6	RQ7
C1. Overgeneralization	●	●	●	●	●	●	●
C2. Focus on the client's perspective			●	●	●	●	●
C3. Reliance on primary data		●	●	●	●	●	●
C4. Reliance on cross-sectional data				●		●	

C: challenge; RQ: research question; ●: addresses challenge.

Table 2. Research Questions and Challenges Addressed

1.3 Structure

This cumulative thesis consists of three parts. Part A gives an overview on this thesis. It consists of three chapters. Chapter A1 introduces the problem statement and gives an overview on the research objective and the structure of this thesis (this chapter). Chapter A2 introduces basic terms in the areas of IS project success, IS project risk and IS project risk management and provides an overview on the current state-of-the-art in these research areas. In chapter A3 the research methods of this thesis are described. Part B of this thesis consists of seven peer-reviewed publications (chapters B1 to B7). The focus of the first three publications is on identifying risks in ERP projects. The focus of the last four publications is on analyzing characteristics and effects of risks in ERP projects. Part C concludes this thesis. It consists of four chapters. In chapter C1, the results of the seven publications are summarized. Chapter C2 discusses the contributions to research and practice. Chapter C3 outlines the study limitations. Finally, chapter C4 illustrates several anchor points for future research. Figure 2 gives an overview on the structure of this thesis.

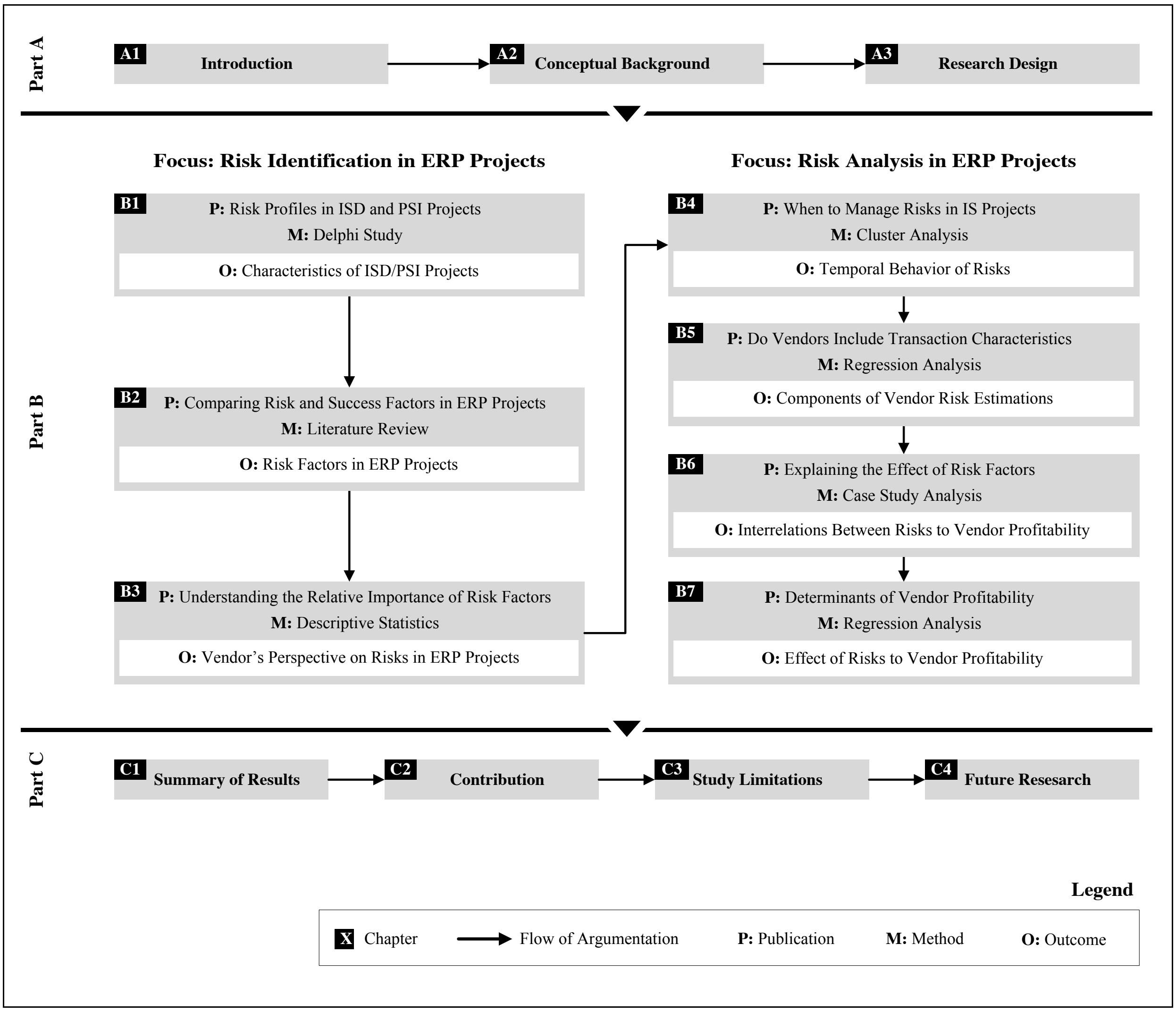


Figure 2. Thesis Structure

In the following paragraphs, we summarize the seven publications embedded in part B. In doing so, the research problem, the methodological approach, and the main contributions of each publication (P) are briefly outlined.

- **P1: Risk Profiles in ISD and PSI Projects.** In order to develop an understanding of the characteristics of ERP projects, one important kind of PSI projects, we contrast the risk profiles of PSI projects and ISD projects using a Delphi approach. While researchers have investigated risks in either PSI projects or ISD projects, an integrated perspective on how the risk profiles of these two types of IS projects differ is missing. To explore these differences, we conducted a Delphi study at a German-based financial services company. Our results suggest that (1) ISD projects seem to be more heterogeneous and face a larger variety of risks than the more straightforward PSI projects, (2) ISD projects seem to be particularly prone to risks related to sponsorship, requirements, and project organization, (3) PSI projects tend to be predominantly subject to risks related to technology, project planning, and project completion, and

(4) in contrast to available lists of risks in IS projects and irrespective of the project type, technology and testing-related risks are of high importance.

- **P2: Comparing Risk and Success Factors in ERP Projects.** This publication reviews the literature on risk and success factors in ERP projects. There are two main streams of research, which aim at increasing the success rate of ERP projects: Research on risk factors and research on success factors. Despite their relatedness, efforts to integrate these two fields have been rare. Against this background, this paper analyzes 68 articles dealing with risk and success factors and categorizes all identified factors into twelve categories. Though some topics are equally important in risk and success factor research, the literature on risk factors emphasizes topics which ensure achieving budget, schedule and functionality targets. In contrast, the literature on success factors concentrates more on strategic and organizational topics. We argue that both fields of research cover important aspects of project success. The paper concludes with the presentation of a framework that may help integrating our understanding of risk and success factors in ERP projects.

- **P3: Understanding the Relative Importance of Risk Factors.** Commonly, project managers and researchers agree that identifying risks is the most crucial step in project risk management. Hence, extant research provides various rankings of risk factors. In this paper, we rank the importance of risk factors based on an archive of project risk reports provided by project managers of a large software vendor. In contrast to previous research that ranks people and processes as most important risk domains, our analysis emphasizes technology-related risk factors. We argue that this conflict might result from two dimensions determining the perceived importance of risk factors: Controllability and micro-politics. A project manager will rank risks higher when he has only limited control on mitigating risks. Risks beyond control will be neglected. However, in a corporate context, micro-political mechanisms change the importance towards these risks. They will exploit risk management to escalate uncontrollable threats to project success and cover risk factors that stem from shortcomings of their own or of colleagues. Thus, micro-political mechanisms reveal the most important risks from a corporate perspective. Detached from the corporate context, project managers emphasize risks threatening efficient project management. We contribute to IS research by proposing alternative explanations for the ranking discrepancies. By demonstrating that the importance of risk factors cannot be determined objectively, this publication sets the stage for a closer investigation of the vendor’s perspective in the following publications.

- **P4: When to Manage Risks in IS Projects.** Research attributes the mixed performance of IS projects to a poor understanding of risks. In line with others, we argue that the poor understanding of risks is partly due to the fact, that current research tends to concentrate on which risks are important in IS projects. In contrast to this static view, we focus on the temporal aspect of project risks, i.e., we explore when risks become more or less important during a project. We analyze an archive of risk reports of completed enterprise software projects. Project managers regularly issued these risk reports to communicate the status of their projects. Our findings are as follows: First, the perceived importance of risks does vary over project phases.

Second, the volatility of risk exposure varies over different types of risks and project phases. Third, risks of various origin exhibit synchronous changes in risk exposure over time. From a research perspective, these findings substantiate the need for a temporal perspective on IS project risks. Thus, we suggest augmenting the predominant static view on project risks in order to help project managers in focusing their scarce resources. From a practical perspective, we highlight the benefits of regularly performing risk management throughout projects and constantly analyzing the project portfolio. In sum, we provide a first time, descriptive and exploratory view on variations in project risk assessments over time.

- **P5: Do Vendors Include Transaction Characteristics in Their Risk Estimation.** In this paper, we study whether transaction characteristics are included in the vendor's estimation of risk to project profitability. Transaction characteristics such as a project's size or its contract type are often seen as considerable risks for software vendors. Thus, we hypothesize that project size, contract type, strategic importance, and client familiarity are included in the risk estimations. Regression analysis suggests that, surprisingly, vendors do not include all transaction characteristics in their risk estimation: While we found that larger projects and FP contracts are significantly associated with the vendor's risk estimation, strategic importance and client familiarity are not. Our data set also incorporates data on project profitability that presents us with the opportunity to test the efficiency of the risk estimation. We found that the vendor's risk estimation is efficient with regard to project size and contract type. Finally, the efficiency analysis also suggests that vendors deliberately accept profitability losses when conducting strategic projects.

- **P6: Explaining the Effect of Risk Factors.** In this paper, we used a multiple case study to investigate interrelations between risk factors in ERP projects and vendor profitability, which is an essential dimension of project success for a vendor. We structured the vendor's perspective on risk factors using a network based on a triangulation of archival data, interviews, and accompanying documents from five projects of a large German-based ERP vendor. The network organizes the risk factors into four major risk scenarios: high deficits in vendor obligations, high deficits in client obligations, strong disagreement concerning scope and requirements, and high client negotiation power. While the identified risk factors themselves seem to be quite straight-forward reflections of the client's perspective, our analysis reveals that the risk scenario high client negotiation power moderates the impact of risk factors on vendor profitability. Furthermore, our findings show that vendor profitability is under threat when, over time, multiple risk scenarios befall the project. This paper contributes by addressing the essential role of interrelations between risk factors and by exploring the vendor's perspective on risk factors in ERP projects, a so far neglected perspective in IS research. It provides the necessary understanding of the effect of risks for the quantitative analysis of vendor profitability conducted in P7.

- **P7: Determinants of Vendor Profitability.** This paper investigates the effects of four determinants of vendor profitability in enterprise resource planning (ERP) projects under two contractual regimes: fixed price (FP) contracts and time and material (TM) contracts. As vendor profitability is one of the most important dimensions of project success for vendors, analyzing selected determinants of vendor profitability seems worthwhile from a risk management perspective. From a transaction cost economics perspective, we hypothesize that project size and project uncertainty are negatively associated with vendor profitability. From a knowledge-based view of the firm perspective, we hypothesize that industry knowledge and client knowledge are positively associated with vendor profitability. We also hypothesize that effect sizes are larger under FP contracts than under TM contracts. We tested these hypotheses on a comprehensive archival data set which included 33,908 projects from a major vendor in the ERP software market. Surprisingly, we found client knowledge to be negatively associated with vendor profitability. Results were mixed with regard to the association between project size and vendor profitability depending on the contractual regime underlying the project. Our results suggest that vendor profitability is negatively affected by project uncertainty and positively affected by industry knowledge. Our analysis confirms the existence of two contractual regimes: The effect sizes are indeed much larger in FP contracts than in TM contracts. By analyzing determinants of the vendor's profit margin in domestic ERP projects, our study offers a more nuanced understanding of vendor profitability in information systems (IS) projects.

No.	Authors	Title	Outlet	Type
P1	Hoermann, Schermann, Aust, Krcmar	Risk Profiles in Individual Software Development and Packaged Software Implementation Projects: A Delphi Study at a German-based Financial Services Company	IJITPM 2013 (accepted)	JNL (NR)
P2	Hoermann, Kienegger, Langermeier, Mayer, Krcmar	Comparing Risk and Success Factors in ERP Projects: A Literature Review	AMCIS 2011 (accepted)	CON (VHB: D)
P3	Hoermann, Schermann, Krcmar	Towards Understanding the Relative Importance of Risk Factors in IS Projects: A Quantitative Perspective	ECIS 2010 (accepted)	CON (VHB: B)
P4	Hoermann, Schermann, Krcmar	When to Manage Risks in IS Projects: An Exploratory Analysis of Longitudinal Risk Reports	ECIS 2011 (accepted)	CON (VHB: B)
P5	Hoermann, Dongus, Schermann, Krcmar	Do Vendors Include Transaction Characteristics in Their Risk Estimation? An Empirical Analysis of ERP Projects	ICIS 2012 (accepted)	CON (VHB: A)
P6	Hoermann, Schermann, Lenk, Krcmar	Explaining the Effect of Risk Factors on Vendor Profitability in ERP Projects: A Multiple Case Study	EURAM 2013 (accepted)	CON (NR)
P7	Hoermann, Hlavka, Schermann, Krcmar	Determinants of Vendor Profitability in Two Contractual Regimes: An Empirical Analysis of Enterprise Resource Planning Projects	JIT 2013 (2nd round of review)	JNL (VHB: B)

IJITPM: International Journal of IT Project Management; AMCIS: Americas Conference on Information Systems; ECIS: European Conference on Information Systems; ICIS: International Conference on Information Systems; EURAM: European Academy of Management; JIT: Journal of Information Technology; JNL: Journal; CON: Conference; NR: Not Ranked; VHB: German Academic Association for Business Research.

Table 3. Overview on Embedded Publications

2 Conceptual Background

The following chapter introduces three interrelated streams of research in the field of ISPRM that provide the conceptual background for this thesis: Research on IS project success, research on IS project risk and research on IS project risk management approaches (see Figure 3). Research on IS project success evolves around criteria that can be used to define and evaluate IS project success. Research on IS project risk investigates reasons for negative deviations from these criteria. Finally, research on IS project risk management approaches is concerned with how to avoid these deviations.

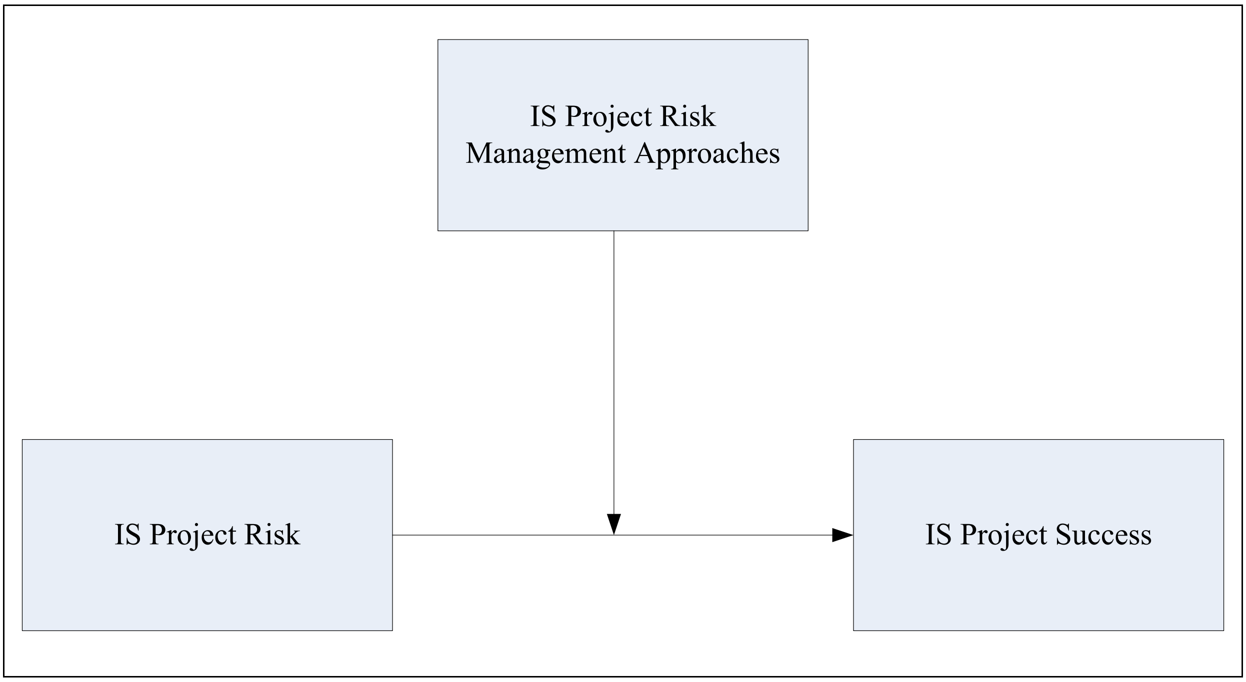


Figure 3. Three Interrelated Streams of ISPRM Research

2.1 IS Project Success

The central concept of this thesis – IS project risk – is closely linked to the concept of IS project success. The question of how to define IS project success has long concerned IS researchers. In fact, an inadequate understanding of IS project success has been proposed to be one of the reasons for the perceived software crisis (Bannerman/Thorogood, 2012). According to the biannual CHAOS reports of the Standish Group, the IS industry is stuck in an era of non-successful IS projects. In 2010, only 32% of IS projects were considered successful. In contrast, 24% were considered failed and 44% were considered partly failed or "challenged" (The Standish Group, 2010). In addition, failing IS projects are hardly a new phenomenon. Fifteen years earlier, in 1995, the Standish Group stated that 31% of all IS projects were cancelled. Even though only a proportion of the value creation in the IS industry is organized in the form of projects, with an overall size of 3.5 trillion USD, the financial consequences of IS project failure are considerable (Gartner Research, 2012). However, a closer look at the numbers is worthwhile. Following the Standish Group's definition, a project is successful if it finishes within budget and schedule and achieves its scope specifications. These three success criteria[2] are also known as the "iron triangle" and represent a traditional and widely spread view of IS project success (Wateridge, 1995; Atkinson, 1999).

In the face of the diverse objectives and stakeholder groups associated with IS projects, this definition, however, seems outdated[3]. Given the IS industry's enormous success in the last decades, it seems quite misjudged to speak of a software "crisis". It rather seems that the traditional criteria of IS project success may sometimes be misleading. The Sydney Opera House is an often cited example to illustrate the notion that there might be further criteria to judge a project's overall success. The construction of the Sydney Opera House amounted to a budget of 50 million GBP and took 14 years. Judging by its original targets of 3.5 million GBP and six years the Sydney Opera is one of the most disastrous project failures in recent history. Nevertheless it's generally regarded as one of the most impressive demonstrations of modern architecture and attracts millions of tourists every year (Lim/Zain, 1999; Shenhar et al., 2001). A vast majority of researchers acknowledges that looking at the three success criteria schedule, budget, and quality is only part of a holistic consideration of IS project success. Recent definitions acknowledge that IS project success is perspective-, time-, and task-dependent. These characteristics of IS project success will be discussed in the following:

- **Dependence on Perspective:** The interests of various project stakeholders have gained increasing importance in the recent literature. Stakeholder satisfaction is seen as an essential part of IS project success (Atkinson, 1999; Baccarini, 1999; Chan/Scott/Lam, 2002). As a consequence, it follows that IS project success cannot be defined objectively (de Wit, 1988). Different stakeholders will assess a project differently according to which success criteria they prioritize most (Shenhar/Levy/Dvir, 1997). Even in the case that two stakeholders agree on a common project objective their views on in how far the objective was achieved could differ considerably (Barclay/Osei-Bryson, 2010). According to Freeman (1984) a stakeholder is 'any group or individual who can affect or is affected by the achievement of the organization's objectives'. In the case of projects, stakeholders typically comprise the project manager, the project team members, the client, the user, and the project sponsors. Depending on which perspective one takes, objectives and success criteria vary. For instance, a project manager might strive for schedule, budget and scope objectives whereas the client considers a high user acceptance rate more

[2] While "success criteria" and "success factors" are sometimes used synonymously, this thesis differentiates between these two terms: Success criteria can be seen as measures used to assess the success of a project. For instance, the iron triangle mentioned above represents three different success criteria. Consequently, success criteria define the term project success, but do not affect it. In contrast, success factors are aspects the presence or absence of which affect the outcome of a project. For instance, the knowledge and experience of the project team is frequently mentioned as an important success factor as it contributes to a positive project outcome. Occasionally, success criteria and success factors are not mutually exclusive: A positive working atmosphere could be regarded as both, an important success criteria and an important success factor.

[3] The CHAOS report was not only criticized for its outdated definition of project success. Several academics also mistrusted its opaque methodological approach and the Standish Group's quite offensive way of marketing the results (Glass, 2006; Jorgensen/Molokken, 2006).

important. Similarly, for the project manager an unsatisfactory outcome might be one which causes schedule/budget overruns or scope constraints (e.g., unstable requirements) while for the client everything which impedes user acceptance is unsatisfactory (e.g., an unintuitive graphical user interface). Accordingly, researchers have suggested that the question whether a project was successful cannot be answered yes or no. Rather, IS project success has to be evaluated in a more differentiated way, integrating various stakeholder perspectives, their evaluation criteria and different levels for each criterion. In order to conduct successful projects, project managers have to be aware of the various stakeholder groups and their objectives (de Wit, 1988). In the wake of this development users have been identified as one of the most important stakeholder groups and user satisfaction as one of the most important success criteria (Lipovetsky et al., 1997; Procaccino et al., 2005). However, even more important seems to be the perspective of the client's top management (Collins/Baccarini, 2004). Considering the perspective of the client's top management has resulted in dividing IS project success into two different components: project management success and product success (de Wit, 1988, Barclay, 2008 #30; Baccarini, 1999). Project management success comprises the evaluation of the project phase, i.e., mainly time, cost, and quality aspects (Wateridge, 1995), but also stakeholder satisfaction related to this phase (Baccarini/Salm/Love, 2004). Product success comprises more complex aspects such as the fulfillment of the client's top management's strategic objectives, in the case of IS projects, for instance, more efficient business processes, but also aspects such as the users' satisfaction with the final system. Collins/Baccarini (2004) state that project management success may positively affect product success but does not guarantee it. Consequently, a project that fulfills time, budget, and quality targets can still be seen as failure (de Wit, 1988)

– **Dependence on Time:** Besides the consideration of stakeholder groups it is beyond dispute that the prioritization of success criteria as well as their evaluation can change over time: At different points in time a project can be seen as both, a success and a failure (de Wit, 1988). Thus, Ojiako/Johansen/Greenwood (2008) recommend assessing project success as late as possible in order to capture all relevant success criteria. Against this, Atkinson (1999) suggests that evaluating project success early might be required. For instance in the case of performance-related pay for project managers, success has to be evaluated immediately after project completion. However, this focus on short-term objectives might result in misaligned incentives for the project managers who as a consequence would exclusively focus on efficient project management and disregard long-term objectives such as user satisfaction or strategic objectives, which are potentially more valuable to the client (Judgev/Mueller, 2005). On the other hand, evaluating project success late comes with issues of its own: The evaluation of success criteria tends to get imprecise as the influence of external events increases the more time passes between project completion and evaluation (Karlsen et al., 2005). For instance, in the case of a new product development project it may seem reasonable to wait for several years until stable sales figures for the new product can be produced. However, external factors such as the overall economic situation, new technological trends, or competitor behavior might affect sales figures the longer the product is on the market. Finding the right point in time for evaluating project success seems to represent a trade-off between imprecise and incomplete success criteria.

Shenhar/Levy/Dvir (1997) and Chan/Scott/Lam (2002) thus recommend evaluating project success criteria at several points in time during and after a project.

- **Dependence on Task:** In addition to the dependence on perspective and on time, researchers acknowledge that project success is also dependent on the characteristics of the task under evaluation. Westerveld (2003) differentiates tasks with regard to objective, size, complexity, external dependencies, and other characteristics. In a similar vein, (Shenhar et al., 2001) suggests that the relevance of success criteria changes depending on the characteristics of the task. The authors propose a classification scheme that differentiates between low-tech, medium-tech, high-tech, and super-high-tech tasks. These tasks strongly differ in terms of how important success criteria, such as efficiency, impact on the client, business success, and preparing for the future. For instance, efficiency tends to be of highest priority in low-tech tasks but becomes less important with increasing technological uncertainty. In contrast, preparing for the future tends to have little significance in these tasks, while being more important in tasks with higher technological uncertainty (Shenhar et al., 2001). As IS projects are not homogeneous (Karlsen et al., 2005), these results are likely transferable to IS projects and promise a more precise evaluation of project success than the traditional, more egalitarian approach. Criteria for differentiating IS projects may comprise urgency, planned functionality, quality specifications (Wateridge, 1995), or technological uncertainty (Shenhar et al., 2001).

Summing up, IS project success is seen as a multidimensional, dynamic concept, depending on a) the perspective of the assessor, b) the time of assessment, and c) the characteristics of the IS project being assessed. By investigating vendor profitability, this thesis focuses on one particular criterion of success from the vendor's perspective that can be determined rather objectively after project completion.

2.2 IS Project Risks

As risks are inherently related to human action (Adams, 1995), the concept of risk is of concern to many different scientific disciplines, such as sociology, psychology, business administration or computer science. In the following, we focus on the concept of risk in the IS discipline, more precisely in the sub-discipline of IS project management. In line with much of the literature on IS project risks, we define risk as risk exposure. Risk exposure comprises two elements: The probability of occurrence of an unsatisfactory outcome and the impact of the unsatisfactory outcome on project success (Boehm, 1991; Charette, 1996; Heemstra/Kusters, 1996). Frequently, the term risk factor is used as a synonym to risk (Boehm, 1991; de Bakker/Boonstra/Wortmann, 2010). We structure the review of literature on IS project risks into studies that identify risks in IS projects (risk identification) and studies that analyze the effect of risks on IS project success (risk analysis).

- **Risk Identification:** There exists considerable literature that is concerned with the identification of risks in IS projects. Based in most cases on surveys or interviews, these studies derive listings of risks in order to provide guidance for IS project managers. These checklists are frequently structured into dimensions or categories of risks and sorted according to the perceived importance of risks. Table 4 depicts one of the most prominent lists (Boehm, 1991) for illustrative purposes. Although discussed controversially by some (e.g., Bannerman, 2008) for their potential to suppress project managers' creativity in identifying risks, checklists provide an easy and low cost approach to risk identification and thus are quite popular among practitioners.

Early studies that derive checklists include Alter/Ginzberg (1978), McFarlan (1981), Boehm (1991), and Barki/Rivard/Talbot (1993). McFarlan (1981), for instance, suggests three dimensions of IS project risk: project size, project structure and experience with technology. Boehm's list of the top ten risks in IS projects (Boehm, 1991) is probably one of the most widely known lists. Among the top three risks are personnel shortfalls, unrealistic schedules and budgets, and developing the wrong functions and properties (see Table 4 for the full list). To quantify IS project risk, Barki/Rivard/Talbot (1993) conduct a comprehensive literature review resulting in 35 risks and employ factor analysis to derive five risk dimensions that elaborate on McFarlan's (1981) dimensions: technological newness, application size, lack of expertise, application complexity, and organizational environment. Schmidt et al. (2001) were the first authors that highlight differences in importance between risks in IS projects. Based on a Delphi study with three different panels from the U.S., Finland and Hong Kong, Schmidt et al. (2001) identify 14 categories (corporate environment, sponsorship/ownership, relationship management, project management, scope, requirements, funding, scheduling, development process, personnel, staffing, technology, external dependencies, and planning) and 53 risks that encompass all but four risks from prior studies. Interestingly, just two of the 53 risks are related to the technical issues. In comparing the ranking from the three different panels, the authors also highlight differences in cultural risk perception. Wallace/Keil (2004) generate an extensive list of risks found in academic literature and articles written by practitioners. The authors derive six dimensions of IS project risk: Planning and control, team, complexity, requirements, user, and organizational environment. These dimensions can be further aggregated to three risk domains: The social subsystem, the technical subsystem and project management. While the latter domain refers to the project team and the planning/control techniques applied by the project manager, the social subsystem domain comprises an unstable or highly political social context and users unable or not willing to contribute to project success. The technical subsystem domain captures risks related to unstable requirements, high project complexity as well as new or unfamiliar technology. Sherer/Alter (2004) critically reflect on existing approaches to classifying IS project risks and propose a work system framework, which integrates risks and work practices, participants, information, technology, products and services, customers, environment, infrastructure, and strategy of a work system. Tiwana/Keil (2004) surveyed 60 MIS directors and identified six key risks: 1) related technical knowledge; 2) customer involvement; 3) requirements volatility; 4) development methodology fit; 5) formal project management practices; 6) project complexity. Finally, Tesch/Kloppenborg/Erolick (2007) reinvestigate the risk categories suggested by Schmidt et al. (2001) and find significant similarities among them. In accordance with the results of Wallace/Keil/Rai (2004a), the authors propose six categories of IS project risk: sponsorship/ownership, funding and scheduling, personnel and staffing, scope, requirements, and relationship management.

Nr.	Risk	Suggested Response
1	Personnel shortfalls	Staffing with top talent, job matching, team building, key personnel agreements, cross training.
2	Unrealistic budgets and schedules	Detailed multisource cost and schedule estimation, design to cost, incremental development, software reuse, requirements scrubbing
3	Developing the wrong functions and properties	Organization analysis, mission analysis, operations-concept formulation, user surveys and user participation, prototyping, early users' manuals, off-nominal performance analysis, quality-factor analysis.
4	Developing the wrong user interface	Prototyping, scenarios, task analysis, user participation.
5	Gold-plating	Requirements scrubbing, prototyping, cost-benefits analysis, designing to cost.
6	Continuing stream of requirement changes	High change threshold, information hiding, incremental development (deferring changes to later increments).
7	Shortfalls in externally furnished components	Benchmarking, inspections, reference checking, compatibility analysis.
8	Shortfalls in externally performed tasks	Reference checking, preaward audits, award-fee contracts, competitive design or prototyping, team-building.
9	Real-time performance shortfalls	Simulation, benchmarking, modeling, prototyping, instrumentation, tuning.
10	Straining computer science capabilities	Technical analysis, cost-benefit analysis, prototyping, reference checking.

Table 4. Top Ten Risks in IS Projects (Source: Boehm (1991))

- **Risk Analysis:** Based on the results of the above mentioned studies on risk identification, several authors statistically analyze the effect of risks on IS project success. The statistical models, which comprise dependent variables representing success dimensions and independent variables representing IS project risks, are in most cases tested on survey data. The results allow conclusions about the effect size and the significance of the relationship of individual risks as well as about the overall quality of the model. While these studies tend to be homogeneous concerning the success dimensions, they are quite heterogeneous with regard to the risks. The studies emphasize different aspects of the risk-success relationship. Some emphasize the role of project characteristics, such as project size and project newness (Yetton et al., 2000; Sauer/Gemino/Reich, 2007), others emphasize the role of governance mechanisms (Nidumolu, 1995; Nidumolu, 1996), or temporal dependencies (Wallace/Keil/Rai, 2004a; Gemino/Reich/Sauer, 2008). In a similar vein, also the levels of abstraction vary: While Nidumolu (1995) and Jun/Qiuzhen/Qingguo (2011) aggregate various risks into one abstract risk construct, others structure risk into more granular constructs. Gemino/Reich/Sauer (2008), for example, differentiate between knowledge resources risks, structural risks, organizational risks, and volatility risks. Wallace/Keil/Rai (2004a) distinguish risks related to the technical subsystem, risks related to the social subsystem, and risks related to project management. Other authors again, who use regression analysis instead of structural equation models, do not use higher order constructs but model direct relationships between individual risks and IS project success (Jiang/Klein, 2000; Yetton et al., 2000).

Despite these different levels of abstractions, some commonalities between the studies can be identified when looking at the significant relationships between risks and project success. Characteristics, such as the size (Yetton et al., 2000; Sauer/Gemino/Reich, 2007; Jun/Qiuzhen/Qingguo, 2011), the strategic importance (Yetton et al., 2000), the technical complexity or the degree of newness (Yetton et al., 2000) of a project, are frequently investigated. These characteristics tend to result in task uncertainty, e.g., in the form of uncertain requirements (Wallace/Keil/Rai, 2004a; Gemino/Reich/Sauer, 2008) or difficulties in effort estimation (Nidumolu, 1995). From this uncertainty project management risks, such as poor planning and difficult governance, emanate (Nidumolu, 1995; Yetton et al., 2000; Wallace/Keil/Rai, 2004a; Gemino/Reich/Sauer, 2008; Jun/Qiuzhen/Qingguo, 2011). Poor planning and difficult governance may be reflected in the use of an inadequate project management methodology or the definition of too ambitious / too unambitious milestones. Furthermore, task uncertainty may result in volatility regarding the requirements, the project objectives (Nidumolu, 1995; Wallace/Keil/Rai, 2004a; Gemino/Reich/Sauer, 2008), or project stakeholders, such as project managers, project team members, and project sponsors (Sauer/Gemino/Reich, 2007; Gemino/Reich/Sauer, 2008). The studies also agree on the negative effect of team risks on IS project success. Team risks comprise conflicts within the project team (Jiang/Klein, 2000; Yetton et al., 2000) and insufficient knowledge and skills among the team members (Jiang/Klein, 2000; Wallace/Keil/Rai, 2004a; Gemino/Reich/Sauer, 2008; Jun/Qiuzhen/Qingguo, 2011). Finally, several studies identify the lack of organizational support by the top management (Yetton et al., 2000; Gemino/Reich/Sauer, 2008) and/or the user (Jiang/Klein, 2000; Yetton et al., 2000; Wallace/Keil/Rai, 2004a; Jun/Qiuzhen/Qingguo, 2011) as critical risks to IS project success. Table 5 gives an overview on these empirically substantiated risks.

Risk Category	Exemplary Risks	Exemplary Reference
Project characteristics	Project size, strategic importance, technical complexity	(Sauer/Gemino/Reich, 2007)
Task uncertainty	Requirements uncertainty, difficulties in effort estimation	(Nidumolu, 1995)
Project management	Poor planning, difficult project governance	(Wallace/Keil/Rai, 2004a)
Volatility	Changing project objectives, changing project stakeholders	(Sauer/Gemino/Reich, 2007)
Team	Conflict within project team, insufficient skills	(Yetton et al., 2000)
Organizational support	Lack of top management support, lack of user support	(Wallace/Keil/Rai, 2004a)

Table 5. Overview on Quantitatively Empirically Substantiated Risks Categories

Summing up, research on IS project risks can be structured into studies that aim at identifying risks and studies that aim at analyzing the effect of risks on various dimensions of IS project success. Both streams of research provide conceptual background for this thesis: The former type of studies frequently results in prioritized checklists of risks. Such a prioritized checklist of risk also informs the risk assessments by our industry partner on which many analyses of this thesis are based on. The latter studies reflect the fundamental idea of this thesis, i.e., linking risks and project profitability from a vendor's perspective.

2.3 IS Project Risk Management Approaches

Risk management was adapted by IS project managers during the 1980s as a response to frequent project disasters (Boehm, 1991). Project risk management aims at recognizing risks to project success and – if necessary – addressing them as early as possible (Boehm, 1991; Charette, 1996; Powell/Klein, 1996). It has become an integral part of codified best practices, such as the Project Management Body of Knowledge (PMBOK) by the Project Management Institute (PMI), the Continuous Risk Management (CRM) Guidebook by the Software Engineering Institute (SEI), or the ISO 31000 standard by the International Organization for Standardization (ISO). Similar to the above mentioned checklists, most of the processes recommended in the IS literature go back to the work of Boehm (1991). Boehm (1991) structures risk management into two phases: (1) risk assessment and (2) risk control (see Figure 4).

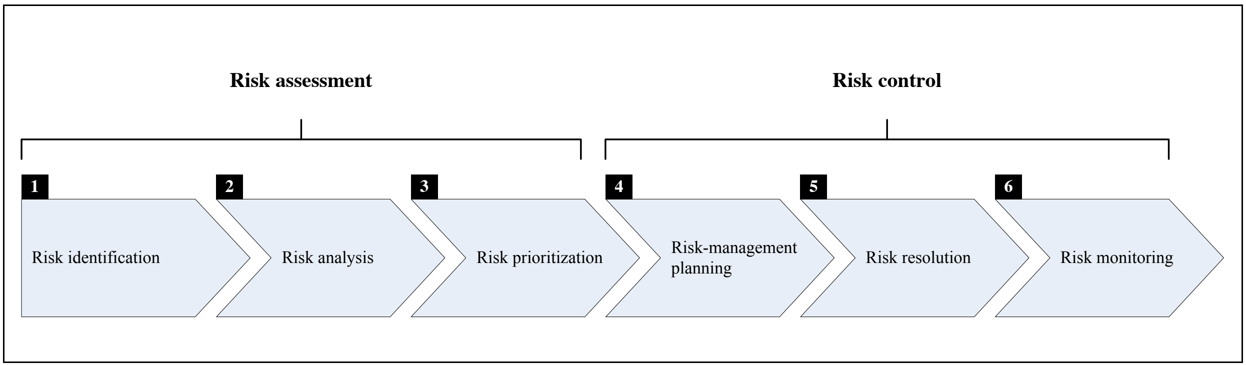


Figure 4. IS Project Risk Management Process (Source: Boehm (1991))

- **Risk assessment:** The first phase, risk assessment, consists of three sub phases: Risk identification, risk analysis, and risk prioritization. During the risk identification sub-phase, a list of all risks relevant to the project at hand is created. Risk identification may be supported by techniques such as checklists, decision-driver analysis, assumption analysis, or decomposition. During the risk analysis sub-phase, each risk is assessed in terms of probability of occurrence and its impact on project success. Furthermore, interdependences between risks should be considered. Techniques for supporting risk analysis include performance and cost models, network analysis, decision analysis, and quality factor analysis. During the risk prioritization sub-phase, risks are ordered according to their importance. This can be done using key figures such as risk exposure and risk leverage.

- **Risk control:** The second phase, risk control, consists of three sub-phases, too: Risk management planning, risk resolution, and risk monitoring. During the risk management planning sub-phase, responses for each risk are planned with regard to responsibilities, tasks, resources, time frame, etc. Supportive techniques comprise checklists with responses, cost-benefit analysis, standardized risk management plan outlines and forms. During the risk resolution phase, risks are resolved by initiating the previously defined responses. Typical techniques are prototyping, simulation, benchmarking, mission-analysis, key personnel agreements, design-to-cost approaches, and incremental development. Finally, during the risk monitoring sub-phase, progress with regard to the responses is tracked. Corrective action is taken if necessary. Milestone tracking and periodically up-dated risk-response histories with the top ten most important risks are apt techniques to support this sub-phase.

While many authors consider it crucial for project success, the benefits of formal project risk management can hardly be quantified. Also, project managers may perceive risk management as an additional effort which comes on top of operational project work (Kutsch/Hall, 2009). As a consequence, organizations sometimes find it difficult to justify and implement formal project risk management. Therefore, in addition to defining formal project risk management, several authors seek to empirically demonstrate the positive effects of formal project risk management on IS project success (e.g., Nidumolu, 1995; Baskerville/Stage, 1996; Ropponen/Lyytinen, 1997; Barki/Rivard/Talbot, 2001; Chen/Law/Yang, 2009). In sum, their results speak in favor of formal project risk management: Nidumolu (1995) investigates the effect of horizontal and vertical coordination on IS project success. While the former refers to communication between IS staff and users through oral and written communication, the latter refers to the extent of coordination done by authorized entities of the IS staff, such as the project manager or the steering committee. Both coordination mechanisms may frequently be the outcome of formal risk management practices Baskerville/Stage (1996). Based on his analysis of 64 software development projects, the author suggests that both mechanisms, horizontal and vertical coordination, significantly contribute to project performance. In their action research project, Baskerville/Stage (1996) apply risk analysis to improve the managerial control over prototyping projects. The authors suggest that by defining risks, specifying their consequences, assigning priorities, and selecting resolution strategies risk management can help improve the communication among users and developers, point out difficulties in maintaining the original project plan, and get a clearer picture on the status of the project. As a consequence, Baskerville/Stage (1996) faced hardly any disruptions from the identified risks during the project. Ropponen/Lyytinen (1997) explicitly examine the effect of project risk management practices on IS project success. The authors analyze survey data from 83 project managers and find that the experience in project risk management and the resources spent on project risk management significantly improve IS project success. In addition, two risk management methods tend to improve IS project success: Decomposing poorly defined project parts and the analysis of key decisions. Barki/Rivard/Talbot (2001) hypothesize that IS project success is affected by the fit between the project's risk profile and its risk management profile. The authors conduct a survey among IS project managers to assess 75 Canadian IS projects. Analysis of correlation between the degree of fit between a project's risk profile and its risk management profile and the performance measures shows that projects that better adapt to their degree of risk exposure tend to perform better. Finally, by presenting case study evidence from an ERP implementation project, Chen/Law/Yang (2009) demonstrate that project management practices in general, and risk management practices in particular, can improve IS project performance. The authors also emphasize the importance of formal risk management methods.

To conclude, research on IS project risk management approaches is concerned with establishing normative guidelines for IS project risk management as well as investigating the benefits of these guidelines. Again both of these streams provide conceptual background for this thesis: While the former stream in general reflects the risk management approach used by our industry partner, the latter stream relates to the efficiency test of the vendor's risk estimation done in publication P5. Efficient estimations of IS project risk are one prerequisite for leveraging the benefits of IS project risk management.

3 Research Design

The following chapter discusses three aspects of a research design: Epistemological positions, strategies of inquiry, and research methods (Creswell, 2009). With regard to epistemological positions, it gives an overview on four epistemological positions that underlie IS research (positivism, interpretivism, critical research, and pragmatism) and motivates this thesis' pragmatic orientation. With regard to strategies of inquiry, it briefly describes qualitative strategies, quantitative strategies and mixed strategies and gives reasons for this thesis' mixed strategy. Finally, with regard to research methods, it introduces the research methods used in this thesis.

3.1 Epistemological Positions

Epistemological positions represent views about knowledge and knowledge generation (Hirschheim, 1992). An epistemological position thus forms the basis for the strategy of inquiry and the research method(s) chosen for a specific research project. Several epistemological positions have been suggested to underlie research in the IS discipline. A frequently used typology of epistemological positions in IS research is the one proposed by Orlikowski/Baroudi (1991). Orlikowski/Baroudi (1991), citing (Chua, 1986), differentiate between positivist, interpretive, and critical research. More recently, a fourth position, pragmatic research, has evolved (Creswell, 2009). In the following, we describe these four positions along their beliefs about reality, knowledge, and the relationship between theory and practice (Chua, 1986; Orlikowski/Baroudi, 1991). Beliefs about reality concern questions about the objectivity of reality, human intentionality, and the stability of social relations. Beliefs about knowledge concern questions about the criteria for generating knowledge and the validity of research methods for doing so. Beliefs about the relationship between theory and practice concern questions about the purpose of knowledge in practice. One caveat before proceeding: The following section is meant to give a rough overview on the main ideas of the above mentioned positions. It necessarily oversimplifies and cannot reflect the depth and diversity of the philosophical viewpoints.

- **Positivist Research:** Positivist thought gained considerable popularity in the natural sciences during the 17^{th} century through influential scholars such as Rene Descartes, Isaac Newton and Francis Bacon (Hirschheim, 1992). During the 19^{th} century positivism was deemed an apt epistemological position also for the social sciences by Auguste Comte, Herbert Spencer, John Stuart Mill, Richard Avenarius, Emile Durkheim and Vilfredo Pareto (Hirschheim, 1992). To date, much of extant IS research can be assigned to the positivist position (Orlikowski/Baroudi, 1991). Characteristics of positivist research include formal propositions, quantifiable measures of variables, hypotheses testing, and inference from a sample to a population (Orlikowski/Baroudi, 1991). With regard to its beliefs about reality, the positivist position assumes that there exists an objective physical and social reality that researchers can discover by using the right methods of data collection and analysis. Individuals are assumed to behave in an intentional and rational way. Social relations are considered to be knowable and stable (Orlikowski/Baroudi, 1991). The researcher can objectively grasp this reality with his human senses (Hirschheim, 1992). With regard to its beliefs about knowledge, positivist research postulates that knowledge is based on generalizable principles, i.e., theories according to which reality functions. These theories tend to manifest in rather deterministic cause-and-effect relationships (Creswell, 2009). To advance knowledge, theories have to be tested via applying the hypothetico-deductive model. In doing so, there exist clearly defined criteria of validity and reliability against which the research results have to be assessed (Orlikowski/Baroudi, 1991). With regard to its beliefs about the relationship between theory and practice, positivism limits the role of the researcher to one of the value-free and neutral observer. The researcher's task exclusively focuses on generating knowledge and excludes judgmental statements of, or interaction with, the phenomenon under investigation (Orlikowski/Baroudi, 1991). As a response to some of the criticism by anti-positivist scholars logical positivism emerged (Hirschheim, 1992). Logical positivism softened some of the stricter assumptions of positivism. For instance, knowledge no longer had to be unchallengeable. Instead, intersubjective agreement was seen as a sufficient justification for knowledge (Hirschheim, 1992). Despite this development, logical positivism is still being criticized for a variety of reasons. This criticism has led to the development of post-positivist positions, some of which are outlined below. Among the issues raised, one stands out in importance for the question discussed in this thesis: While a uni-directional mapping from reality to knowledge might be viable for the natural sciences, this does not hold true for the social sciences and humanities. The questions and contexts explored in this thesis are diverse and complex and need to account for bi-directional influences between the subject matter explored and the researcher exploring the subject matter.

- **Interpretive Research:** During the later 19th century opposition against the positivist school of thought in the social sciences developed. Referring to the views of Immanuel Kant, Georg Hegel and Karl Marx, scholars such as William Dilthey, Edmund Husserl, and George Herbert Mead recognized that positivist research is problematic when applied to social phenomena (Hirschheim, 1992). With regard to its beliefs about reality, interpretivism argues that social reality cannot be objectively grasped, but rather is dependent on the meaning individuals attach to it (Creswell, 2009). The aim of interpretive research is to understand how individuals attach this meaning, adjust their social actions accordingly and in the process reconstruct social reality (Orlikowski/Baroudi, 1991). With regard to its beliefs about knowledge, interpretive researchers focus on understanding social reality. In contrast to positivism, however, interpretivism does not perceive knowledge as the product of uni-directional causal relationships. Rather, knowledge manifests in the form of "circular or reciprocally interacting models of causality, with the intention of understanding actors' views of their social world and their role in it." (Orlikowski/Baroudi, 1991, 14). Consequently, accepted methods for generating knowledge are those which study phenomena of interest in their natural context. As the meaning attached by individuals is in the focus of interpretive interest, these methods necessarily follow an inductive approach, with as little theoretical preconception as possible (Creswell, 2009). Given the focus on context and subjective meaning, interpretive research also does not aim at generalizing (Orlikowski/Baroudi, 1991, 14). With regard to its beliefs about the relationship between theory and practice, interpretivism acknowledges that the personality of the researcher cannot be disconnected from the phenomenon under investigation. Researchers tend to influence the research process through their personal beliefs, values, assumptions, and interests, according to some conceptions even to the extent that the researcher is part of the creation of a new social reality (Orlikowski/Baroudi, 1991).

- **Critical Research:** Critical research has its roots in the rejection of one of positivism's central assumptions, namely that science should be free from values (Hirschheim, 1992). According to Creswell (2009, 9), critical research needs to be "intertwined with politics and a political agenda". Prominent theorists of the critical position included amongst others Max Horkheimer, Theodor Adorno, Erich Fromm, and Juergen Habermas (Hirschheim, 1992). With regard to its beliefs about reality, critical research emphasizes three aspects: First, social reality is regarded as being historically constituted and as being in continuous change. Second, social reality has to be seen in its totality, i.e., every element of a social system is not only dependent on its context but essentially defined by it. And finally third, social systems undergo phases of contradictions that result in conflicts and inequalities. The main objective of critical research addresses this latter aspect: The researcher's task is to create awareness and understanding of these conflicts and inequalities, so that they can eventually be resolved (Orlikowski/Baroudi, 1991). With regard to its beliefs about knowledge, critical research assumes that knowledge is rooted in an in-depth understanding of the phenomenon of interest including its historical development and its contemporary context and contradictions. Thus, in contrast to interpretivism, critical researchers do not only focus on individuals' interpretation of reality but also include the physical conditions that lead to these interpretations. Due to its emphasis on the historical development and the contemporary context of a phenomenon of interest, critical researchers often rely on longitudinal and qualitative forms of analyses (Orlikowski/Baroudi, 1991). With regard to its beliefs about the relationship between theory and practice, critical researchers argue that theory needs to point out reality's contradictions and guide social change. Contrary to positivist and interpretive researchers, critical researchers are suggested to take on a more active role (Orlikowski/Baroudi, 1991).

- **Pragmatic Research:** More recently, pragmatism as another epistemological position has gained popularity among researchers. It derives from the works of Charles Peirce, William James, John Dewey, and George Mead and others and is partly opposed to the strict assumptions made by positivism, amongst others positivism's failure to provide theory-independent observation reports and for its failure to incorporate inductive reasoning (Hirschheim, 1992). According to Hirschheim (1992), pragmatism rejects the preoccupation with theory of other epistemological positions and their disregard for the way scientists actually work. With regard to its beliefs about reality, the pragmatic worldview suggests that there exists a reality independent of the observer (Creswell, 2009). Importantly, however, pragmatists do not attribute much importance to questions concerning the nature of reality (Cherryholmes, 1992). In a similar vein, pragmatists are also skeptical of our ability to grasp reality in an objective way (Cherryholmes, 1992). Instead, the pragmatic worldview focuses on whether the actions taken based on our conception of reality led to the desired results. Accordingly, with regard to its beliefs about knowledge, pragmatists suggest that knowledge relates to the actions that are used to cope with specific situations and the consequences of these actions (Johnson/Onwuegbuzie/Turner, 2007). Contrary to positivism, knowledge is not restricted to general laws of nature. The acceptable methods for generating knowledge are chosen according to the research problem, and consequently can be of either quantitative or qualitative or of either cross-sectional or longitudinal nature (Creswell, 2009). In line with this, a central pragmatist tenet is that "truth is what works at a time" (Creswell, 2009, 11). Finally, with regard to beliefs about the relationship between theory and practice, pragmatists do not see theory and practice as distinct domains. Instead, theory and practice are closely connected and theory is essential for achieving so called informed practice (Cherryholmes, 1992).

With these foundations in mind, this thesis' epistemological position can be described closest as pragmatic. We are skeptical about the exclusive focus on uni-directional cause-and-effect relationships as put forward by positivism. We are also skeptical about interpretivism's tendency to emphasize meaning as the main constituent of reality. We also cannot identify with critical research's focus on contradictions. Instead, we see parallels to some of pragmatism's main tenets: We draw on both, quantitative and qualitative research methods, dependent on which fits best to the research problem at hand and which is likely to maximize our understanding of the phenomenon in question. Thus, we share pragmatism's pluralistic stance. In a similar vein, we identify with pragmatism's focus on consequences. Throughout this thesis, we emphasize the importance of the practical implications of our research results which aim to improve risk management practices in IS projects.

3.2 Strategies of Inquiry

Strategies of inquiry describe types of research methods. Following Creswell (2009), we differentiate between three different strategies of inquiry: Quantitative strategies, qualitative strategies, and mixed strategies to behavioral research[4]. Though positivist researchers frequently employ quantitative strategies, interpretive and critical researchers frequently employ qualitative strategies, and pragmatic researchers frequently employ mixed strategies, there is no predetermined association between epistemological position and strategy of inquiry (Johnson/Onwuegbuzie/Turner, 2007). Instead, the epistemological position and the strategy of inquiry are to a major extent independent of each other. There exist good examples of positivist research that employs qualitative strategies of inquiry (e.g., Dibbern/Winkler/Heinzl, 2008), as well as critical research that employs quantitative strategies of inquiry (e.g., Mursu et al., 2003; Zachariadis/Scott/Barrett). Even in the case of interpretive research and quantitative strategies the lines become blurred: Westerman (2006) argues that much quantitative research does actually emphasize meaning and context and thus can be considered interpretive.

- **Quantitative Strategies:** Quantitative research strategies originate from the natural sciences (Stebbins, 2001) and rapidly gained importance in the social sciences

[4] In addition to behavioral research, Wilde/Hess (2007) describe constructive research as a second paradigm of IS research. Constructive research comprises reference modeling, prototyping, action research, formal-deductive reasoning, conceptual-deductive reasoning, argumentative-deductive reasoning, and simulation. As this thesis follows the behavioral paradigm, we use the behavioral paradigm as a reference point when describing quantitative, qualitative, and mixed strategies.

between 1930 and 1950 (Glaser/Strauss, 1967). Supported by the increasing power of statistical software, quantitative research strategies established themselves as the predominant strategy of inquiry in the social sciences. The key characteristic of quantitative research is its reliance on the interpretation of quantitative, i.e., numeric, data (Straub/Gefen/Boudreau, 2005). Quantitative research focuses on large numbers of units of analysis for which a limited number of variables of interest are available. As a consequence – and in contrast to qualitative strategies – quantitative strategies put much less focus on meaning and context. Instead, it commonly aims at generalization from samples to the populations of interest. Ways of collecting data for quantitative strategies comprise surveys, experiments, archival records or structured interviews (Straub/Gefen/Boudreau, 2005). Depending on the number of variables analyzed simultaneously, approaches for data analysis range from simple uni- and bivariate approaches to complex multivariate ones (Hair et al., 2006). The validity of the results is judged on the basis of a comprehensive catalogue of validity criteria. One frequently used typology for these criteria is proposed by Straub/Boudreau/Gefen (2004). The authors differentiate between criteria relating to instrumentation validity, criteria relating to internal validity, and criteria relating to statistical conclusion validity. Only if a minimum set of criteria from all three forms of validity are fulfilled, research results are considered to be meaningful.

- **Qualitative Strategies:** Due to their perceived less rigorous approach, qualitative research strategies were long seen by researchers as being merely a preparatory exercise for subsequent quantitative strategies. According to this view, qualitative strategies had no purpose on its own but served instead to inform quantitative strategies (Glaser/Strauss, 1967; Stebbins, 2001). In recent years, however, methodological guidelines for qualitative strategies have appeared, making qualitative strategies reproducible and giving more credibility to their evidence. Examples comprise guidelines for grounded theory (Glaser/Strauss, 1967; Corbin/Strauss, 1990), case study research (Dube/Pare, 2003; Yin, 2009), or ethnography (Hammersley/Atkinson, 2007; Van Maanen, 2011). The aim of qualitative research is to understand and explain social phenomena by analyzing qualitative data, such as interviews, documents, and participant observation (Myers, 1997). To do this, qualitative researchers get in an intense contact with real life situations and try to generate an in-depth understanding of how the actors perceive and manage these situations. Due to the breadth and depth of the data collected, qualitative strategies focus on a limited number of units of analysis. Typically, however, this limited number of units of analysis is investigated in rich detail, often including various levels of contexts, perspectives, or points in time. Though several variations exist, most forms of analysis are based on words from which the researcher derives his or her interpretation. The analytic process comprises in most cases of assigning codes and reflections to the field material; structuring the field material by identifying, e.g., sequences, relationships, or patterns; acquiring and analyzing new field material; gradually deriving a set of generalizations that is contrasted with the extant body of knowledge (Miles/Huberman, 1994). Qualitative research is still frequently criticized on the grounds that it is in most cases almost impossible to judge the reliability and validity of research results. More recently, however, criteria for judging the reliability and validity of research results have begun to emerge (e.g., Dube/Pare, 2003).

– **Mixed Strategies:** Recognizing that both, quantitative and qualitative, strategies have their limitations, researchers in recent years turned to mixed strategies (Agerfalk, 2013). Venkatesh/Brown/Bala (2013) define mixed strategies as combination of qualitative and quantitative strategies to collect and analyze data (in contrast to multi strategies studies, which use different methods belonging to either a quantitative or a qualitative strategy) in a single research inquiry. Based on this understanding, Venkatesh/Brown/Bala (2013) also emphasize the potential (and the necessity) of mixed method strategies to draw meta-inferences that are based on the findings of both strategies of inquiry. Although there have been some comments on the incompatibility of quantitative and qualitative strategies due to different underlying epistemologies (e.g., Denzin/Lincoln, 2011), others have suggested that it is feasible and beneficial to integrate these two strategies (e.g., Mingers, 2001; Johnson/Onwuegbuzie/Turner, 2007; Creswell, 2009). Mixed strategies aim at combining the strengths of quantitative and qualitative strategies (Johnson/Onwuegbuzie/Turner, 2007). More specifically, mixed strategies allows researcher to better address confirmatory and exploratory research at the same time, to provide stronger inferences, and to generate a richer understanding of the phenomenon of interest than either a quantitative or a qualitative strategy on its own (Venkatesh/Brown/Bala, 2013). Creswell (2009) distinguishes between three different approaches to mixed strategies: sequential, concurrent, and transformative. Sequential approaches elaborate on the results of one strategy with the other strategy. Concurrent approaches collect and analyze quantitative and qualitative data in parallel and integrate both analyses into overall findings. The distinctive feature of transformative approaches, finally, is to apply a theoretical lens to guide either a sequential or a concurrent mixed strategy (Creswell, 2009).

This thesis sequentially combines quantitative and qualitative strategies of inquiry to investigate risks in ERP projects from a vendor's perspective. As such it can be said to pursue a mixed strategy in the sense of Venkatesh/Brown/Bala (2013). Being employed in the publications P1, P2, P3, P4, P5, and P7, the quantitative strategy is clearly the dominant one. The qualitative strategy is explicitly employed in P6 only. Importantly, however, qualitative data (interviews and project documentation) implicitly shaped our understanding and informed our research throughout the whole research project. Combining quantitative and qualitative strategies seems particularly promising in our case: On the one hand, the availability of unique numeric data calls for quantitative analyses. On the other hand, little is known on risks in ERP projects from a vendor‘s perspective, making it necessary to explore the subject in a qualitative way. We acknowledge, however, that we analyze different aspects of our phenomenon of interest which are rather loosely coupled. As a consequence, the meta-inferences that we draw in the contributions section are not as stringently derived as proposed by Venkatesh/Brown/Bala (2013).

3.3 Research Methods

Following the pragmatic paradigm and a mixed strategy of inquiry, this thesis employs both, qualitative and quantitative research methods. The next section briefly introduces the methods used in this thesis. The detailed procedures are presented in the respective papers. Steps that apply to scientific methods in general, such as the formulation of a research problem in the beginning or the presentation of the results in the end of a research process, will not be described in this section. Rather, we focus on the characteristics of each research method.

3.3.1 Delphi Study

The Delphi study aims at answering complex and often times diffuse questions by eliciting and integrating expert opinions on a given subject matter (Linstone/Turoff, 1976). It is characterized by the mutual anonymity of the participating experts and several sequential stages in order to disseminate intermediate results of the study between the experts. By informing the experts of the intermediate results and giving them the possibility of refining their opinion in the subsequent rounds, the Delphi study means to iteratively increase the validity of the overall result which – in the ideal case – is finally based on a strong consensus among the experts (Haeder/Haeder, 1994). Originally, the research method was developed by the RAND Corporation in a research project sponsored by the US Air Force. Over time, it has been applied in a variety of research fields for multiple purposes (Schmidt, 1997). According to Haeder (2009) purposes for conducting a Delphi study comprise the aggregation of ideas, the prediction of an uncertain or diffuse subject matter, or reaching consensus-based decisions. In the IS community, ranking type Delphi studies are frequently used for identifying and ranking project risks (Schmidt et al., 2001; Keil/Tiwana/Bush, 2002; Mursu et al., 2003; Liu et al., 2010).

Important steps in the Delphi study include:

- **Selecting the experts:** Haeder/Haeder (1994) recognize the difficulty of selecting subject matter experts and recommend a systematic approach to it. Important decisions refer to the size and the structure of the expert group and to the selection criteria according to which the experts are recruited. Selection criteria may for instance include being currently occupied in the field of interest and a minimum professional experience in this field. With regard to the sample size Haeder/Haeder (1994) note that larger samples are preferable to smaller ones as individual misjudgments are compensated for; however, as the validity of the results heavily depends on the participants' level of expertise, quality should be prioritized over quantity. Finally, potential participants should be informed about the study design and its iterative nature in order to minimize drop-out rates during the research process.

- **Consulting the experts:** During the actual Delphi study several waves or rounds of interviewing and surveying the participants are conducted. After each round, the intermediate results are analyzed, documented, and fed back to the experts. Feeding back the intermediary results to the participants is intended to trigger additional reasoning about the research question, and potentially a reevaluation of prior opinions. In this way the iterative approach helps continually increasing the validity of the study results (Haeder, 2009). The survey instrument or the interview guidelines may have to be adapted after each round according to the participants' feedback. For instance, in ranking type Delphi studies, such as the one used in this thesis, different tools have to be employed depending on whether the objective is identifying, selecting, or assessing objects of interest (Schmidt, 1997). Anonymity between the experts during this phase helps rule out some of the biases related to group work, in particular biases related to the dominant behavior of individuals. The iterations come to an end when one of the pre-specified abortion criteria is met, e.g., reaching a certain number of iterations or a certain level of consensus (Linstone/Turoff, 1976).

- **Analyzing the results:** Depending on the research question, there are various elements that should be part of the analysis. For ranking type Delphi studies the identification, the selection, and the assessment, i.e., the rank of objects of interest, should be part of the analysis (Schmidt, 1997). Accordingly, the analysis is meant to give insights on which objects were identified, which of the identified objects were deemed to be important, and on how the important objects compare to each other. For each of these questions, changes in the results and in the level of consensus across iterations should be analyzed. Besides graphs and tables, various statistical techniques may be employed for this (Linstone/Turoff, 1976): Cluster analysis or multidimensional scaling may be used for reducing the number of objects; cross-impact analysis may be employed to identify interrelations among the objects of interest; the strength and significance of Kendall's W (Kendall/Gibbons, 1990) can help researchers assess the degree of consensus among the experts.

3.3.2 Literature Review

Knowing and understanding the current body of knowledge is essential to all scientific endeavors (Iivari/Hirschheim/Klein, 2004). Literature reviews represent a systematic approach to do so by investigating relevant studies and their results pertaining to a particular research question (Cooper, 1988). Literature reviews have a long history in science and presumably exist since researchers publish their work in scientific literature (Fettke, 2006). As the amount and the complexity of scientific output is increasing, systematic reviews of the literature are gaining in importance (Fettke, 2006). In some disciplines, dedicated journals for review articles (e.g., the Academy of Management Review) have been established (Webster/Watson, 2002). In the comparatively young and interdisciplinary field of information systems, there still seems to be a scarcity of published literature reviews (Webster/Watson, 2002; Levy/Ellis, 2006), though some journals, e.g., Wirtschaftsinformatik or MIS Quarterly, have sections devoted to reviews of the state-of-the-art. Webster/Watson (2002) argue that literature reviews are worthwhile for both, mature and emerging topics of research. Foci of literature reviews may include research outcomes, research methods, theories, or applications while goals may comprise integrating and synthesizing prior work, criticizing it, or identifying central issues (Cooper, 1988).

Important steps in a literature review comprise:

- **Searching for relevant publications:** Literature related to the research problem is identified from various sources, such as electronic databases or fellow researchers. According to Cooper (1988), one can differentiate between three different types of coverage: Exhaustive, representative, and pivotal. While an exhaustive coverage aims at including all the publications relevant to the underlying research question, a representative coverage chooses a sample that is deemed characteristic for a larger group of publications and makes inferences from the sample to that group. Finally, the pivotal coverage focuses on publications that are considered central to the topic of interest. With regard to coverage, Webster/Watson (2002) argue that literature reviews should aim for an exhaustive coverage and suggest a systematic, three-step approach to identifying relevant publications: First, a key-word based search in the leading journals and conference proceedings of the field employing electronic databases is recommended. The focus on leading publication outlets ensures a high quality input for the review (Levy/Ellis, 2006). The key word search should be complemented by a manual scan of the journals' and conference proceedings' tables of content to make sure that all relevant studies in the leading publication outlets have been identified. Second, a backward search should be conducted. The backward search reviews the citations of the articles identified in the first step to identify prior work that should be considered. Finally, third, a forward search that identifies articles citing the selected articles concludes the search process. The search for relevant literature can be considered complete when no new arguments, methodologies, findings, concepts, and authors relevant to answering the underlying research question can be found (Webster/Watson, 2002; Levy/Ellis, 2006).

- **Assessing relevant publications:** The identified articles are assessed in terms of relevance and organized systematically to allow for further analysis. For each publication the researcher has to decide whether or not it is relevant for the purpose of the review. In this regard, Levy/Ellis (2006) suggest to focus on publications that address the core of the underlying research problem and to assign lower priority to only remotely relevant publications. The relevant publications are then organized in a systematic way and with regard to adequate dimensions that help answer the underlying research question. Adequate dimensions may comprise the unit of analysis, theoretical concepts and relationships, or the approaches to data collection and data analysis (Webster/Watson, 2002).

- **Analyzing and interpreting relevant publications:** The organized set of articles is analyzed and interpreted with the research question in mind. Levy/Ellis (2006) state that there is little knowledge on how researchers actually perform analyzing and interpreting tasks and refer to the taxonomy of educational objectives by Bloom et al. (1984) for guidance. According to Bloom et al. (1984) the learning process can be structured into six sequential activities with increasing cognitive demands. While the first three of these activities (knowing, comprehending, and applying) may be associated with assessing relevant publications (see above), the last three activities (analyzing, synthesizing, and evaluating) may be linked to analyzing and interpreting relevant publications. Amongst others, tasks relevant for these activities include selecting, explaining, comparing, integrating, generalizing, judging, and concluding. Analyzing and interpreting may be supported by various means ranging from elementary graphical displays to sophisticated statistical tools (Cooper/Hedges/Valentine, 2009). Ways of arranging publications comprise a historical way, that follows a chronological order, a conceptual way that groups similar ideas, or a methodological way that groups similar methods (Cooper, 1988).

Webster/Watson (2002) argue that in order to be able to provide a meaningful synthesis of the literature publications should be arranged in a conceptual way.

3.3.3 Cluster Analysis

Cluster analysis belongs to a group of statistical techniques that aim at discovering structures in data (Backhaus et al., 2006). More specific, the objective of cluster analysis is to structure a heterogeneous population of objects into homogenous groups according to a set of pre-specified criteria, frequently called the cluster variate (Hair et al., 2006). Grouping is done in a way that maximizes the similarity between objects within groups and minimizes the similarity between objects across groups (Backhaus et al., 2006). In doing so, the researcher is able to reduce complexity and to give a more meaningful and a more concise description of a population of objects. The intention to structure populations in groups is one that is inherent in almost all scientific disciplines. Consequently, cluster analysis has been frequently applied in a broad range of disciplines, e.g., strategic management research (Ketchen/Shook, 1996) or marketing research (Punj/Stewart, 1983). Exemplary studies in the IS discipline that employ cluster analysis comprise Wallace/Keil/Rai (2004b), Sauer/Gemino/Reich (2007), or Larsen (2003). For instance, Wallace/Keil/Rai (2004b) uses cluster analysis to group IS projects into three categories (low, medium, and high risk projects) according to their values along six risk dimensions. However, the use of cluster analysis is not without controversy: The method is frequently criticized for lacking a statistical basis, for being mechanistic in character, and for not being robust in a sense that minor adjustments of its parameters can lead to vastly different results (Ketchen/Shook, 1996; Hair et al., 2006). It is all the more advisable to adhere to the available methodological guidelines in order to provide sound justifications for any design decisions taken in the process.

Main steps during a cluster analysis include:

- **Selecting the covariate:** The starting point of and arguably the most important step in cluster analysis is selecting the criteria or characteristics according to which the objects should be clustered. Collectively, these criteria are called the covariate. While the covariate can be determined inductively, i.e., in a data-driven way, a deductive, i.e., theory-based, approach is recommended as irrelevant characteristics in the covariate can negatively affect the validity of the results (Ketchen/Shook, 1996). Different scales and multicollinearity of the characteristics can cause further problems that may need to be addressed by means of standardization or factor analysis respectively (Ketchen/Shook, 1996).

- **Determining proximity:** The starting point for clustering objects is to determine their proximity. In the context of cluster analysis, proximity defines the distance / similarity between two objects based on selected criteria of the objects (Hair et al., 2006). Researchers have proposed various measures of distance / similarity that vary depending on the scale of the variables used to group the objects (e.g., metric vs. nominal). Frequently used measures of distance are the squared Euclidian distance and the city block distance. Measures of similarity include the Q-correlation coefficient. Whereas measures of distance represent the absolute distance across the characteristics of two objects, measures of similarity represent similar patterns across the characteristics of the objects, irrespective of their distance. Which type of proximity measure to choose depends on the nature of the research question (Backhaus et al., 2006).

- **Selecting a clustering algorithm:** Clustering algorithms provide rules that help create solutions with varying number of groups or clusters based on the measures of proximity. Clustering algorithms can be differentiated into hierarchical approaches and non-hierarchical approaches (Hair et al., 2006). Hierarchical approaches form clusters in a step-wise fashion starting with either one cluster that contains all objects or a number of clusters equal to the number of object. In hierarchical approaches the number of clusters increases or decreases in a strictly monotonic way and objects will stay in the cluster they were assigned to. On the other hand, non-hierarchical approaches start from cluster seed points determined by the researcher. The number of clusters is also predetermined by the researcher. However, objects may change clusters during the process (Hair et al., 2006). Hierarchical approaches are considerably more popular as they tend to be less subjective than non-hierarchical ones (Backhaus et al., 2006). Well-known and frequently used examples of hierarchical approaches are the single-linkage approach, the complete-linkage approach, or the Ward approach. The various approaches differ in terms of how proximity between objects is calculated and consequently have favorable or less favorable characteristics depending on the underlying data (Ketchen/Shook, 1996).

- **Determining the number of clusters:** In the case of hierarchical approaches, multiple solutions with differing numbers of clusters will be generated. When deciding on the best solution, the researcher faces a trade-off between a manageable number of clusters and a sufficient degree of heterogeneity between the clusters. As the number of clusters changes, so does heterogeneity between them. One approach for determining the number of clusters is using the elbow criterion (Ketchen/Shook, 1996; Backhaus et al., 2006). Here, the researcher charts the measure of heterogeneity against the respective number of clusters. The “elbow” of the resulting graph indicates jumps in heterogeneity based on which the best number of clusters can be identified (Ketchen/Shook, 1996).

3.3.4 Case Study

The case study approach is widely used in the social sciences to investigate complex phenomena in a real-life context, where the boundaries between the phenomenon and its context are hard to delineate and the researcher has little or no control over events (Yin, 2009). Case studies focus on one or few data-rich "cases" which provide detailed insights into the phenomenon of interest and are thus particularly apt for answering "how" and "why" research questions. Case study research is frequently categorized as an interpretive / qualitative approach (Wilde/Hess, 2007). It may, however, also be grounded in other-than interpretive epistemological positions and employ quantitative methods as well (Klein/Myers, 1999; Dube/Pare, 2003; Yin, 2009). Accordingly, Miles/Huberman (1994) differentiate two major purposes of case studies: First, exploration and description, and second, explanation and testing. While exploration and description fosters understanding by "making a clear accounting of the phenomena at hand" (Miles/Huberman, 1994, 90), explanation and testing makes a phenomenon intelligible, mostly by establishing relationships between its elements (Miles/Huberman, 1994). While not being an imperative, interpretive and qualitative studies tend to get associated with the former purpose, positivistic and quantitative studies with the latter one.

As case studies seem to be well suited for IS research (Dube/Pare, 2003), there are numerous examples in our field, e.g., Bussen/Myers (1997), Gallivan/Spitler/Koufaris (2005), Sumner (2000), or Dibbern/Winkler/Heinzl (2008). For instance, Dibbern/Winkler/Heinzl (2008) provide a well-known example for a positivistic, multiple case study within the IS discipline: Based on five purposefully sampled software development projects, the authors test several hypotheses grounded in transaction cost economics (TCE) and the knowledge based view (KBV) that explain extra costs the client incurs in these projects.

Yin (2009) describes and addresses four frequently perceived disadvantages of case studies: (1) Lack of rigor, (2) limited potential to generalize, (3) unreasonable effort and bulky results, and (4) limited potential to investigate causality. While the perceived lack of rigor may have been caused by a lack of methodological guidelines, researchers have started to devise specific procedures which facilitate rigorous case studies (e.g., Benbasat/Goldstein/Mead, 1987; Swanson/Beath, 1988; Lee, 1989; Miles/Huberman, 1994; Dube/Pare, 2003; Eisenhardt/Graebner, 2007; Yin, 2009; Wynn/Clay, 2012). Lee (1989) suggests that also the criticism on the basis of limited generalizability is somewhat misplaced as theories need to be confirmed in a variety of study circumstances independent of the research method used. Finally, Yin (2009) comprehensively argues that case studies need not to be unreasonably cumbersome and also illustrate their potential to complement experimental research on causality.

Central steps in case study research comprise:

- **Developing theory:** As Yin (2009) highlights, developing a sound theoretical understanding of the phenomenon of interest is crucial in case study research as it allows for defining precise research questions and propositions, sheds light on potential rival explanations, and thus guides data collection and analysis. When building theory from case studies, Eisenhardt (2007) even recommends defining constructs a priori to entering the field. This stands in contrast to other rather qualitative approaches such as Grounded Theory or Ethnography that may not put emphasis on a priori theoretical development.

- **Defining and selecting the case(s):** The definition of what actually is a "case" / the unit of analysis depends on the investigator's research interest and the research questions. Cases should be defined by clear contentual, geographical, and temporal boundaries. Ideally, a study's case definition can be related to definitions used in previous literature. Commonly used cases / units of analysis comprise individuals, groups, projects, products, organizations or organizational units, or whole industries. In contrast to random sampling which is used in many statistical techniques, sampling cases in case study research is commonly done in a purposeful way in order to maximize the potential insights from each case. For instance, polar cases which exhibit extreme characteristics concerning one or several variables of interest may be selected, in order to provide a contrasting perspective.

- **Collecting the data:** Propositions derived at the beginning of the case study can help to maintain focus during data collection. What data to collect depends on the research questions and the requirements posed by the methods chosen to answer these questions. Triangulation of various sources and forms (i.e., qualitative and quantitative) of data is recommended in order to achieve a richer and more convincing understanding of the phenomenon of interest than it would be possible with only one source or form of data (Dube/Pare, 2003). Eisenhardt (2007) also stresses the usefulness of a certain overlap of data collection and data analysis which yields early results and allows for a more informed data collection.

- **Analyzing and interpreting the data:** Analyzing case data tends to be "the most difficult and the least codified part of the process." (Eisenhardt, 2007, 538). It seems that the analytical process is difficult to explicate which sometimes causes a gap between data and the conclusions drawn from them (Eisenhardt, 2007). General analytic strategies comprise relying on theoretical propositions, developing case descriptions, using both quantitative and qualitative data, and examining rival explanations (Yin, 2009). Specific analytic techniques, such as pattern matching, explanation building, time-series analysis or logic models (Yin, 2009) provide the investigator with more detailed guidelines for analyzing case data and Miles/Huberman (1994) illustrate a plethora of data displays that provide ways of visualizing data analysis, such as critical-incident charts, folk taxonomies, or causal networks. To manage the complexity that often comes with the extensive data richness of case studies, the authors also suggest to differentiate between within-case analysis, that investigates each case separately, and cross-case analysis, that compares the cases with each other and in this way delivers new insights and increases the validity of the result.

3.3.5 Regression Analysis

Regression analysis is one of the most important statistical techniques for describing relationships between variables and predicting values of dependent variables (Gefen/Straub/Boudreau, 2000). The technique dates back to the mathematicians Legendre and Gauss who used it in the early nineteenth century to estimate the planets orbit around the sun (Wooldridge, 2002b). Despite the proliferation of second generation statistical tools, i.e., structural equation models (Gefen/Straub/Boudreau, 2000), regression analysis remains widely popular. Some scholars even caution against the use of too complex statistical models and highlight the usefulness and simplicity of regression analysis (Angrist/Pischke, 2009). In the IS discipline regression analysis has been widely used. For instance, Gopal/Koka (2012) use regression analysis to analyze the effect of relational flexibility on vendor profitability and software quality moderated by the contract type. Yetton et al. (2000) regresses IS project performance (budget variance, project completion) on a set of project risks such as instability of the project team, technical complexity, or newness.

Following Backhaus et al. (2006), steps in regression analysis include:

- **Specifying a regression model:** Based on theoretical considerations, the researcher specifies a regression model that describes the dependent variable of interest as a linear function of one or multiple dependent variables:

  $$y = ß_0 + ß_j x_j + u$$

  with y being the dependent variable of interest, $ß_0$ being the intercept, $ß_j$ being the slope parameter for a dependent variable x_j and u being an error term that captures factors other than those being represented by the dependent variables x_j (Wooldridge, 2002b).

- **Estimating the parameters:** Given sample data from the population of interest and minimal variance in the independent variables $x_{j,}$ estimates for the parameters $ß_0$ and $ß_j$ can be obtained using the ordinary least squares approach (OLS) (Wooldridge, 2002b). These estimates minimize the sum of squared residuals, i.e., the difference between the actual value of the dependent variable and the value of the dependent variable predicted by the model (Wooldridge, 2002b). The estimated intercept parameter $\widehat{ß}_0$ indicates the predicted value of y when x_j equals zero. The estimated slope parameter $\widehat{ß}_j$ indicates how much the predicted value of the dependent variable y changes with a one unit change in the dependent variable x_j holding all other variables constant (Wooldridge, 2002b).

- **Assessing the regression model:** In order to assess how well the regression line fits the sample data, the adjusted R^2 can be used. The adjusted R^2 indicates how much of the variance in the dependent variable is explained by the model adjusted by the number of dependent variables and the number of observations (Backhaus et al., 2006). It is worth mentioning even in the case of a low adjusted R^2, the regression model might still be a realistic representation of the relationship of interest (Wooldridge, 2002b). In order to assess if inferences from the sample to the population of interest can be made with regard to the investigated relationships, the F-statistic can be used. The F-statistic is calculated based on the above mentioned decomposition of variances, the sample size, and the number of dependent variables. The according null hypothesis is that none of the independent variables explains any variance. If the null hypothesis can be rejected (based on a comparison between the empirical value of the F-statistic and a theoretical one), the researcher can have some confidence that the overall regression model explains some of the variance in the dependent variable in the population (Backhaus et al., 2006).

- **Assessing the regression parameters:** Similar to the F-statistic, which allows assessing the applicability of the overall regression model for the population, t-statistics can be calculated for assessing the applicability of the regression parameters $\hat{ß}_0$ and $\hat{ß}_j$ by dividing the parameters by their standard errors. Again, by comparing the empirical values for the t-statistics with theoretical ones, the researcher tests the null hypothesis that there is no effect of the respective independent variable on the dependent variable y in the population. The higher the absolute value of the t-statistic, the more confident the research can be in rejecting the null hypothesis and in assuming that the independent variable has a systematic effect on the dependent variable in the population. In this case, the relationship is said to be significant (Backhaus et al., 2006).

- **Assessing regression assumptions:** The quality of the estimators for the parameters, $\hat{ß}_0$ and $\hat{ß}_{j,}$ depends on a set of assumptions. OLS estimators are said to be the best linear unbiased estimators (BLUE) if the assumptions A1 to A6 (see next paragraph) hold true. If the sample on which our estimators are calculated is somehow typical, unbiased estimators are close to population values of the parameters, $ß_0$ and $ß_j$. In addition, the OLS estimators are said to be the best estimators if they have the smallest variance from a set of available unbiased estimators (Wooldridge, 2002b).

  A1: The regression model is specified correctly, i.e., it includes relevant independent variables, it is linear with regard to its parameters, and the number of independent variables is smaller than the number of observations. There is a frequent misunderstanding that regression analysis can only estimate linear relationships; however, regression analysis only requires linearity in the parameters. Consequently, non-linear relationships can be represented by applying transformations such as logarithmic or exponential transformations to the dependent or independent variables (Backhaus et al., 2006).

  A2: The expected value of the error term given any value of x_j is equal to zero. If all relevant independent variables are included in the regression model, residuals should only be due to random errors; if, however, there are systematic errors incorporated in the residuals, the estimator of the intercept of the regression function will be biased. In many applications of regression analysis, however, the constant is only of limited interest rendering this bias acceptable in many cases (Backhaus et al., 2006).

  A3: There is no correlation between the independent variables and the error term. Frequently, not all relevant independent variables can be incorporated into the regression model, e.g., because not all relevant variables are known or it is not possible to collect them. In this case, estimators might be biased if the residuals (which incorporate the missing variables) are correlated to the independent variables. If there is a correlation between two independent variables, one of which is not included in the regression model, then the estimator of the included variable might incorporate parts of the effect of the omitted variable (Backhaus et al., 2006).

A4: The residuals are homoscedastic, i.e., have a constant variance σ^2 for all observations. That means that residuals must not be dependent on the independent variables and the order of observations. In the case of heteroscedasticity the estimators can become inefficient and biased. Heteroscedasticity is frequently caused by non-linearity between the dependent and the independent variables and might be corrected for by adequate transformations. Alternatively using robust standard errors or different estimation approaches such general least squares (GLS) or weighted least squares (WLS) are accepted procedures for dealing with heteroscedasticity (Backhaus et al., 2006).

A5: There is no correlation between the residuals (autocorrelation). In case of autocorrelation, residuals are not any longer random but depend on, e.g., the residuals of prior observations. Autocorrelation is frequently problematic in time series and can result in biases with regard to the standard errors of the coefficients and thus also in biases in their confidence intervals. Autocorrelation can, for instance, be detected with the Durbin/Watson test (Backhaus et al., 2006).

A6: The independent variables do not perfectly explain each other, i.e., there is no multicollinearity. In the case of perfect multicollinearity, the regression equation cannot be calculated mathematically. Whereas minor degrees of multicollinearity may be acceptable, major multicollinearity results in biased estimators as the effect of each independent variable cannot clearly be determined. Indications of pairwise correlation between independent variables can be detected by looking at the correlation matrix; the Variance Inflation Factor (VIF), that is based on regressing the independent variables on each other, provides a way to assess whether multicollinearity is present (Besley/Kuh/Welsch, 1980). Ways of addressing multicollinearity include increasing the sample size, deleting non-essential variables or forming factors via factor analysis (Backhaus et al., 2006).

A7: The residuals are normally distributed. This assumption is not necessary to obtain best unbiased linear estimators (BLUE). Rather, it is a precondition for conducting valid F- and t-tests, see above. Backhaus et al. (2006) state that even in case of non-normally distributed residuals, the estimators can be assumed to be normally distributed when the sample size is sufficiently large (n>40).

Part B

1 Risk Profiles in Individual Software Development and Packaged Software Implementation Projects: A Delphi Study at a German-based Financial Services Company[5,6]

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Status	Accepted
Contribution of First Author	Problem Definition, Research Design, Data Analysis, Interpretation, Reporting

Table 6. Fact Sheet Publication P1

Abstract. The aim of this paper is to compare risk profiles of individual software development (ISD) and packaged software implementation (PSI) projects. While researchers have investigated risks in either PSI projects or ISD projects, an integrated perspective on how the risk profiles of these two types of information system (IS) projects differ is missing. To explore these differences, we conducted a Delphi study at a German-based financial services company. Our results suggest that: First, ISD projects seem to be more heterogeneous and face a larger variety of risks than the more straightforward PSI projects. Second, ISD projects seem to be particularly prone to risks related to sponsorship, requirements, and project organization. Third, PSI projects tend to be predominantly subject to risks related to technology, project planning, and project completion. Finally, in contrast to available lists of risks in IS projects and irrespective of the project type, we find a surprisingly high prominence of technology and testing-related risks.

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[5] An earlier version of this research was published in the proceedings of the 45th Hawaii International Conference on Information Systems (HICSS) 2012.

1.1 Introduction

Although the discipline of information systems (IS) project management has matured considerably over the last decades, a lot of IS projects still face time, quality and budget issues. Failure rates of IS projects range from 23% to 68% – even in the optimistic case of 23% a high number for a professional discipline (Sauer/Gemino/Reich, 2007; The Standish Group, 2010). As successful IS project managers tend to be good at managing risks (Boehm, 1991) project risk management has increasingly gained importance among practitioners and academics (Bannerman, 2008).

Project risk management typically comprises the two phases of risk analysis (the identification, the assessment and the prioritization of possible events that pose a threat to project success) and risk control (the planning of responses, risk resolution and continuous monitoring) (Charette, 1996; Heemstra/Kusters, 1996). Studies on project risk management in the IS discipline tend to focus on the first phase, and, in particular, on risk identification. In this regard, researchers have devised various generic lists of risks or checklists (Alter/Ginzberg, 1978; Zmud, 1980; McFarlan, 1981; Boehm, 1991; Barki/Rivard/Talbot, 1993; Moynihan, 1997) to guide IS project managers in identifying and analyzing potential threats to IS project success. More recently, researchers have started to acknowledge that there is no one-size-fits-all risk profile for IS projects. Existence and importance of risks seem to vary depending on contextual, project-related, or individual characteristics. In this regard, researchers have analyzed how the cultural and socioeconomic (Schmidt et al., 2001; Mursu et al., 2003) context, a project's outsourcing location (Nakatsu/Iacovou, 2009), an individual's role in a project (Keil/Tiwana/Bush, 2002; Liu et al., 2010), and how his or her experience (Du et al., 2007; Warkentin et al., 2009) influence the existence and importance of IS project risks. Existing studies tend to either subsume various project activities under the general category of IS projects or exclusively focus on either individual software development (ISD) projects or packaged software implementation (PSI) projects. An integrated perspective on how risk profiles of these two types of information system (IS) projects differ is missing.

We argue that besides the mentioned contextual, project-related and individual characteristics, a main factor affecting a project's risk profile is the type of project that is being analyzed. The development of individual software differs considerably from the implementation of packaged software in terms of the project lifecycle and the intensity of the relationship between client and vendors (Lucas/Walton/Ginzberg, 1988; Markus/Tanis, 2000). With regard to the project lifecycle, individually developed software is typically designed to fit a company's extant business processes, which puts considerable emphasis on requirements analysis. The implementation of packaged software, in contrast, oftentimes comes with major business process changes as tailoring the software package to extant processes is difficult and only possible to some extent. With regard to the client-vendor relationship, individual software development projects are frequently limited to the short- or medium-term. On the contrary, the implementation of packaged software oftentimes means long-term relationships between clients and vendors in order to maintain and update the software.

While extant research on risks sets the basis for understanding success and failure in IS projects, a consideration of risk profiles contingent on the project type may allow for a more effective management of risks. Hence, our research question is: *What differences exist* *between individual software development and packaged software implementation projects with regard to their risk profiles?*

In order to answer this question, we conducted a Delphi study at a German-based financial services company. The focus on a single research site enables us to control for organizational characteristics (Hofstede, 1980) and to achieve more open discussions on the sensitive topic of project risk and failure. Our experts included twelve IS project managers representing two types of IS projects: 1) individual software development (ISD) projects, in which new software is developed from scratch, and 2) packaged software implementation (PSI) projects, which integrate off-the-shelf software packages such as data base management systems into the existing IS landscape.

Our results suggest that: (1) ISD projects seem to be more heterogeneous and face a larger variety of risks than the more straightforward PSI projects. (2) ISD projects seem to be particularly prone to risks related to sponsorship, requirements, and project organization. (3) PSI projects tend to be predominantly subject to risks related to technology, project planning, and project completion. Finally, (4) in contrast to available lists of risks in IS projects and irrespective of the project type, we find a surprisingly high prominence of technology- and testing-related risks.

The remainder of the paper is structured as follows: In section 2, we review the related literature on IS project risks with a focus on risk identification and risk analysis. Section 3 outlines our research approach. In section 4, we present the results and compare them to previous findings. Finally, we conclude by pointing out the limitations as well as the implications of our study.

1.2 Related Literature

A considerable body of research on IS project risks has focused on the identification of risks as a necessary condition for successful project risk management (Clarke/O'Connor, 2012). While there are various tools to improve risk identification such as brainstorming, scenarios, or failure trees, lists of risks or checklists are arguably the most frequently used among practitioners and researchers (Li, 2011). Checklists typically contain a list of key risks and descriptions of these risks and thus provide a starting point for risk identification and analysis. Though there is an ongoing debate about the advantages and disadvantages of checklists (Budzier, 2011; Drummond, 2011; Li, 2011; Lyytinen, 2011), empirical evidence suggests that checklists indeed can help risk managers to identify project risks more effectively (Keil et al., 2008).

Based on early checklists that identify and describe risks in IS projects (Alter/Ginzberg, 1978; Zmud, 1980; McFarlan, 1981; Boehm, 1991; Barki/Rivard/Talbot, 1993; Moynihan, 1997), more recent research has acknowledged that there is no one-size-fits-all checklist. Rather, project risks seem to vary in existence and importance depending on certain characteristics related, e.g., to the project's context, the project, the individuals involved in risk management, or the risk itself.

For instance, the cultural background has been shown to affect the relative importance of project risks (Schmidt et al., 2001; Sam/Bhasi, 2012): While cultures with a collectivist philosophy such as Hong Kong seem to emphasize risks for which there is collective responsibility, individualistic cultures such as Finland or the United States tend to focus on risks attributable to single individuals (Schmidt et al., 2001). In addition to cultural influences also the socioeconomic background is of importance when prioritizing risks. Extending the work by Schmidt et al. (2001), Mursu et al. (2003) investigate how Nigerian project managers identify and rank risks in software development projects. The findings suggest that the socio-economic background and the constraints it implies in terms of reliable energy and telecommunication infrastructure and educational standards strongly affect a software development project's risk profile (Mursu et al., 2003): Nigerian project managers ranked the risks "energy supply" and "unreliable communication network" among the most important risks in software development projects. In contrast, these risks are not mentioned at all by project managers in industrialized countries (Schmidt et al., 2001).

Besides the cultural and socioeconomic background, characteristics of the project exert influence on the risk profile of software development projects, as for example illustrated in a study by Nakatsu/Iacovou (2009) on offshore and domestic outsourcing projects. Not surprisingly, the offshore context resulted in specific risks such language barriers, cultural differences, or political instabilities which were not deemed relevant in the domestic context (Nakatsu/Iacovou, 2009).

The role of individuals is also known to affect the risk profile of IS projects. While senior executives tend to focus on more strategic risks related to politics, organization structure, and culture, project managers put emphasis on tactical risks related, e.g., to user involvement, or requirements engineering (Liu et al., 2010). Users seem to prioritize risks related to the project manager and his or her abilities (Keil/Tiwana/Bush, 2002). Another important individual characteristic concerns the risk managers' level of experience. Warkentin et al. (2009) suggest that more experienced project managers and system engineers see organizational risks as the ultimate source of other risks. In contrast, less experienced project managers and system engineers seem to focus on operational risks such as a project's technical feasibility (Warkentin et al., 2009). The results of an experimental study by Du et al. (2007) add that project managers with more experience tend to perceive higher levels of risks than project managers with less experience.

Finally, characteristics of a risk itself have been suggested to influence its perceived importance. Keil et al. (1998) provide a framework for categorizing risks into four quadrants, based on their importance and the level of control as perceived by the project manager. The results illustrate that these two dimensions are not independent of each other. The level of control actually seems to negatively affect the importance a project manager attributes to a risk, i.e., the lower the level of direct control, the higher a risk's perceived importance tends to be (Keil et al., 1998). Table 7 gives an overview studies that investigate these variations in risk profiles.

Study	Characteristic influencing project risk profile	Research approach	# Risks identified
Schmidt et al. (2001)[x]	Cultural background	Delphi study	53
Mursu et al. (2003)	Socioeconomic background	Delphi study	51
Nakatsu/Iacovou (2009)	Outsourcing location	Delphi study	25 / 20[*]
Liu et al. (2010)	Role	Delphi study	57
Keil/Tiwana/Bush (2002)	Role	Delphi study	-[†]
Warkentin et al. (2009)	Experience	Case study	7[‡]
Du et al. (2007)	Experience	Experimental study	-
Keil et al. (1998)	Perceived control	Delphi study	53

[x]: The results are based on the Delphi study conducted by Keil et al. (1998).

[*]: Nakatsu/Iacovou (2009) identified 25 risks for offshore and 20 for domestic outsourcing projects.

[†]: Keil/Tiwana/Bush (2002) used the 53 risks identified in Schmidt et al. (2001) as a starting point for risk selection.

[‡]: Warkentin et al. (2009) identified no risks but seven themes which include combinations of several risks.

Table 7: Overview on Studies on Variations in Risk Profiles

By devising specific checklists for ISD (e.g., Boehm, 1991; Barki/Rivard/Talbot, 1993; Moynihan, 1997; Reed, 2012) and PSI projects (e.g., Sumner, 2000; Finney/Corbett, 2007; Chen/Law/Yang, 2009) researchers also acknowledge that the project type is an important characteristic affecting a project's risk profile. For instance, based on known risks in ISD projects, Sumner (2000) investigates risks specific to PSI projects by the example of enterprise resource planning (ERP) projects. Her analysis of seven large ERP implementations yields several ERP specific risks that relate the enterprise-wide design of business processes, the integration of external expertise, the customization and the integration with legacy systems. Research on software economics also supports the notion of project type specific risks: Appari/Benaroch (2010) explore a pricing method for software development risks based on two parameters: a risk premium and a project's sensitivity to the risk. Their results suggest that different project types may have different sensitivities to project risks: The authors found that system software projects tend to react twice as sensitive to technology platform risks as support software projects, implying that the priority of risks varies depending on the project type. While studies which investigate risks of either ISD or PSI projects provide valuable insights for risk managers of these projects, comparing their findings and drawing inferences as to how different projects vary in terms of their risk priorities is almost impossible due to the varying study contexts. An integrated perspective on how the risk profiles of ISD and PSI projects differ is missing. By analyzing these differences in one common context, we aim to fill this gap and contribute to the IS discipline's understanding of project risks.

1.3 Research Approach

In order to answer our research question we conducted a ranking type Delphi study at a German financial services company. The Delphi approach is a common approach for this kind of research (see Table 7) and aims at achieving consensus among experts regarding complex problems through iterative feedback loops (Linstone/Turoff, 1976). We conducted the Delphi study between October 2010 and April 2011 within the IS unit of a German, DAX-30-listed financial services company (for reasons of anonymity called OMEGA). We chose a one-company setting for two reasons: First, it helps control for any organizational or industry characteristics (Hofstede, 1980). Second, as information about project risks and failure is potentially confidential, limiting the study to in-house experts from one research site ensures more open discussions and feedback from the participants (Linstone/Turoff, 1976). OMEGA's IS unit provides development, implementation, operations and maintenance services to OMEGA internal clients. We distinguished two types of IS projects: First, ISD projects, in which new software is developed according to OMEGA's specific requirements. Second, PSI projects, where off-the-shelf software packages such as data base management systems are integrated in OMEGA's existing IS landscape.

1.3.1 Composition of Panels

We recruited a total of 12 project managers from OMEGA. We followed a systematic selection approach as recommended by Linstone/Turoff (1976). To account for role-based (Keil/Tiwana/Bush, 2002; Liu et al., 2010) and cultural (Schmidt et al., 2001) biases, we limited our study participants to German project managers. In addition, we preferred participants with a visible interest in the research topic in order to achieve meaningful results and keep the drop-out rate as low as possible. Furthermore, the study participants' projects should cover various project contexts within their panel to gain a picture as holistic as possible. We emailed invitations to participate in the study including procedural details to project managers from ten different departments within OMEGA's IS unit. Based on the positive responses two panels were composed, each consisting of six project managers whose last or ongoing project belonged to the panel's project type. Table 8 shows descriptive statistics for the two panels.

	ISD project panel				PSI project panel			
	Ø	**SD**	**Min**	**Max**	**Ø**	**SD**	**Min**	**Max**
IS experience [in years]	17,3	8,1	10	25	23,5	7,5	14	35
PM experience [in years]	13,3	7,2	7	22	14,3	4,3	10	30
Project effort [in man-months]	491	320	53	1033	46	49	6	150
Project duration [in months]	13,6	4, 8	9	24	15,8	9,5	8	36

SD: Standard deviation.

Table 8: Descriptive Statistics for the Two Panels

1.3.2 Data Collection and Data Analysis

To investigate the relative importance of project risks we followed the Delphi approach as described by Schmidt (1997): Data collection was not exclusively done via electronic mail but also via semi-structured interviews. Through the interviews we could develop an in-depth understanding of the identified risks and the reasoning behind the participants' individual rankings. Furthermore, the interviews turned out to be helpful in keeping the project managers motivated throughout the study. In total, the study took seven months. It involved three sequential phases as depicted in Figure 5.

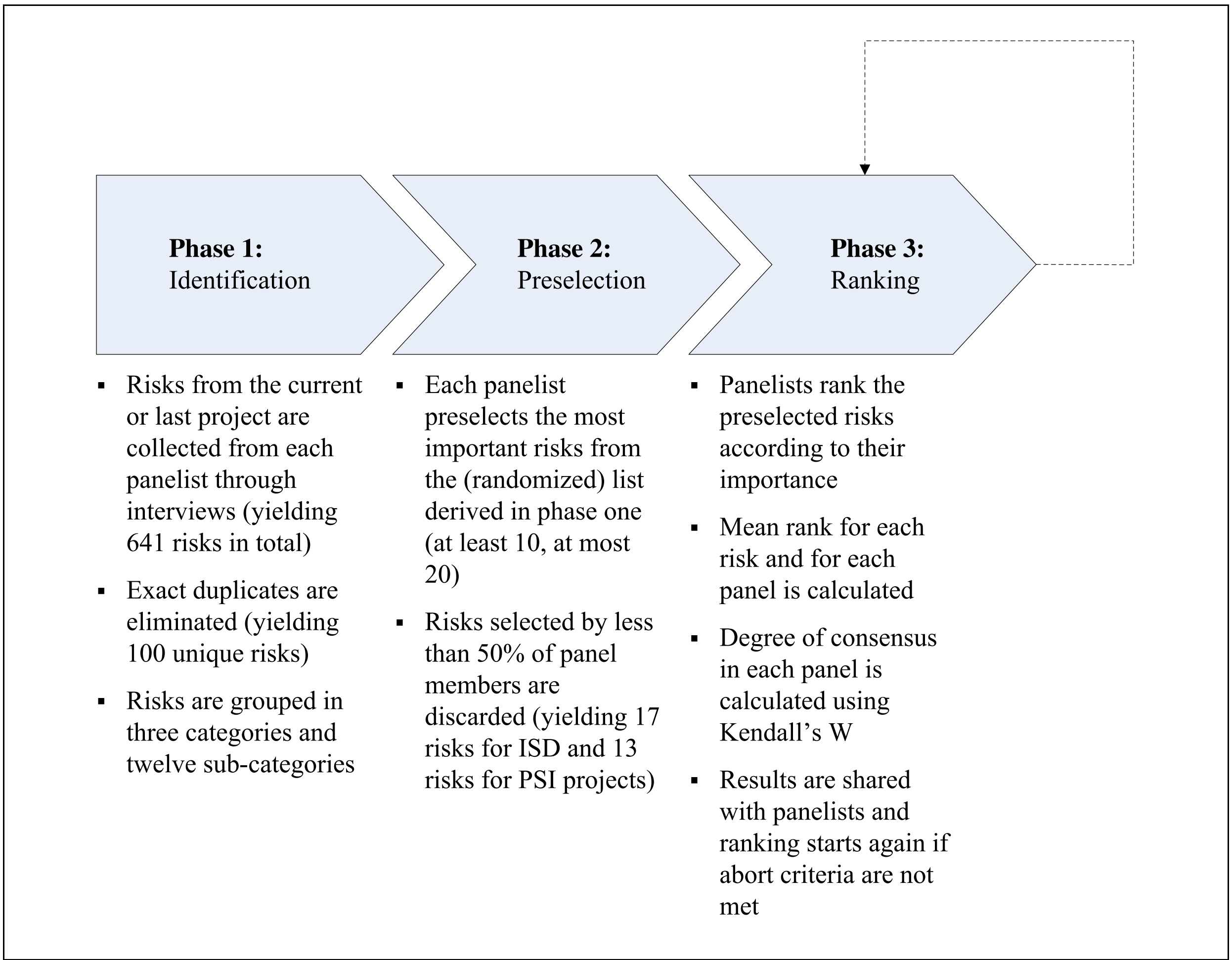

Figure 5. Delphi Methodology (Source: Schmidt (1997))

In phase one, we conducted semi-structured interviews with each project manager. The semi-structured interviews aimed at identifying as many risks as possible. The discussions during the interviews resulted in a total of 641 risks. Besides, the discussions were useful for developing the understanding necessary for the subsequent consolidation: we removed exact duplicates from the list, yielding 100 unique risks. We grouped similar risks following the categorization proposed by Wallace/Keil/Rai (2004b) and Schmidt et al. (2001).

In phase two, we divided the project managers into the two panels. In order to allow for a meaningful assessment of the risks, we asked the project managers to select between 10 and 20 risks from a randomized list of the 100 unique risks derived in phase 1. Risks which were selected by at least half of the project managers in one panel were kept for phase three. Phase two yielded 17 risks for ISD projects and 13 risks for PSI projects.

In phase three, we presented each project manager with an ordered list of risks for the respective panel. In order to provide the project managers with feedback from the second phase (Keil/Tiwana/Bush, 2002), the list of panel-specific risks was ordered by the relative number of mentions descending. We emphasized that a high number of mentions is not necessarily an indicator of the importance of the risks. Similar to phase one, the first round of the ranking was done via interviews. This approach helped us capture the reasons for ranking risks high or low. In the interviews we asked the project manager to sort the risks by descending importance and to explain the final ranking to us. The subsequent ranking rounds were carried out via email. After each round we calculated the degree of consensus within the panels using Kendall's coefficient of concordance (W). In addition, we provided the panelists with the mean rank of each risk and also the reasons for the rankings as stated by the project managers during the interviews.

We stopped the ranking in both panels after the second round as the participants made clear that their individual rankings won't change. The panel of ISD project managers reached a low to moderate agreement (W = 0.43); the panel of PSI project managers reached a strong agreement (W = 0.68) (Schmidt, 1997). Although both panels did not reach the predefined threshold of 0.7, we can have a fair degree of confidence in our results (Schmidt, 1997).

1.4 Results and Discussion

In the following section, we present and discuss the results of our study in three subsections: First, we analyze the results of the identification phase. Second, we take a detailed look at the risks selected for each panel for ranking. Third, we analyze the final rankings agreed upon by the panels.

1.4.1 Risk Identification

In phase one a comprehensive list of risks in ISD and PSI projects at OMEGA was developed. The list comprises 100 risks and is organized in three categories and twelve sub-categories based on Wallace/Keil/Rai (2004b) and Schmidt et al. (2001). Due to space limitations, we do not present it here. However, the list is available from the authors upon request. Consistent with the findings of Keil et al. (2008), checklists seem to support individuals in risk identification: OMEGA project managers who used checklists were able to identify on average 23.3 different risks. In contrast, their colleagues, who did not use checklists, could only name 15.1 different risks on average.

As the main goal of our study was to explore differences in risk profiles across ISD and PSI projects, we will refrain from a detailed one-on-one comparison of the risks identified in this study with the risks identified in related studies. Overall, a considerable number of risks in our study can be matched to the risks identified in our reference studies by Schmidt et al. (2001) and Liu et al. (2010). However, two major differences to these studies are apparent: First, the project managers at OMEGA identified considerably more (almost twice as many) risks than participants in Schmidt et al. (2001) and Liu et al. (2010). On the one hand, this may be due to the fact that our list is more granular, i.e., that several of the risks identified in our study are reflected in only one risk in Schmidt et al. (2001) and Liu et al. (2010). On the other hand, this may be due to the second major difference, namely the surprisingly high number of risks related to the technology and testing sub-categories. Although these sub-categories are mentioned in Schmidt et al. (2001) and Liu et al. (2010), the number of risks belonging to these sub-categories is substantially lower than in our study. We assume that the prominence of risks related to technology and testing in our study may result from the general trend of information systems becoming ever more complex, which is especially true in the financial services industry with its large and interlinked systems. Furthermore, as project management practices in companies become more and more mature, the focus of project managers may have shifted away from risks related to project management towards risks related to technology and testing issues.

Overall, project managers of ISD projects identified substantially more risks (79 risks) than project managers of PSI projects (51 risks), suggesting that development projects are subject to a greater variety of risks than implementation projects. Figure 6 depicts the share of risks identified in each sub-category relative to the total number of risks identified in the ISD and the PSI project panel, respectively. Sub-categories with a considerable share of identified risks, e.g., the technology sub-category, can be said to contain a larger bandwidth of risks than categories with a smaller share.

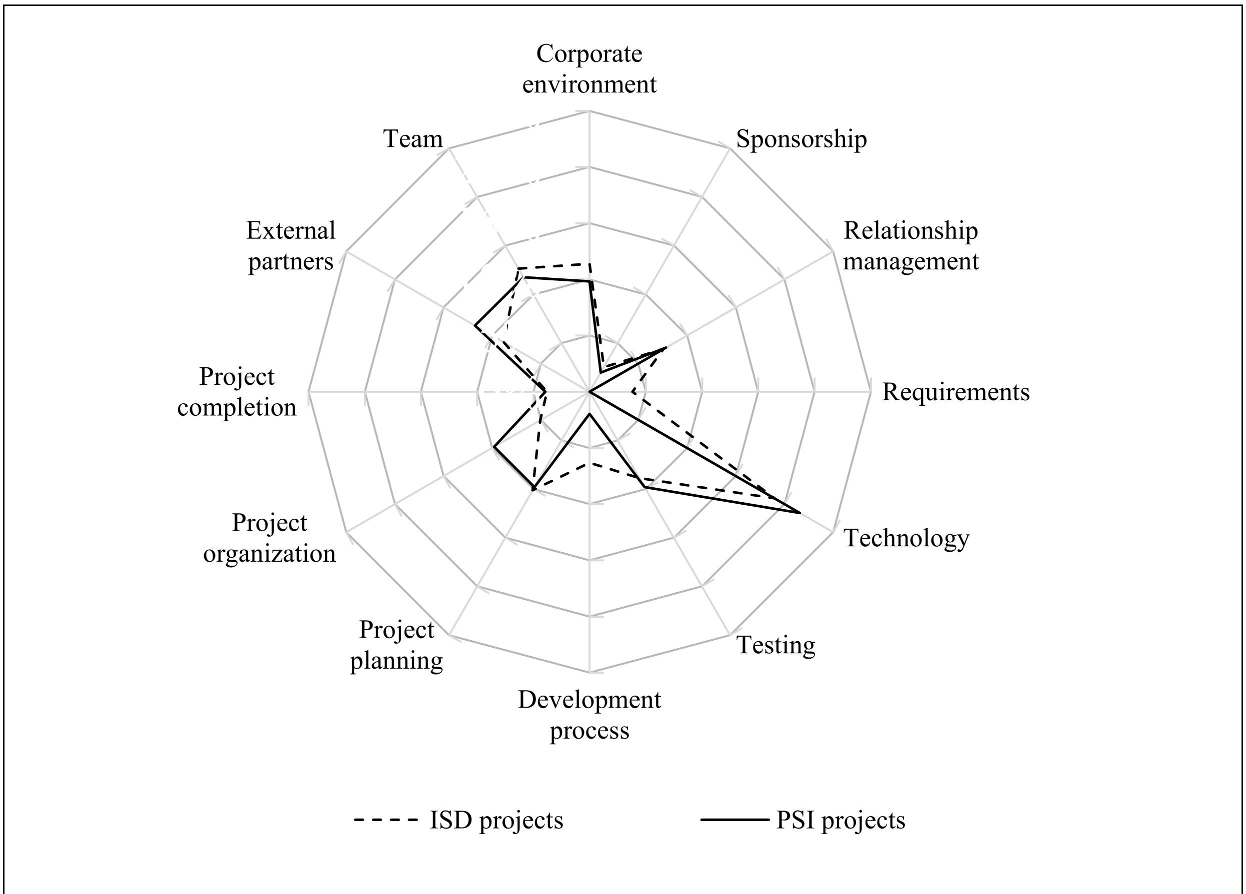

Figure 6. Share of Risks Identified in Each Sub-Category in ISD and PSI Projects

In contrast to our expectation, the risk profiles of ISD and PSI projects look quite similar suggesting that the common context in which the projects take place also determines the variety of risks the projects are subject to. Both panels identify many risks in the technology, team, corporate environment and project planning sub-categories. While the prominence of team, corporate environment and planning related risks is also found in related work, the high share of technology related risks is rather surprising. In addition, project managers from both panels identify few risks in the sub-categories sponsorship and project completion, probably due to mature project management practices which reduce the breadth of possible for risks in these sub-categories.

Major differences between ISD and PSI projects become visible in the subcategories requirements, development process, project organization, and external partners. Not surprisingly, ISD projects are subject to a broader variety of risks related to requirements, above all unclear or unstable requirements. This aptly reflects the creation of new software from scratch, where the focus lies on understanding what the client exactly wants and building the software accordingly. Naturally, there are also fewer limits to the clients' ideas in ISD projects than in PSI projects which may result in frequent requirement changes. In a similar vein, also the development process tends to bear considerably more risks such as an inefficient change management or excessive administrative requirements in ISD projects. On the other hand, PSI projects seem to face more risks related to the project organization and external partners. Risks related to the project organization include for example no risk management or a lack of communication guidelines. As these risks have no obvious link to the specific project type, we argue that they might originate from the fact that PSI projects are substantially smaller than ISD projects and, thus, less attention is paid to organizational issues which again increases the spectrum of risks in this sub-category. Finally, external partners tend to pose more risks to PSI projects as these projects are typically conducted with the help of specialized consultants over which OMEGA has little or no control.

1.4.2 Risk Selection

In the second phase of our Delphi study, the project managers were asked to select between ten and twenty risks they deemed most critical for project success from the complete randomized list developed in phase 1. Again project managers of ISD projects selected more risks (17) than project managers of PSI projects (13) corroborating the notion that ISD projects tend to be subject to a greater variety of risks.

Table 9 shows the number of selected and identified risks in ISD and PSI projects by risk sub-category. Risks in the sub-categories corporate environment, relationship management, requirements, technology, testing, project planning, and team were selected for ranking in both, ISD and PSI projects. Risks in the sub-category external partners were ignored by both panels, indicating that these risks are not deemed critical for project success by ISD and PSI project managers. Besides these commonalities, also several differences between ISD and PSI projects are recognizable: In contrast to project managers of PSI projects, project managers of ISD projects selected risks in the sub-categories sponsorship, development process, and project organization for ranking. Conversely, project managers of ISD projects did not select risks in the sub-category project completion. The focus on the development process by the ISD project managers and on project completion by the PSI project managers, respectively, aptly reflects the inherently different project activities of developing and implementing software.

Risk sub-category	ISD projects		PSI projects	
	# of risks identified in p1	# of risks selected in p2	# of risks identified in p1	# of risks selected in p2
Corporate environment	9	2	5	2
Sponsorship	2	1	1	-
Relationship management	6	3	4	1
Requirements	3	1	-	2
Technology	15	3	11	2
Testing	7	1	5	1
Development process	5	2	1	-
Project planning	8	1	5	1
Project organization	4	1	5	-
Project completion	3	-	2	2
External partners	7	-	6	-
Team	10	2	6	2
Total	**79**	**17**	**51**	**13**

Table 9: Number of Identified and Selected Risks by Panel and Risk Sub-Category

While the results of phase 1 indicate slightly different bandwidths of risks in ISD and PSI projects, the results of phase 2 highlight that the risk profiles of ISD and PSI projects seem to vary above all with regard to the importance of risk sub-categories and the risks themselves. Out of the 17 risks identified by the ISD project managers, twelve risks are important for ISD project managers only. Five risks were also selected for ranking by the PSI project managers. Conversely, the PSI project managers selected eight risks for ranking that the ISD project managers considered unimportant. In the following, we discuss these differences in more detail.

1.4.3 Risk Ranking

The third phase of our study aimed at ranking the risks selected in phase 2. Project managers in both panels were asked to rank order the risks by declining importance. To achieve panel consensus, the results of the first round of ranking were fed back to the panelists and a second round was conducted. The ranking stopped after this second round as it became clear that the consensus within both panels would not improve further. Interestingly, the degree of consensus within the two panels is quite different: Whereas the panel of ISD project managers only reached weak consensus (W = 0.43), the panel of PSI project managers reached a moderate to strong consensus (W = 0.68). The difficulty of reaching a stronger consensus in the ISD panel may be explained by the fact that ISD projects tend to be more heterogeneous with regard to their risks than PSI projects, which again substantiates the findings of phase 1. The final risk rankings for ISD and PSI projects and a mapping to Schmidt et al. (2001) are shown in Table 10.

Risk		**Sub-category**	**Rank ISD projects**	**Rank PSI projects**	**Rank Schmidt et al. (2001)**
A	Dependencies on other projects	Project organization	1		(17) [USA]
B	Unavailability of testing infrastructure	Testing	2	4	
C	Unclear requirements	Requirements	3		2
D	Unrealistic external deadlines	Corporate environment	3		7 [FIN]
E	Complex interfaces	Technology	5	2	
F	Lack of skilled resources	Team	6	1	5
G	Inter-divisional decisions	Relationship management	7		11
H	Unrealistic sponsor expectations	Sponsorship	8		(9)
I	Low project priority	Corporate environment	9	3	(1)
J	Unclear roles and responsibilities	Team	10		15 [USA]
K	End user resistance	Relationship management	11		4 [HKG]
L	Parallel release development	Development process	12		
M	Poor coordination between sub projects	Development process	13		(5) [FIN]
N	Missing stakeholders	Relationship management	14	11	(4)
O	Heterogeneous system architectures	Technology	15		
P	No integration of experienced team members	Planning	16		(5) [FIN]
Q	New technology	Technology	17		8
R	Unstable requirements	Requirements		6	6
S	High technical complexity	Technology		5	(16) [FIN]
T	Optimistic project planning	Planning		7	(5) [FIN]
U	No implementation strategy	Project completion		8	(5) [FIN]
V	Budget cuts	Corporate environment		9	(1)

W	Unrealistic project scope	Requirements	10	(18) [FIN]
X	No fall-back scenarios	Project completion	11	(5) [FIN]
Y	Dependency on third parties	Team	11	(5)

Round brackets indicate related risks rather than one-to-one mappings.
Square brackets indicate the respective panel ranking.

Table 10: Risk ranking for ISD and PSI projects at OMEGA

Looking at Figure 7, some commonalities between ISD and PSI rankings stand out. In both panels the risk sub-categories corporate environment, testing, and team rank relatively high, whereas the sub-categories relationship management, external partners and development process rank relatively low. Regarding the corporate environment, low project prioritization seems to be an issue for both, ISD and PSI projects, albeit being slightly more important for PSI projects. In PSI projects a low project prioritization tends to translate into budget cuts whereas this seems not to be the case for ISD projects. ISD projects in addition face unrealistic external deadlines, which possibly reflect the higher urgency and strategic importance of ISD projects. In the testing sub-category, the unavailability of the testing infrastructure ranks high in both panels. Although of slightly higher importance in ISD projects, the prominence of testing in PSI projects is rather surprising. We argue that this may be due to increasingly interlinked information systems, which make integration and system tests a critical issue for PSI projects as well. Another risk sub-category ranked high by project managers in both panels is the team sub-category. Irrespective of the specific project type, adequately skilled resources are scarce. This is particularly exacerbated in PSI projects, where a lack of skilled resources was ranked the most important risk, probably being a consequence of the low project priority and the conditional access to the company's resource pool by these projects. Risks related to the relationship management, the external partners, and the development process sub-categories rank comparatively low in both panels. Whereas risks related to relationship management appear in both rankings, risks related to external partners were not ranked in either panel, making external partners the least important sub-category for ISD and PSI projects. As indicated by the results of phase 1, especially PSI project managers seem to recognize external partners as a potential source for risks though. Risks related to the development process were ranked by ISD project managers only, see above. However, as indicated by their low rank, these risks seem not to be the most critical ones for project success.

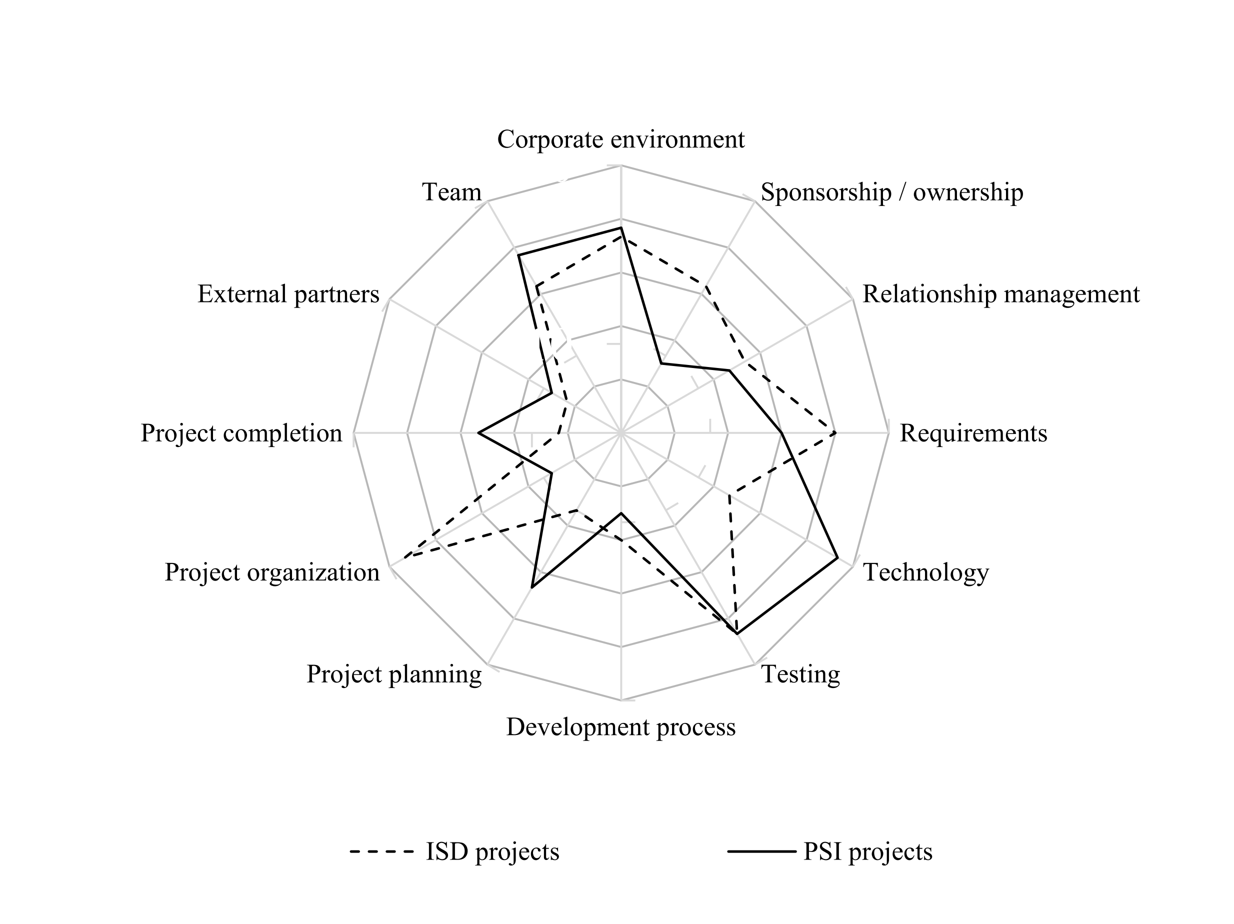

Figure 7. Relative Importance of Risk Sub-Categories in ISD and PSI Projects

Regarding the differences between the two rankings, the most important risks for ISD projects reside in the project organization, the requirements, and the sponsorship sub-categories. ISD project managers rank risks related to these sub-categories substantially higher than PSI project managers. The project organization sub-category is the most important sub-category with dependencies on other projects posing the most important risk in the ISD panel. The fact that ISD projects at OMEGA tend to be part of large development programs with many sub-projects seem to be the reason for this. Furthermore, risks in other sub-categories appear to be related to the considerable size of these development programs, such as inter-divisional decisions, a poor coordination between sub-projects, and the development of parallel releases. Additionally, although requirements play an important role in PSI projects as well, they are particularly important for ISD projects. As described above, ISD projects, in which new software is developed from scratch, leave more room for the client's ideas than PSI projects, in which the functionalities are clearly defined upfront by the respective software package. Accordingly, the risks of unclear requirements and unrealistic sponsor expectations are among the top ten risks in ISD projects, whereas these risks are not ranked in the PSI panel. However, PSI projects are apparently more vulnerable to unstable requirements and an unrealistic project scope, which is understandable given the tight budgets of PSI projects. Unrealistic sponsor expectations in ISD projects may also be driven by the frequent use of new, state-of-the-art technology in these projects which sometimes is not mature enough to deliver on its promises. Where these promises cannot be kept, user resistance tends to be high as well. In contrast to ISD projects, which seem particularly exposed to risks in the project organization, the requirements, and the sponsorship sub-categories, the most important risks in PSI projects seem to be related to the technology, the project planning, and the project completion sub-categories. First, with regard to technology, complex interfaces and high technical complexity in general were ranked high by PSI project managers. Again we argue, that today's interlinked IS landscapes in the financial services industry pose new challenges with regard to the integration of packaged software adding substantial complexity to these projects, and also making integration testing an important issue. Second, project planning seems to be more important for PSI projects. Due to their comparatively small size and the use of "ready-to-use" packaged software, project planners tend to underestimate the effort necessary for successfully implementing these projects: The risk of planning the project too optimistically ranks seventh among PSI project managers while it was not ranked by ISD project managers. This issue is also reflected in two planning related risks in the project completion sub-category: While not an issue for ISD projects, the risks of having no implementation strategy and no fall-back scenarios ranked eighth and tenth in the PSI panel. The risk of no fall-back scenarios may relate to the high costs of switching to another software package once it has been found out that the chosen software package cannot deliver the required functionality.

1.5 Conclusion and Implications

In addition to national culture, hierarchical roles, and personal experience, the project type also seems to exert considerable influence on a project's risk profile. We explore this proposition using a Delphi study approach with two different panels representing individual software development (ISD) projects and packaged software implementation (PSI) projects.

Our results suggest that ISD projects tend to be more heterogeneous and face a greater variety of risks than the more straightforward PSI projects as indicated by the greater number of risks identified/selected by ISD project managers in phase 1/phase 2 or the greater difficulty of reaching a consensus among ISD project managers in phase 3 of our study. Additionally, both, ISD and PSI projects rank risks related to the corporate environment, the testing and the team sub-category high. ISD projects in particular seem to be prone to risks related to sponsorship, requirements, and project organization. Furthermore, ISD projects face more risks related to the development process than PSI projects reflecting the different nature of software development, e.g., a focus on requirements and the way the software is created, when compared to software implementation. In contrast, PSI projects tend to be subject to risks related to technology, project planning, and project completion. These particularities in the risk profile may be due to the fact that PSI projects are often underestimated with regard to technological risks and risks related to project planning because of the use of presumably mature packaged software and their more manageable size, respectively. Irrespective of the project's type, we find a surprisingly high prominence of technology- and testing-related risks compared to other studies. We see two explanations for this: Either, we can observe a general trend towards more complex information systems, which should be especially true in the financial services industry. Or, the prominence of testing and technology related risks partly reflects a cultural particularity by German engineers, who tend to focus more on technical issues than for example their American or Chinese colleagues.

The following limitations have to be kept in mind: First and foremost, the one company setting of our study potentially limits the generalizability of our results. The characteristics of the chosen industry and company may bias the identified risk profiles: For instance, technology- and testing-related risks may be more accentuated in the financial services industry than in other industries in which information systems do not play such a crucial role. Also, company specifics, such as the resource pool of OMEGA's internal IS unit may bias the risk profiles of both project types. As mentioned above, however, focusing on one research site also enabled us to hold these factors constant across our two panels. We found no indication that company specifics affected either ISD or PSI projects alone, giving us confidence that the observed differences between ISD and PSI projects may be generalizable to other organizational settings. Furthermore, limiting the study participants to in-house experts from a single company helped obtain more open feedback when discussing confidential topics with the study participants, enhancing our confidence in the validity of our results. A second limitation is our selection of project managers: We preferred project managers with a visible interest in the research topic in order to ensure a high response rate. However, this focus potentially disguises risks that individuals with different roles or less interested project managers are faced with (Warkentin et al., 2009). Accordingly, our findings should be treated with caution when studying different settings. Third, our risk profiles depend on our subjective definition and categorization of risks. Although we tried to minimize this bias by cross-checking the definition of risks and their categorization by all four authors of this study, subjectivity cannot be ruled out completely.

Despite these limitations, we are confident that our study contributes by shedding a first light on differences in the risk profiles of ISD and PSI projects. Practitioners should keep in mind that the importance of similar risks may vary in ISD and PSI projects. Future research should address the limitations mentioned above. In particular, the study should be replicated in different industry and organizational settings. Further promising avenues for future research include the development of project risk profiles and matching project risk management approaches. Also, investigating dependencies between several risks in specific project risk profiles seems to bear great potential in order to be able to tackle problems in IS projects at their root cause.

2 Comparing Risk and Success Factors in ERP Projects: A Literature Review

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Status	Accepted
Contribution of First Author	Problem Definition, Research Design, Interpretation, Reporting

Table 11. Fact Sheet Publication P2

Abstract. Although research and practice has attributed considerable attention to Enterprise Resource Planning (ERP) projects their failure rate is still high. There are two main fields of research, which aim at increasing the success rate of ERP projects: Research on risk factors and research on success factors. Despite their topical relatedness, efforts to integrate these two fields have been rare. Against this background, this paper analyzes 68 articles dealing with risk and success factors and categorizes all identified factors into twelve categories. Though some topics are equally important in risk and success factor research, the literature on risk factors emphasizes topics which ensure achieving budget, schedule and functionality targets. In contrast, the literature on success factors concentrates more on strategic and organizational topics. We argue that both fields of research cover important aspects of project success. The paper concludes with the presentation of a possible holistic consideration to integrate both, the understanding of risk and success factors.

2.1 Introduction

In recent years Enterprise Resource Planning (ERP) systems have become a necessity for most companies to stay competitive. In contrast to stand-alone applications, ERP systems are integrated standard software systems supporting core business processes across several functions. As such these software systems have considerable potential to contribute to business value creation (Davenport, 1998). The large and fast growing market for ERP systems reflects this importance: By 2011 the market is expected to grow to 47.7 billion USD, achieving a compound annual growth rate of 11 % (AMR Research, 2007).

Expected benefits from ERP systems range from tangible ones, mainly productivity gains through cost reduction (e.g., inventory reduction, reduction of personnel, reduction in IT and procurement cost, transportation and logistics costs, reduction in the need for system maintenance) and increased effectiveness (e.g., improvement of cash flow management, improvement in on-time delivery performance, improvements in order management) to intangible ones, such as increased visibility of corporate data, improved responsiveness to customers, increased flexibility, and global information sharing (Al-Mashari/Al-Mudimigh/Zairi, 2003)

The challenge in realizing the above mentioned benefits is deploying such systems successfully. For various reasons (e.g., ERP systems build on legacy systems or because of their cross-functional nature) ERP projects tend to be more complex than typical software development projects and thus also tend to bear a higher risk of failure. Pawlowski (1999) estimate that the failure rate in ERP projects equals 50 %. Panorama Consulting Group, a market research company, found that one third of ERP implementations take longer than expected. Two thirds exceed the initially projected budget and fail to realize more than half of the expected benefits (Kimberling, 2010). Failed ERP projects can severely affect company performance as illustrated by the well-known example of FoxMeyer, a drug company, which blamed its bankruptcy on a failed ERP implementation (Scott, 2004).

There exist two main approaches in the literature, which deal with success and failure of ERP projects in a narrow sense. On the one hand researchers on risk factors are concerned with how to identify, assess and control events that might influence the project's success negatively. On the other hand, researchers on success factors concentrate on variables that promote project success. Given these common definitions, risk factors and success factors should be two sides of the same coin and deal mainly with the same topics. However, in the current literature risk and success factors are mostly considered separately. Thus, the goal of this paper is to integrate these two streams of research within a holistic consideration by conducting a comprehensive literature review and analyzing similarities and differences of risk and success factors in ERP projects.

2.2 Methodological Approach

To ensure a systematic review of the state of the art literature, we follow the approach suggested by Webster/Watson (2002). In a first step, we searched the online databases EBSCO, ScienceDirect and the ACM Digital Library using the search terms "risk", "failure" "success", and "erp" in the abstract, title and keywords. In total around 600 papers were identified.

In a second step we filtered the identified articles for whether they were published in A or B ranked journals following the MKWI 2008 ranking. The MKWI 2008 ranking was established at the Multikonferenz Wirtschaftsinformatik in Munich 2008 and covers most of the AIS top 20 journals. In both research fields, the journals "Information & Management" and "Business Process Reengineering" yielded the most results. In order to avoid a cultural bias we focused on studies in the western (i.e., North America and Europe) region only. Finally, a shortlist of about 70 papers from 24 different journals was created, which we believe is a good representation of the literature. These papers were analyzed in detail concerning the risk and success factors they present. Table 12 lists the number of identified articles in each journal.

Journal	**Risk Factors**	**Success Factors**
Business Process Management Journal	3	5
Communications of the ACM	1	2
Decision Support Systems		2
European Journal of Information Systems		1
European Journal of Operational Research	2	2
IEEE Software		2
IEEE Transactions on Engineering Management	2	1
Information & Management	3	8
Information Systems Journal	1	1
Information Systems Management	1	5
Information Technology and People		1
International Journal of HCI		3
International Journal of Information Management	2	2
International Journal of Internet and Enterprise Management		1
Journal of Computer Information Systems	1	3
Journal of Database Management		1
Journal of Information Systems	1	
Journal of Information Technology	3	1
Journal of Management Information Systems	1	

Journal of Strategic Information Systems	2	
Journal of Systems & Software	1	
Journal of the AIS		1
MIT Sloan Management Review	1	
Omega		1
TOTAL	**25**	**43**

Table 12. Number of Identified Articles According to Journal

The articles were published from 1999 to 2010 with a peak of twelve articles published in 2007 and 2008 respectively (see Table 13).

Year	# of Articles considering RF	# of Articles considering SF
1999	2	
2000	3	4
2001		2
2002	2	1
2003	8	3
2004	3	3
2005	6	2
2006	2	2
2007	8	4
2008	5	7
2009	1	1
2010	3	
TOTAL	**25**	**43**

Table 13. Number of Identified Articles According to Year

2.3 Results

Altogether, we identified 80 factors in the success factor literature and 67 factors in the risk factor literature. These were classified in twelve groups in order to be able to analyze the differences between these two fields of research. The categorization follows extant approaches in the literature (e.g., Nah/Zuckweiler/Lee-Shang Lau (2003)) and is based on the topical relationships between the factors. In the following, we present a short description of each category and the main differences between the risk factor literature and the success factor literature.

Existing Environment and Systems: This category summarizes surrounding conditions that have an influence on the introduction of an ERP system. These are the existing business systems and the legacy system (Holland/Light, 1999; Al-Mashari/Al-Mudimigh/Zairi, 2003) as well as the size of the company, its structure, cultural aspects and external factors such as the economic and industry climate (Ifinedo, 2006). These issues are covered within the success factor literature only.

Planning and Strategy: The category "Planning and Strategy" contains factors like business vision and clear goals and objectives (Shanks/Parr, 2000; Akkermans/van Helden, 2002; Aloini/Dulmin/Mininno, 2007) as well as ERP and IS-/ IT-strategy (Lee/Myers, 2004; Bernroider, 2008). Also a project's justification (Willcocks/Sykes, 2000), the financial planning and the workflow planning with a clear project plan (Holland/Light, 1999; Gargeya/Brady, 2005) are included in this category. The success factor literature puts an emphasis on more strategic factors than the risk factor literature, which attaches more importance to the planning factors, such as the risk of inadequate resources (Karimi/Somers/Bhattacherjee, 2007). Especially the necessity of a business vision is a strategic factor, which is only considered in the success factor literature. Gargeya/Brady (2005) state that inadequate planning and budgeting is a factor that can result in project failure but does not in itself constitute ERP implementation success.

Selection and Adaption of the ERP System: The careful selection of an ERP system is a crucial factor within implementation projects (Plant/Willcocks, 2007; Lui/Chan, 2008) as the organizational fit of the ERP system and the company has to be taken into account (Krumbholz et al., 2000). The differences between the organizational structure and/ or culture and the ERP system have to be reduced by adaption. Here two possibilities exist: On the one hand, Business Process Reengineering (BPR) and, on the other hand, the customization of the ERP system can be employed to even out the differences between the system and the organization (Nah/Islam/Tan, 2007; Rettig, 2007). Scheer/Habermann (2000) amongst others prefer BPR: "ERP implementation should involve the analysis of current business processes and the chance of reengineering, rather than designing an application system that makes only the best of bad processes".

Change Management: In this category only minor to no differences exist between the two fields of research. Both recognize the necessity of change management due to the organizational modifications in the context of Business Process Reengineering (Somers/Nelson, 2004). These changes have an impact on a company's strategy, its processes and its employees. Change management aims at preventing resistance against these changes. Both streams of literature state training and education (Haekkinen/Hilmola, 2008), user integration and the increase of user acceptance as important factors (Wright/Wright, 2002). Only with regard to one aspect, the two fields of research complement each other: Whereas the risk factor literature mentions the resistance against the organizational und cultural changes (Sumner, 2000) as important factors but provides few response strategies for it, literature on success factor fills this gap by proposing an effective re-configuration of the organizational culture as a solution (Ke/Wei, 2008).

Communication: Although the success factor literature discusses communication issues more intensely than the risk factor literature, both fields deal mainly with identical factors. Important factors comprise: cross-departmental communication (Plant/Willcocks, 2007; Haekkinen/Hilmola, 2008), cross-functional communication primarily between business and IT (Holland/Light, 1999) communication with stakeholders and users of the system (Somers/Nelson, 2004). In this regard, communication should always comprise a project's goals and objectives as well as its progress (Sumner, 2000; Al-Mashari/Al-Mudimigh/Zairi, 2003).

Team Work and Team Composition: With regard to team work and team composition, risk and success factor literature deal with roughly the same factors. These include a balanced composition of the team with internal and external employees from business and IT, the availability of the required skills and the acquisition and retaining of talented team members. A more detailed look reveals that the success factor literature explicitly emphasizes the necessity of cross-departmental co-operation (Akkermans/van Helden, 2002) and deals more intensely with the issue of skills and abilities of the team (Willcocks/Sykes, 2000). The risk factor literature concentrates more on the difficulty of acquiring and retaining qualified employees for the project (Markus et al., 2000; Sumner, 2000). In this regard, the success factor literature gives suggestions how to motivate the project members and how to develop a good solidarity within the team.

External Expertise: In the category "External Expertise" the two fields of research complement each other. While the success factor literature emphasizes the necessity of the integration of external experts (Akkermans/van Helden, 2002), the risk factor literature works out the risks of employing inadequate consultants. They are essential to bridge the gaps in the company's existing knowledge. In this regard, ensuring long term success requires a knowledge transfer from external to internal employees (Willcocks/Sykes, 2000). This knowledge transfer can of course only take place if consultants are carefully selected and controlled (Somers/Nelson, 2004). These caveats are also mentioned in the risk factor literature which cautions about the high costs of incompetent consultants (Markus et al., 2000; Aloini/Dulmin/Mininno, 2007).

Performance Measurement: Authors dealing with the performance measurement emphasize the careful definition of indicators in order to control results (Markus et al., 2000). According to Al-Mashari/Al-Mudimigh/Zairi (2003) "measuring and evaluating performance is a very critical factor for ensuring the success of any business organization and indeed for making IT systems such as ERP pay back". The risk factor literature warns of inadequate success measures as they lead to unknown and disappointing business results (Umble/Haft/Umble, 2003). In contrast, the success factor literature does not only focus on performance measurement after the project is finished. Here, the importance of an early definition of success metrics and indicators for controlling a project's progress is emphasized (Holland/Light, 1999).

Project Champion: Shanks/Parr (2000) describe a project champion as an "advocate for the system who is unswerving in promoting the benefits of the new system". He is primarily valuable in the first steps of the project in order to promote the project's benefits within the company and to increase the user acceptance. The project champion is clearly dealt with more intensely in the literature on success factors. Only two authors in the risk factor literature mentioned the necessity of a project champion (Sumner, 2000; Aloini/Dulmin/Mininno, 2007).

Project Management: Factors related to the project management are discussed more often in the risk factor literature. However, the two fields of research overlap with respect to the activities of project management: For instance, both categories emphasize the necessity of project planning and control, scope management, human resources management, risk management, management of expectations, crisis management as well as the definition of a clear vision and goals (Somers/Nelson, 2004; Gargeya/Brady, 2005). Apart from that, the success factor literature gives suggestions about the characteristics of a good project management such as systematic planning, compassing the whole project and the importance of good strategic and tactical skills (Al-Mashari/Al-Mudimigh/Zairi, 2003). In contrast, the risk factor literature mentions risks, which can appear during project management, for example the lack of a central management structure, underestimation of size, scope and complexity, ineffective methods and lack of information (Aloini/Dulmin/Mininno, 2007; Haekkinen/Hilmola, 2008).

Roll out and Configuration: Concerning the roll out and the configuration of an ERP system, the two research areas agree about the importance of making architecture decisions, conversion and correctness of the data as well as company-wide integration and testing (Markus et al., 2000; Plant/Willcocks, 2007). Issues such as the company-wide integration and testing are more important in the risk factors literature. In addition, the risk factors of: a poor specification and system design, an inadequate roll out, complex legacy systems, a difficult and costly maintenance and a variety of interfaces and bugs are mentioned (Sumner, 2000; Wright/Wright, 2002; Lui/Chan, 2008). These factors are not mentioned in the success factor literature, but here the importance of a structured and disciplined approach for deploying an ERP system is pointed out (Umble/Haft/Umble, 2003).

Top Management Support: The availability of top management support is a very often-cited factor in the success factor literature. In contrast the risk factor literature pays little attention to it. The necessity of top management support results from the company-wide consequences of ERP implementation projects (Holland/Light, 1999). The involvement of the top management is necessary throughout the whole implementation process and particularly important in controversial projects (Lui/Chan, 2008).

Table 14 shows a ranking of the categories according to the numbers of authors discussing factors within these categories. A detailed mapping of authors to categories and factors to categories is available upon request.

Rank	Success Factor Literature	#		Rank	Risk Factor Literature	#
1	Selection and Adaption	19		1	Selection and Adaption	16
1	Change Management	19		2	Change Management	12
1	Planning and Strategy	19		3	Roll out and Configuration	11
4	Team Work and Composition	18		4	Project Management	10
5	Top Management Support	17		5	Planning and Strategy	9
6	Project Management	13		6	Team Work and Composition	8
6	External Expertise	13		7	External Expertise	5
8	Communication	12		8	Top Management Support	4
9	Project Champion	9		9	Communication	3
10	Roll out and Configuration	8		10	Performance Measurement	2
11	Performance Measurement	7		10	Project Champion	2
12	Existing Environment and Systems	5		12	Existing Environment and Systems	0

Table 14. Importance of Risk and Success Factors According to Citations

Table 14 illustrates that the categories “Selection and Adaption of the ERP System” and “Change Management” are in both fields of research the categories with the highest number of citations. This confirms the results of Finney/Corbett (2007), which also rank these two factors among the most important ones. One of the biggest differences between the two fields concerns the roll out and the configuration of a new system. In the risk factor literature it is the third most frequently cited factor while in the success factor literature it is only ranked tenth. The low rank in the success factor literature is in line with the results of other studies where the roll out and the configuration also ranks low (Gargeya/Brady, 2005; Finney/Corbett, 2007).

Figure 8 shows the number of citations in each category relative to the total number of articles in the risk and the success factor literature respectively. By taking into account the differences in the absolute numbers of papers found in each field of research, the respective foci between the two fields become clear. Whereas the risk factor literature seems to focus on the categories “Project Management”, “Roll out and Configuration”, and the “Selection and Adaption of the ERP System”, all other categories are cited more frequently in the success factor literature.

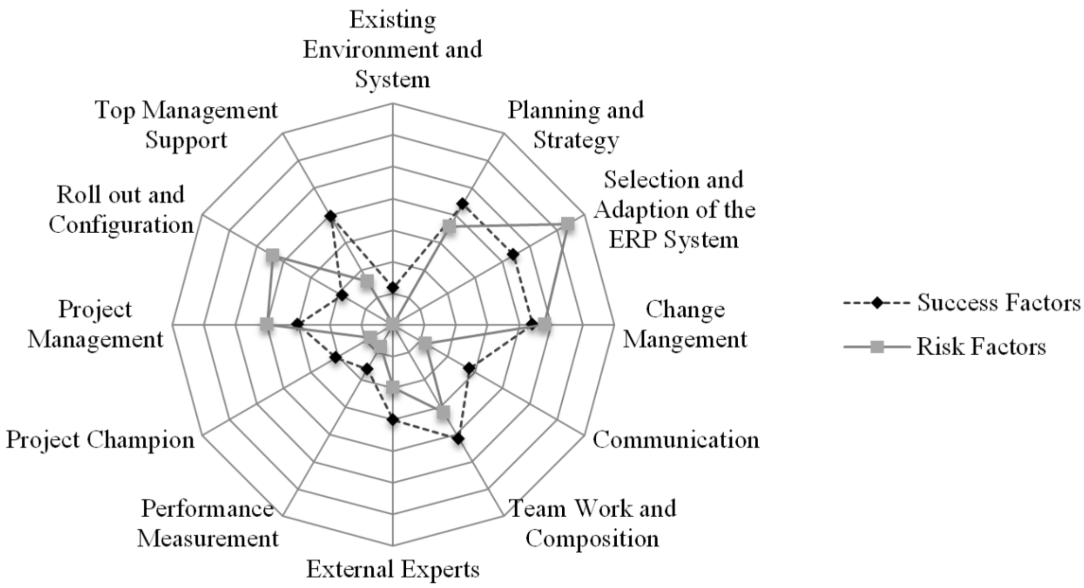

Figure 8. Relative Importance of Categories in Risk and Success Factor Research

2.4 Discussion

In the following we present an approach which integrates our understanding of risk and success factors. The different foci in the two fields may be due to different views on project success. Taking a look at the focus categories in the risk factor literature, we propose that they particularly concern traditional dimensions of project success, i.e., adherence to schedule, budget and functionality objectives of a project (Atkinson, 1999): "Project Management" concern means to achieve a high project management efficiency, whereas the "Roll out and Configuration" is primarily concerned with implementing the required functionality. The risk factor literature's emphasizes on traditional success dimensions is in line with the results of de Bakker/Boonstra/Wortmann (2010). However, as recent research suggests, project success also comprises several other dimensions such as user acceptance or strategic benefits in addition to schedule, budget and functionality (DeLone/McLean, 1992; Shenhar et al., 2001). These factors, which constitute business success, are accounted for in the success factor literature: The categories: "Top Management Support", "Project Champion", "External Experts", "Communication", "Performance Measurement" tend to aim at achieving long term success dimensions.

An analogy may be drawn to Herzberg's (1968) Two-Factor-Theory about motivation at work: Whereas the absence/ presence of "Hygiene Factors", which include factors such as firm policies and administration, work conditions and income, result in dissatisfaction/ no dissatisfaction at work, the so called "Motivators" can cause satisfaction/ no satisfaction. In the context of ERP projects this requires differentiating between unsuccessful – not unsuccessful and successful and not successful projects. An unsuccessful project may be one which is not finished in time, budget or with the required functionality, whereas a not unsuccessful one satisfies each of the three criteria. Successful projects would also realize long term individual or organizational benefits. Thus, following Herzberg (1968), also risk and success factors might be divided into “Motivators” and “Hygiene Factors” depending on which success criteria they focus (see).

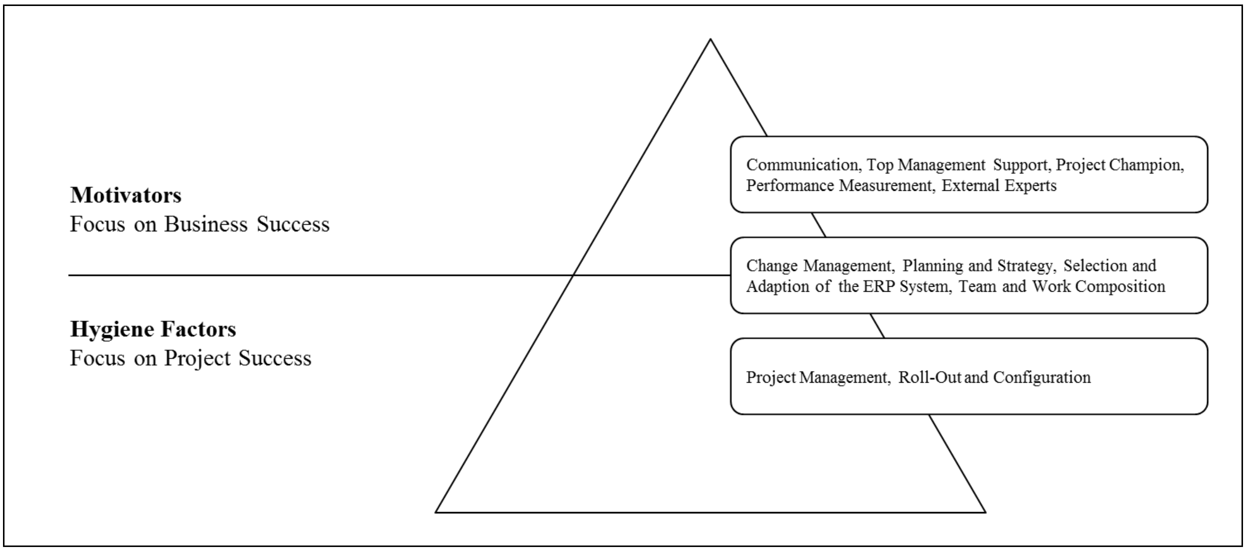

Figure 9. Exemplary Categorization of Risk and Success Factors

We propose that the categories “Communication”, “Top Management Support”, “Project Champion”, “Performance Measurement”, as well as “External Expertise”, which are discussed with particular emphasis in the success factor literature, can be said to be “Motivators”. Factors in these categories ensure business success. On the contrary, the categories “Roll out and Configuration” and “Project Management”, which are foci in the risk factor literature, are suggested to be the “Hygiene Factors”, which are mainly concerned with project success in a narrow sense. The categories “Change Management”, “Planning and Strategy”, “Selection and Adaption of the ERP System” as well as “Team and Work Composition” have influence on both, project and business success. We conclude that the risk factor literature emphasizes a project manager’s perspective, i.e., the necessity for finishing a project within time, budget and with the required functionalities. In contrast, research on success factors concentrates more on the executive’s perspective, i.e., realizing organizational or individual benefits. These different perspectives of project managers and executives have been confirmed by earlier studies (DeLone/McLean, 2003) and might offer a preliminary explanation for the discrepancy between the risk and success factor literature. Integrating these two streams of research in more detail might help to achieve more successful projects from both, a project manager’s and a senior executive’s perspective.

2.5 Summary and Contribution

In this paper we identified 80 success factors and 68 risk factors in ERP projects. In order to analyze differences in these two fields of research we mapped the factors to twelve categories. Though some topics are equally important in risk and success factor research, the literature on risk factors emphasizes topics which ensure achieving budget, schedule and functionality targets. In contrast, the literature on success factors seems to concentrate more on strategic and organizational topics. By drawing an analogy to Herzberg's (1968) Two-Factor-Theory about motivation at work we propose an approach to integrate these two streams of research. Due to their different foci, a more detailed integration might help to manage ERP projects more successfully.

3 Towards Understanding the Relative Importance of Risk Factors in IS Projects: A Quantitative Perspective

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Table 15. Fact Sheet Publication P3

Abstract. Commonly, project managers and researchers agree that identifying risks is the most crucial step in project risk management. Hence, extant research provides various rankings of risk factors. In this paper, we rank the importance of risk factors based on an archive of project risk reports provided by project managers of a large software development company. In contrast to previous research that ranks people and processes as most important risk domains, our analysis emphasizes technology-related risk factors. We argue that this conflict might result from two dimensions determining the perceived importance of risk factors: Controllability and micro-politics. A project manager will rank risks higher when he has only limited control on mitigating risks. Risks beyond control will be neglected. However, in a corporate context, micro-political mechanisms change the importance towards these risks. They will exploit risk management to escalate uncontrollable threats to project success and cover risk factors that stem from shortcomings of their own or of colleagues. Thus, micro-political mechanisms reveal the most important risks from a corporate perspective. Detached from the corporate context, project managers emphasize risks threatening efficient project management. We contribute to IS research by proposing alternative explanations for the ranking discrepancies.

3.1 Introduction

Both practitioners and researchers argue that risk management is one of the key approaches to reduce the likelihood of IS project failure (Schmidt et al., 2001; Wallace/Keil/Rai, 2004a). Managing project risks allows project managers to identify, analyze, control, and monitor risks and the underlying risk factors (Chapman/Ward, 1996). Obviously, the capability of project managers to identify the risks and underlying risk factors that are most important for a given project largely determines the effectiveness of project risk management.

Hence, a substantial amount of extant research on managing risks in IS projects focuses on ranking risks or their underlying risk factors (Barki/Rivard/Talbot, 1993; Schmidt et al., 2001; Kappelman/McKeeman/Zhang, 2006). Although researchers provide few explanations, they agree that people-related risk factors and process-related risk factors should play the most important role in project risk management while technological risk factors are negligible (Schmidt et al., 2001; Kappelman/McKeeman/Zhang, 2006).

Despite the apparent agreement, most of the rankings ground on the expertise of project managers, i.e., project managers were specifically asked to relatively weight given risk factors. Little research is available where other data sources where investigated. Furthermore, the majority of studies on the relative importance of risk factors are of descriptive nature (Gregor, 2006). Despite the amount of research, no definite set of underlying mechanisms has been established yet.

The purpose of this paper is to appraise the extant research critically by shedding a quantitative light on the relative importance of risk factors. Our research question is: *What are mechanisms that explain rankings of risk factors in IS projects?* We analyze an archive of project risk reports of ALPHA, a large, internationally acting software development company. The purpose of the project risk reports is to evaluate project proposals, allow a corporate perspective on the status of the IS projects at ALPHA, and to signal critical project situations. We consolidate the project risk reports in a database to replicate extant rankings of risk factors.

The remainder of our paper is as follows. In the next section, we review existing rankings of risk factors in IS projects. Then, we outline our research design and the approach used to analyze the archive of project risk reports. Subsequent, we present the results of our analysis and compare them with a subset of rankings identified in the literature review. In contrast to existing rankings, our results show that the project managers weighted technology-related risks as most important in their projects. Then, we apply theories from the domain of risk management to propose initial explanations on the ranking discrepancies and critically review potential limitations of our approach.

In sum, our research contributes to the domain of project risk management by providing a new perspective on the relative importance of risk factors in IS projects. Furthermore, we contribute to the theoretical foundations of project risk management by proposing alternative explanations that consolidate existing research on risk factors and allow new attempts to understand the mechanisms of risk perceptions of IS project managers.

3.2 Literature Review

The literature on IS project risk factors is comprehensive: Early studies were done by Alter/Ginzberg (1978), McFarlan (1981), Boehm (1991), Barki/Rivard/Talbot (1993) or Moynihan (1997). More recently, Jiang/Klein (2000) surveyed 86 IS executives to rank twelve risk categories they derived from prior literature. However, the authors could only show a significant relation to project success in three cases. Tiwana/Keil (2004) asked 60 MIS directors to evaluate the risk situation of 12 separate projects and derived 720 single evaluations on which they based their analysis. Using structural equation modeling, the authors identified five key risk factors. Wallace/Keil/Rai (2004a) identified six dimensions of software project risk factors, grouped them into three risk domains, namely "Social Subsystem", "Technical Subsystem" and "Project Management", and investigated dependencies between risk dimension and project success. While the latter domain refers to the project team and the planning / control techniques applied by the project manager, the social subsystem domain comprises an unstable or highly political social context and users unable or not willing to contribute to project success. The technical subsystem domain captures risks related to unstable requirements, high project complexity as well as new or unfamiliar technology. As these domains reflect the consensus of 507 PMI members from various countries and have been substantiated in more recent research, we will employ them in order to compare our findings to prior studies (Tesch/Kloppenborg/Erolick, 2007; Huang/Han, 2008).

Table 16 shows a sample of existing studies. Among other things, they differ in their perspective on risks and the number of risk factors identified (i.e., level of abstraction). However, almost all of them collect their data by the means of surveys and/or interviews.

Study	Risk perspective	Number of risk factors identified	Method of data collection	Number of projects investigated/ participants surveyed	Emphasized research approach	Statement on the importance of risk factors	Provide rationales for ranking results
Alter/Ginzberg (1978)*	Project	8	Survey/ Interviews	29/56	Empirical-Qualitative	No	No
Zmud (1980)	Project	4	-	-	Theoretical	No	No
McFarlan (1981)	Corporate	3	-	-	Theoretical	No	No
Boehm (1991)	Project	10	Survey	not specified	Empirical-Qualitative	Yes	No
Barki/Rivard/Talbot (1993)	Corporate	34	Survey	120	Empirical-Quantitative	No	No
Moynihan (1997)	Project	22	Survey	42	Empirical-Qualitative	No	No
Jiang/Klein (2000)	Project	12	Survey	86	Empirical-Quantitative	Yes	No
Schmidt et al. (2001)	Project	53	Delphi Study	41	Empirical-Qualitative	Yes	Yes
Wallace/Keil/Rai (2004a)	Project	6	Survey	507	Empirical-Quantitative	No	Yes
Tiwana/Keil (2004)	Corporate	6	Survey	12	Empirical-Quantitative	Yes	No
Kappelman/McKeeman/Zhang (2006)	Project/ Corporate	12	Survey	55	Empirical-Quantitative	Yes	No

* The study combines two separate articles on risk factors

Table 16. Comparison of Studies on Risk Factors in IS Projects

We consider the studies by Schmidt et al. (2001) and Kappelman/McKeeman/Zhang (2006) central for this paper, as these are the most apt in terms of level of abstraction. Schmidt et al. (2001) were the first authors that highlight differences in importance between IS risk factors. Based on prior work by Keil et al. (1998), the authors' goal was to develop an authoritative, ordered list of common risk factors in order to support project managers in identifying IS project risk factors. Therefore, they conducted a "ranking-type" Delphi study with project managers among three different panels from the U.S., Finland and Hong Kong. The authors emphasized the importance of a cross-cultural perspective as differences in Hofstede's five dimensions may affect risk assessment (Hofstede, 1980). As a first result a list of 53 risk factors which encompasses all but four risk factors that had been identified in prior studies so far is presented. It includes 26 new factors. Risk factors related to project management and the social subsystem account for the lion's share of the 53 items. Interestingly, just two of the 53 risk factors are related to the technical subsystem. The authors assumed that the apparently diminishing importance of those risk factors is due to "better performance and scalability of hardware and software, and the widespread adoption of graphical user interfaces" – an argument which in the face of the ever increasing complexity of information technology seems at least dubious to us. Finally, a ranked list of risk factors is generated by each panel. As a rationale for the ranking-order, Schmidt et al. (2001) proposed that project managers rank risk factors according to their level of control over a certain risk. This thought is based on a study by March/Shapira (1987) according to which a limited extent of control causes a high level of attention by project managers. No control at all and full control over a risk factor cause low and medium levels of attention respectively.

Finally, Kappelman/McKeeman/Zhang (2006) derived 53 "early warning signs" from prior literature as well as panel interviews and conducted a ranking-survey among 55 IS project managers and IS executives. The result of their study is a list of the "dominant dozen" risk factors in IS projects which were ranked above six on average on a seven point scale. Similar to the results of Schmidt et al. (2001), none of the twelve risk factors can be allocated to the technical subsystem. The authors argue, that their findings are not surprising "because IS projects almost never fail because of technical causes, despite the fact that people and process problems may manifest technically" (Kappelman/McKeeman/Zhang, 2006, 32).

For several reasons we feel that further research on risk factors in IS projects is important: First of all, and despite its high practical relevance, several prior studies do not draw any conclusions about the relative importance of risk factors. Those studies which do rank risk factors somewhat agree on the fact, that risk factors related to the social subsystem and project management are more important than risk factors associated to the technical subsystem. However, the rationales offered to explain this result are not substantiated.

What is more, several authors state themselves that their results might be biased towards managerial risk factors as (senior) executives and not project managers or project team members assessed risk factors (e.g., Tiwana/Keil, 2004). Following Barki/Rivard/Talbot (1993), different levels of involvement within a project might result in different perspectives on risk. Hence, our archival research approach to risk importance allows us avoid biases caused by the research process and flaws in data collection (Keil et al., 1998).

3.3 Research Approach and Results

3.3.1 Overview

Our analysis aims at developing a ranking of risk factors in IS projects according to their relative importance as assessed by project managers before and during a certain project. Our data comprises a large set of risk assessments done by project managers of a major software company (ALPHA) between 2004 and 2007. By studying archival data an influence of the research process on the collected data is ruled out.

3.3.2 Data Collection

Risk management at ALPHA follows a standard approach comprising the four steps: "Risk Identification", "Risk Assessment", "Risk Response Planning" as well as "Risk Monitoring". The process takes place at several stages before and during a project and is conducted by the project manager and partly by the project team. Depending on the project value, a central risk management unit assists the process. Risk identification is supported by a prompt list containing 317 questions from which the project manager chooses those risk factors that might occur during the project. In total there are 45 different risk types (see Table 18). Amongst other things, the identified risk factors are assessed in terms of probability and impact (from 0 "Insignificant" to 5 "Catastrophic"). After risk identification and assessment responses to counter the identified risk factors are defined.

The results of this process are stored in a spreadsheet file called risk register. For each risk review conducted during the course of a project one risk register file is created. In total 1548 files were available for our study. Thereof we were able to analyze 1222 files from 111 software implementation projects. The remaining 326 files were either corrupt, empty or it was not possible to identify the according project and/or customer. We extracted the data in a semi-automated way using a manual control mechanism where our extraction tool did not work (e.g., because of a slightly different structure of the spreadsheet file) in order to ensure data quality.

The projects in our sample dealt with the implementation or modification of large enterprise software systems and spanned various industries, with a focus on the consumer products sector (15 projects), the automotive sector (15 projects), the banking sector (14 projects), the high tech sector (9 projects) and the chemicals sector (8 projects).

3.3.3 Data Analysis

After adjusting for duplicates and incomplete records, 4570 risk factors remained for analysis. Table 17 shows several basic statistics for the three key variables "Impact", "Probability" and "Risk Exposure", the latter one being the product of "Impact" and "Probability". We deem risk exposure a suitable construct for illustrating the relative importance of a given risk (Boehm, 1991; Carbone/Tippett, 2004).

Variables	Mean	Std. Dev.	Minimum	Maximum
Impact	2,58	1,23	0,00	5,00
Probability	0,45	0,21	0,00	0,99
Risk Exposure	1,22	0,86	0.00	4,95

N: 4570

Table 17. Descriptive Statistics of Key Variables

In order to compile a ranking we calculated the average risk exposure per risk type (see Table 18).

Rank	Risk Type	N	Mean	Std. Dev.
1	Inadequate Technical Infrastructure	49	1,93	1,24
2	Customer Expectations	135	1,69	0,89
3	Core Development Dependencies	114	1,59	0,77
4	Complex System Architecture	129	1,53	1,01
5	Post Go Live Approach Not Defined	172	1,47	0,91
6	Customer Financial Obligations	40	1,42	0,99
7	Expected Performance Issues	204	1,37	0,91
8	Customer Inability to Undertake Project	203	1,36	0,87
9	Non-TM Payment Terms	242	1,35	0,98
10	Functionality Gaps	191	1,34	0,93
11	Risk Tolerance	91	1,32	0,80
12	Unrealistic Budget	209	1,27	0,84
13	Ramp-Up	124	1,26	0,90
14	Non-Conducive Political Environment	126	1,24	1,09
15	Implementation & Development Interdependencies	77	1,22	0,74
16	No Implementation Strategy	52	1,22	0,88
17	Low Project Priority	146	1,22	0,74
18	Unclear Customer Objectives	161	1,18	0,79
19	Complex Data Conversion	119	1,18	0,69
20	No Comparable Installations	173	1,15	0,82

21	Undocumented Third Party Services	142	1,15	0,76
22	High Number of Interfaces	128	1,15	0,92
23	Unclear Critical Success Factors	100	1,15	0,96
24	High Impact on Processes	171	1,13	0,73
25	Unclear Roles	70	1,11	0,67
26	Weak Business Commitment	46	1,11	0,74
27	Requirements Not Understood	126	1,11	0,82
28	No Steering Committee	36	1,09	0,84
29	Ongoing Escalation Events	87	1,08	0,80
30	Unclear Governance Model	53	1,08	0,67
31	No QA or Risk Management	39	1,03	0,69
32	Production Downtime Impact	202	1,00	0,70
33	Incomplete Contract Requirements	76	0,95	0,81
34	Hardware Partner Not Involved	58	0,94	0,75
35	Penalties and Royalties	13	0,90	0,85
36	Implementation Partner Unknown	29	0,88	0,74
37	High Customer Visibility	140	0,86	0,61
38	No Risk Sharing Agreements	66	0,84	0,67
39	No Org Change Management Approach	86	0,83	0,60
40	Industry Specific Solutions	58	0,82	0,72
41	Internal and External Decision Makers	6	0,78	1,39
42	Inexperienced Project Lead	58	0,77	0,56
43	Solution Uncertainties	13	0,68	0,72
44	Language of Development Project	7	0,66	1,31
45	Development Methodology	3	0,17	0,21

Table 18. Risk Perception by Risk Type

Table 19 describes the top 10 ALPHA risk factors in more detail. In order to be able to draw a comparison to existent rankings we mapped the risk factors to the domains suggested by Wallace/Keil/Rai (2004a).

Rank	Risk Title	Explanation	Risk Domain
1	Inadequate Technical Infrastructure	The planned technical infrastructure is inadequate to meet the business requirements; the technical feasibility has not been validated by a reliable source.	Technical Subsystem
2	Customer Expectations	The Customer's expectations are not consistent with the complexities of the project.	Social Subsystem
3	Core Development Dependencies	Dependencies between ALPHA component release planning and the development project have not been considered or are unclear, or the custom development project is based on one or several unstable ALPHA components.	Technical Subsystem
4	Complex System Architecture	A complex or state-of-the-art system architecture is required to meet the requirements (whether or not the Customer is aware of or acknowledges the complexity).	Technical Subsystem
5	Post Go Live Approach Not Defined	The approach and responsibilities for post go-live application or system management have not been determined.	Project Management
6	Customer Financial Obligations	The customer may be unable or unwilling to meet its financial obligations under the contract.	Social Subsystem
7	Expected Performance Issues	Performance issues are expected either due to the high number of transactions, product limitations, or volumes are unknown.	Technical Subsystem
8	Customer Inability to Undertake Project	The customer does not have the ability, skills and/or culture to successfully undertake the project.	Social Subsystem
9	Non-TM Payment Terms	The proposed services agreement is other than Time and Materials and/or contains non-standard prices, future price protection, or non-standard payments terms.	Social Subsystem
10	Functionality Gaps	There are gaps between the customer's business requirements and ALPHA's current/expected functionality.	Technical Subsystem

Table 19. Explanation of Risk Factors and Mapping to Risk Domains

3.3.4 Results

We compared the top 10 risk factors of our ranking to the top 10 risk factors of the rankings by Schmidt et al. (2001) and Kappelman/McKeeman/Zhang (2006). Regarding the ranking by Schmidt et al. (2001), we chose the results of the Finnish panel for comparison, since Germany and Finland show similar cultural attributes (Hofstede, 1980). Table 20 juxtaposes the three rankings.

Rank	ALPHA		(Schmidt et al., 2001)		(Kappelman/McKeeman/Zhang, 2006)	
1	Inadequate Technical Infrastructure	T	Lack of Effective Project Management skills	P	Lack of Top Management Support	S
2	Customer Expectations	S	Lack of Top Management commitment	S	Lack of Documented Requirements	P
3	Core Development Dependencies	T	Lack of Required Skills in Project Personnel	P	Weak Project Manager	P
4	Complex System Architecture	T	Not Managing Change Properly	P	No Change Control Process (Change Management)	P
5	Post Go Live Approach Not Defined	P	No Planning or Inadequate Planning	P	No Stakeholder Involvement and/or Participation	S
6	Customer Financial Obligations	S	Misunderstanding the Requirements	P	Ineffective Schedule Planning and/or Management	P
7	Expected Performance Issues	T	Artificial Deadlines	P	Weak Commitment of Project Team	P
8	Customer Inability to Undertake Project	S	Failure to Gain User Commitment	S	Communication Breakdown among Stakeholders	S
9	Non-TM Payment Terms	S	Lack of Frozen Requirements	P	Team Members Lack Requisite Knowledge and/or Skills	P
10	Functionality Gaps	T	Lack of People Skills in Project Leadership	P	Subject Matter Experts are Overscheduled	P

T: Technical Subsystem, S: Social Subsystem, P: Project Management

Table 20. Comparison of Risk Factor Rankings

As Table 20 shows, the risk rankings of ALPHA project managers deviate clearly from the quite similar rankings of Schmidt et al. (2001) and Kappelman/McKeeman/Zhang (2006). The latter two exclusively consider project management and social subsystem risks and are almost consistent concerning the order[7]. For instance, both rankings deem top management support and effective project management very important. In contrast, ALPHA project managers put considerably more emphasis on risk factors related to the technical subsystem, such as “Inadequate Technical Infrastructure” or “Core Development Dependencies”. In total, only five out of ten risk factors belong to the social subsystem or the project management domain. In general, the mismatch between the ALPHA ranking and the other two is eye-catching: Except for the risk factor “Post Go Live Approach Not Defined” that can be mapped partly to “No Planning or Inadequate Planning” / ”Ineffective Schedule Planning”, no similarity between the rankings exist.

[7] To be sure, we also checked against the US and Hong Kong panel rankings in Schmidt et al. (2001): As in the Finnish ranking, the other panels did not include risk factors from the technical subsystem.

3.4 Discussion of Results

Two lines of argument may be put forward to explain the identified discrepancies. First, the level of controllability of risk factors might effect a project manager's assessment. Research shows that a project manager will rank risks higher when he has only limited control on mitigating risks. Risks beyond control will be neglected and risks with full control will be ranked relatively lower (March/Shapira, 1987; Schmidt et al., 2001). We argue that risk factors from the technical subsystem are beyond the control of the project manager because they are determined prior to the start of the project. Hence, changing the technical subsystem will always require support from outside the actual project. Risk factors from the social subsystem are to some extent within the control of the project manager, e.g., the relationship with the client and the prospected users. Project managers are in full control of risk factors stemming from the project management domain, e.g., project planning or project staffing.

However, in a corporate environment the assessments will be used as organizational and political instruments. Thus, the relative importance assigned by the project manager is subject to micro-political bias (Crozier/Friedberg, 1980). Here, project managers will exploit the risk management process to escalate uncontrollable threats to project success. Furthermore, they cover risk factors that stem from shortcomings of their own or of colleagues (Crozier/Friedberg, 1980). Thus, we argue that micro-political mechanisms reveal the most important risks from a corporate perspective. Since project managers try to defer responsibility for uncontrollable risks, they report them with the highest importance. In contrast, they do not assign a high importance to risks from the social subsystem and the project management domain in order to avoid negative connotations for colleagues or themselves (Crozier/Friedberg, 1980).

Figure 10 shows a conceptual model integrating these two lines of argument. The degree of control increases from the technical subsystem towards the project management domain. So does the potential for micro-political bias.

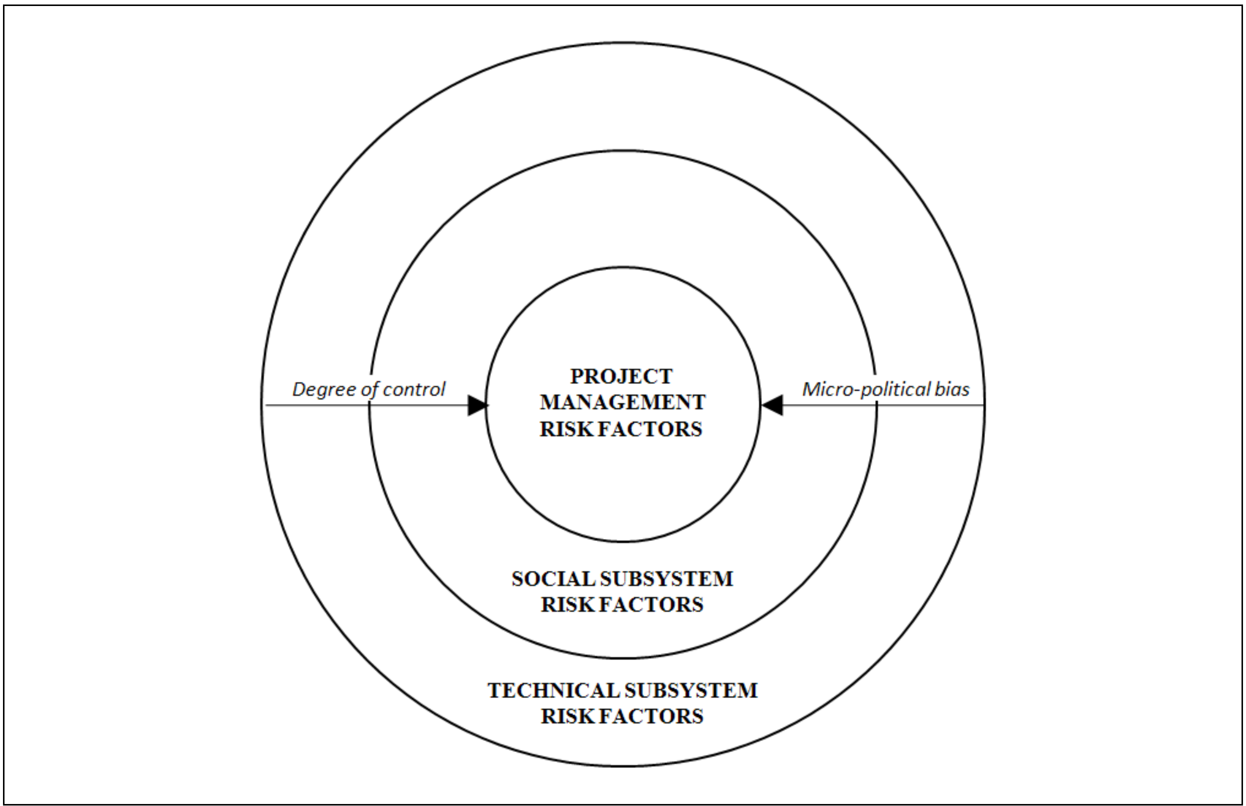

Figure 10. Conceptual Model of Controllability and Micro-Political Bias

As March/Shapira (1987) showed, managers in general tend to focus on risks which they consider controllable. Thus, when interviewed or surveyed, there is a high chance that project managers concentrate on risks they can actively manage. In addition, this bias might be amplified by the way prior studies approached project managers. For instance, Schmidt et al. (2001) asked project managers to identify risk factors they consider "most deserving of their attention and resources" (Schmidt et al., 2001, 11). A closer look at the rankings by Schmidt et al. (2001) and Kappelman/McKeeman/Zhang (2006) substantiates this thought: Risk factors identified by those studies are either directly controllable, e.g., a lack of effective project management skills can be compensated by training and adequate tool support, or controllable to some extent, e.g., top management support can be encouraged by constant communication efforts.

In contrast, the micro-political bias in the project risk reports of ALPHA amplifies risks that are perceived as uncontrollable by the project manager but pose a significant threat to project success. As can be seen, our ranking predominantly contains uncontrollable risk factors from the technical subsystem, such as "Inadequate Technical Infrastructure", "Complex System Architecture", and "Development Dependencies". Such risks are controllable on a corporate level. For instance, a corporate steering committee may renegotiate a given project or cancel it in time. In the case of an inadequate technical infrastructure the project may be postponed until legacy systems are consolidated. However, such decisions are almost certainly beyond the reach of a project manager. Despite the fact that the project manager is not able to control such risks, escalating them might be essential for project success and releases the project manager from the responsibility for such risks.

Similarly, micro-political bias might also play a role in explaining the low importance of risk factors from the project management domain. For instance, a project manager might face conflicts of interests when assessing his or her own capabilities or the skills and commitment of line managers and team members. In this regard, the most prominent example in the rankings investigated is “Lack of Effective Project Management Skills”. Ranked first by Schmidt et al. (2001), this risk factor does not appear at all in our ranking. Other examples include “Lack of Top Management Support” or “Lack of Required Skills in Project Personnel”.

In sum, we provide initial rationales that potentially explain underlying mechanisms of risk assessment by project managers. With the dimensions of controllability and micro-political bias, we highlight two candidates for understanding these mechanisms.

3.4.1 Limitations

There are various limitations to take into account. First, due to the fact, that we analyze risk assessment data of one company only, there might be issues concerning the representativeness of our results. For instance, ALPHA’s culture, its organizational context or the particular nature of its projects might influence project managers’ perception of risk in such way, that their risk assessments are not comparable to other companies or projects. We especially consider the nature of the analyzed projects an issue. IS projects may range from small internal development projects to implementations of large ERP systems, each with an own risk profile. However, as few details are known of the type of projects investigated in other studies, our comparison might still be valid. Our future research will address these issues.

A potential second limitation of this study relates to our comparison of two different cultural backgrounds. As mentioned before, we compared the risk rankings of Schmidt et al. (2001) Finnish panel, whereas most of ALPHA’s project managers are of German nationality. Although Finland does not differ considerably from Germany concerning Hofstede’s cultural dimensions “Power distance”, “Individualism” and “Uncertainty avoidance” (with the latter one supposedly being most influential when assessing risk factors), there is a considerable difference with respect to “Masculinity” for which we do not control (Hofstede, 1980). However, as the U.S. and Hong Kong panel in Schmidt et al. (2001) also differ considerably from our ranking we conclude that cultural differences do not render our rationale invalid.

Furthermore, we define risk importance as probability multiplied by impact and do not include risk frequency, which arguably is another dimension of importance. However, in line with prior IS research on risk, we deem impact and probability as the most central factors when assessing risk importance within a specific project (e.g.,Alter/Sherer, 2004). Another objection to this approach could be March/Shapira (1987) finding, that executives are more concerned about the impact of a risk rather than its likelihood. Nevertheless, we consider risk exposure as the apt measure for importance: First, our study focuses on project managers who assess risk factors rather than executives who base their decisions on them. Second, risk assessment was done in the knowledge that both values – impact and probability – determine risk importance.

Eventually, a fourth potential limitation concerns the fact that our dataset treats multiple assessments of the same risk as multiple risk factors. Thus, the number of “unique” risk factors is in fact 2020 instead of 4570. However, due to the changing project context, we feel that a new assessment can be regarded as independent risk.

Overall, we argue that these limitations need to be addressed in further research. Since our research is of exploratory nature, they do not affect the initial explanations of the ranking discrepancies.

3.4.2 Implications for Research

Prior research has somewhat agreed on the overall relative importance of IS risk factors. It seemed clear that risk factors related to the technical subsystem do not pose a severe threat to project success. The ranking compiled from the ALPHA data set contrasts this perspective: Five of the top 10 risk factors are related to the technical subsystem. We indicated two possible reasons for this discrepancy: First, risks related to the social subsystem as well as to project management tend to be more controllable and thus more visible to project managers taking part in surveys or interviews. In practice, however, other dimensions such as the micro-political bias significantly influence the importance of risk factors. Hence, future research needs to control for the social construction of risk factors. Depending on the given context and the purpose of risk assessments risk perception changes.

Furthermore, we argue that different perspectives on IS project risks will enhance the understanding of project risk management. Most of the analyzed studies – including our own – focus on the project manager as central unit of investigation. Including additional perspectives, such as the ones of project team members, members of steering committees, or top management will contribute to the understanding of project risks.

3.4.3 Implications for Practice

Despite our research being at an initial stage, we see several implications for practitioners. First, project managers may use the compiled ranking as an extension to their own risk factor lists. Our ranking could act as supplementary guideline where to look for IS project risks and thus help not to neglect risk factors beyond the control of the project manager. In this regard, we do not only highlight the significance of risk factors related to the technical subsystem but also of environmental risk factors such as contract design (“Non-TM Payment Terms”) or the financial health of the customer (“Customer Financial Obligations”). In addition, our ranking shows the importance of different roles within the risk management process in order to identify as many important risk factors as possible. Finally, our paper highlights the impact of additional dimensions such as the micro-political bias on the risk management process. Project risk management is not the sole responsibility of the project manager alone but has to be supported by management, steering committees, and corporate risk management experts.

3.5 Conclusion

In this paper we compile a relative ranking of risk factors based on an archive of project risk reports and compare it to extant rankings. In contrast to previous research that ranks people and processes as most important risk domains, our analysis emphasizes technology-related risk factors. We suggest that this discrepancy can be resolved by analyzing risk perception based on the two dimensions controllability and micro-politics. We argue that the discrepancy is due to different perspectives on the risk importance in the respective studies.

However, our research presents just a first attempt towards understanding the relative importance of risk factors in IS projects. Our future research will focus on substantiating the presented arguments. It seems likely that micro-political issues influence risk factor assessment. To the best of the authors' knowledge this influence has not been addressed by IS literature so far. Furthermore, we argue that additional domains of risk factors, such as contract, governance modes, and the customer need to be incorporated in the rankings.

In sum, our research contributes to the development of project risk management by proposing alternative explanations that consolidate existing research on risk factors and allows for new attempts to understand the mechanisms of risk perceptions of IS project managers.

4 When to Manage Risks in IS Projects: An Exploratory Analysis of Longitudinal Risk Reports

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Table 21. Fact Sheet Publication P4

Abstract. Research attributes the mixed performance of IS projects to a poor understanding of risks and thus limited capabilities to manage such risks. In line with others, we argue that the poor understanding of risks is partly due to the fact, that current research almost exclusively concentrates on which risks are important in IS projects. In contrast to this static view, we focus on the temporal aspect of project risks, i.e., we explore when risks become more or less important during a project. In doing so, we analyze an archive of risk reports of completed enterprise software projects. Project managers regularly issued the risk reports to communicate the status of the particular project. Our findings are as follows: First, risk exposure and thus the perceived importance of risk types does vary over project phases. Second, the volatility of risk exposure varies over risk types and project phases. Third, risks of various origin exhibit synchronous changes in risk exposure over time. From a research perspective, these findings substantiate the need for a temporal perspective on IS project risks. Thus, we suggest augmenting the predominant static view on project risks to help project managers in focusing their scarce resources. From a practical perspective, we highlight the benefits of regularly performing risk management throughout projects and constantly analyzing the project portfolio. In sum, we provide a first time, descriptive and exploratory view on variations in project risk assessments over time.

4.1 Introduction

Both, researchers and practitioners agree on the challenging nature of managing IS projects. Since the beginning of the IS discipline, researchers continuously report remarkably high failure rates for IS projects (e.g., Alter/Ginzberg, 1978; Zmud, 1980). Despite the breadth and depth of research results on effective project management and the widespread use of tools, methods, and standards designed for supporting project managers, today's IS projects do not seem to be any more successful. Contemporary studies still report failure rates of 33% (Sauer/Gemino/Reich, 2007).

A major research stream on IS project management attributes the low performance of IS projects to a poor understanding of related risks and limited capabilities to manage risks in IS projects (e.g., Ropponen/Lyytinen, 1997; Iversen/Mathiassen/Nielsen, 2004). Following fundamental definitions of risk in reference disciplines (March/Shapira, 1987; Knight, 2002), IS researchers commonly define project risks as events with a perceived probability of occurrence and a perceived negative impact on project objectives (Boehm, 1991; Charette, 1996; Heemstra/Kusters, 1996; Alter/Sherer, 2004). The product of probability and impact is called risk exposure (RE) and denotes the perceived importance of a risk at the time of assessment. Managing risks requires first to identify, understand, and prioritize risks. Following this, the project manager and other stakeholders plan, implement, and monitor actions to control or mitigate risks. Although names and number of phases of risk management vary across authors, the first phase is usually called risk assessment or risk analysis while the latter is called risk control (Boehm, 1991; Heemstra/Kusters, 1996).

Being pivotal to effectively controlling risks in IS projects, many IS researchers focus on the capabilities required for assessing risks (Tiwana/Keil, 2006). Research on ranking and classifying risks establishes the variety of risks in IS projects and subsequently help project managers identify and prioritize risks more effectively (e.g., Boehm, 1991; Barki/Rivard/Talbot, 1993; Moynihan, 1997; Keil et al., 1998; Schmidt et al., 2001; Kappelman/McKeeman/Zhang, 2006). Other researchers focus on understanding project risks by proposing frameworks of dimensions and domains of projects risks and their effect on IS project performance (e.g., Nidumolu, 1995; Jiang/Klein, 2000; Wallace/Keil/Rai, 2004a; Karimi/Somers/Bhattacherjee, 2007; Sauer/Gemino/Reich, 2007). Furthermore, research is available on the effects of risk control activities and contingency factors of IS project risk management and their effect on IS project performance (Ropponen/Lyytinen, 2000; Barki/Rivard/Talbot, 2001).

In this paper, we focus on the temporal aspect of project risks. While still being relatively unexplored, extant literature argues that understanding how risks change over time is pivotal for progress in managing IS risks effectively and efficiently (Alter/Ginzberg, 1978; Pinto/Mantel, 1990; Somers/Nelson, 2004; Gemino/Reich/Sauer, 2008). Hence, we argue that managing IS project risks successfully, i.e., initiating the appropriate measures, depends on the temporal nature of risk and the appropriate point in time for action. This argument is reinforced by the fact that resources for project risk management are frequently in short supply. Understanding the temporal characteristics of project risks would help IS professionals allocate those resources more precisely. Hence, our research question is: *How do IS project risks evolve over time?* Our research goal is to establish a descriptive and exploratory view on the temporal aspect of IS project risks. To do this, we analyze continuous risk reports from 111 enterprise software projects. Our analysis suggests three findings: First, risk exposure and thus the perceived importance of risk types does vary over project phases. Second, the volatility of risk exposure varies over risk types and project phases. Third, risks of various origin exhibit synchronous changes in risk exposure over time. In sum, we provide a first illustration on how risk assessments of project managers vary over time.

The remainder of the paper is structured as follows: In the next section, we analyze extant research on dimensions of IS project risks. In particular, we review existing results on temporal aspects of IS project risks. Extant literature suggests that risks evolve in distinctive ways and that understanding temporal patterns may provide useful insights for both IS researchers and IS practitioners. Next, we analyze an archive of risk assessments by project managers of a leading multinational enterprise software company. Since our goal is to provide a first descriptive and exploratory perspective on temporal patterns of IS project risk types, we employ cluster analysis based on variations in the perceived importance of risk types along the project course. We derive nine clusters with distinct patterns representing changing risk perceptions of project managers. Next, we discuss the characteristics and implications of the patterns. Finally, we describe the potential limitations of our results and recommend future areas of research.

4.2 Theoretical Background

4.2.1 Dimensions of IS Project Risk

IS researchers agree that IS project risks are multidimensional. The checklists mentioned in the introduction are frequently extended by classifying the risks into various dimensions. McFarlan (1981) for instance, suggests three dimensions of IS project risks: project size, project structure and experience with the technology. To quantify IS project risks, Barki/Rivard/Talbot (1993) conduct a comprehensive literature review resulting in 35 risks and employs factor analysis to derive five dimensions of IS project risk which elaborate on McFarlan (1981) dimensions: technological newness, application size, lack of expertise, application complexity, and organizational environment. Schmidt et al. (2001) elicit 53 risks using a Delphi study approach and group them into 14 dimensions: Corporate environment, sponsorship/ownership, relationship management, project management, scope, requirements, funding, scheduling, development process, personnel, staffing, technology, external dependencies, and planning. The risks and dimensions identified by Schmidt et al. (2001) do not only comprise all risks identified in prior studies but also extend these suggesting that new risks have emerged over time.

In another attempt to answer the question of dimensionality, Wallace/Keil/Rai (2004a) generate an extensive list of risks found in academic literature and articles written by practitioners. They also come up with six dimensions of IS project risk: Planning and control, team, complexity, requirements, user, and organizational environment. These dimensions can be mapped to three domains: Project management (planning and control, team), the technical subsystem (complexity, requirements), and the social subsystem (user, organizational environment). Tesch/Kloppenborg/Erolick (2007) reinvestigate the risk dimensions identified by Schmidt et al. (2001) and find significant similarities among them. In line with the results of Wallace/Keil/Rai (2004a), the authors reduce the number of dimensions back to six: sponsorship/ownership, funding and scheduling, personnel and staffing, scope, requirements, and relationship management. Sherer/Alter (2004) critically reflect on existing approaches to classifying IS project risks and propose a work system framework, which integrates risks and work practices, participants, information, technology, products and services, customers, environment, infrastructure, and strategy of a work system. Table 22 gives an overview on the dimensions identified in these studies.

Study	Dimensions
McFarlan (1981)	(1) Project size, (2) Experience with technology, (3) Project structure
Barki/Rivard/Talbot (1993)	(1) Technological newness, (2) Application size, (3) Lack of expertise, (4) Technical complexity, (5) Organizational environment
Schmidt et al. (2001)	(1) Corporate environment, (2) Sponsorship/ownership, (3) Relationship management, (4) Project management, (5) Scope, (6) Requirements, (7) Funding, (8) Scheduling, (9) Development process, (10) Personnel, (11) Staffing, (12) Technology, (13) External dependencies, (14) Planning
Wallace/Keil (2004)	(1) Project management, (2) Technical subsystem, (3) Social subsystem
Tesch/Kloppenborg/Erolick (2007)	(1) Sponsorship/ownership, (2) Funding and scheduling, (3) Personnel and staffing, (4) Scope, (5) Requirements, (6) Relationship management
Sherer/Alter (2004)	(1) Environment, (2) Strategies, (3) Infrastructure, (4) Customers, (5) Products and services, (6) Work practices, (7) Participants, (8) Information, (9) Technology

Table 22. Overview on Dimensions of IS Project Risks

While it is arguable, whether or not these dimensions are exhaustive, all of them are derived in a rather intuitive manner and are based on the domain of origin of the respective risks.

The literature mentioned above has considerably extended our understanding of IS project risks and supports project managers in identifying potential threats to their project goals and formulating ‘more specific risk management strategies’ (Wallace/Keil/Rai, 2004a). However, in addition to the knowledge which risks appear in IS projects, the question of when they appear and how they evolve is also of substantial interest to IS project managers and researchers. Alter/Sherer (2004) discuss several potential limitations of extant research on IS project risk, one of them being the ‘frequent omission of the temporal nature of risk’. As the authors state, risks are likely to have different temporal patterns, i.e., not only might their importance vary over the project life cycle but also the points of time at which they occur.

4.2.2 Temporal Aspects of IS Project Risks

In an early study, Alter/Ginzberg (1978) address the temporal aspect of IS project risks and suggest that linking risks to project phases and consequently adapting project risk management increases the likelihood of successful IS projects. The authors identify eight risks and allocate them to seven project phases depending on when their effects become apparent. The identified risks include: ‘non-existent or unwilling users’, ‘multiple users and designers’, ‘disappearing users, designers or maintainers’, ‘inability to specify the purpose or usage pattern in advance’, ‘lack or loss of support’, ‘lack of prior experience with similar systems’, ‘inability to predict and cushion the impact on all parties’, and ‘technical problems or cost-effectiveness issues’. Alter/Ginzberg (1978) map all of these risks to one of the first four project phases and propose several risk-reducing strategies.

Sherer/Alter (2004) pick up this approach and allocate 228 risks identified in the IS literature to the work system life cycle developed by (Alter, 2002). The lifecycle describes how work systems evolve over time and consists of the four phases: ‘operation and maintenance’, ‘initiation’, ‘development’, and ‘implementation’. It provides a useful and comprehensible model for classifying risks in the context of a work system.

In a more recent study, Gemino/Reich/Sauer (2008) introduce a temporal model of IS project performance that classifies IS project risks into a priori risks and emergent risks. While a priori risks are associated to either structural elements of the project or knowledge resources available to the project team, emergent risks denote deficiencies in organizational support or result from the volatility of IS projects. A project manager may estimate a priori risks before the start of the project; emergent risks become apparent not until particular project phases. Using structural equation modeling the authors show that their model offers an improved explanatory power over traditional models of performance, partly resulting from the temporal perspective on IS project risks.

4.2.3 Research Gap

Looking at extant work on IS project risks, we see two issues. One is the limited value of present classifications when it comes to managing risks: On the one hand, a broad variety of classifications exist, indicating that little agreement has been established on the scope and scale of IS project risks. On the other hand, extant classifications largely build on the domains of IS project risks. While such classifications reduce the complexity of establishing a thorough and systematic overall risk inventory for a given project, they do not support project managers in managing the life cycle of IS projects (Pinto/Mantel, 1990; Somers/Nelson, 2004).

Second, extant literature agrees on the potential of exploring the temporal aspect for developing a deeper understanding of IS project risks. Existing studies provide a basis by suggesting first classifications such as the differentiation of a priori risks and emergent risks (Alter/Sherer, 2004; Gemino/Reich/Sauer, 2008). Other studies conceptually allocate risks to different phases of a work system life cycle (Sherer, 2004). However, to the best of the authors’ knowledge, an empirical investigation of the temporal nature of IS project risks which draws on risk archives is not yet available.

4.3 Research Design

4.3.1 Overview

In the following, we explore the temporal aspect of IS project risk types based on a risk management archive from the multinational enterprise software company BETA. The archive consists of a large set of risk assessments done by project managers at BETA during operational project risk management. Our data set covers 111 software projects between 2004 and 2007. The focus of the projects is implementing, customizing, and updating enterprise software for medium to large customers across various industries. Studying longitudinal archival data allows us to reconstruct the temporal aspect of risks in more detail than it would be possible with sectional ex-post interviews or surveys.

In order to answer the research question mentioned above we proceed as follows: We first describe how the data was collected and prepared for analysis. In the subsequent data analysis phase, we substantiate the central assumption of our research by combining the research design of Alter/Ginzberg (1978) and Schmidt et al. (2001). Schmidt et al. (2001) rank IS project risks according to their perceived importance (i.e., their risk exposure) while Alter/Ginzberg (1978) allocate the risks to different project phases. In sum, we first analyze the perceived importance of risk types in particular project phases. To do so, we: (1) Integrate the temporal aspect by applying a five-phase process model of IS projects, (2) map risk assessments according to their occurrence in the project to the five project phases, (3) calculate the mean risk exposure per risk type in each project phase, and (4) rank the risk types according to their mean risk exposure in each project phase.

Since the risk exposure varies across project phases, we then examine the archive for patterns in the temporal profiles of risks. We first calculate the changes in the mean risk exposure from project phase to project phase for each risk type, and then cluster the risk types according to similar changes in the mean risk exposure. Finally, we present and discuss the results of our analysis.

4.3.2 Data Collection and Preparation

Project risk management at BETA follows a common approach: First, risks are identified and assessed. Then actions for controlling the risks are planned, implemented and monitored. The risk reviews take place once before and several times during a project. They are conducted by the project manager and partly by the project team. Depending on the project value and its strategic importance, a central risk management unit assists the process. Risk identification is supported by a check list containing a subset of altogether more than 300 questions which help the project manager identify risks that might occur during the project. Project managers at BETA can chose between 45 different predefined types of risks (see Table 18) which largely match the risks identified by Schmidt et al. (2001). We choose the singular risk as unit of analysis to avoid any influences from particular project types within the project portfolio of BETA. In addition to the type of risk, project managers also assess the risks in terms of their probability of occurrence (from 0 to 1) and their impact (from 0-'Insignificant' to 5-

'Catastrophic'). The product of the perceived probability of occurrence and the perceived impact yields the risk exposure of a risk at the time of assessment. Eventually, further quantitative information (such as the expected financial loss or the impact and probability effects of the responses) and qualitative information (such as the condition, the indicator, or the consequence) is recorded for each risk.

Table 23 shows the basic statistics for the three key variables 'Impact', 'Probability' and 'Risk Exposure'. In line with Boehm (1991) and others, we argue that the risk exposure is a suitable construct for illustrating the perceived importance of a given risk at the time of assessment.

Variable	Mean	Min	Max	Std. Dev.
Impact (I)	2,59	0	5	1,25
Probability (P)	0,46	0	0,99	0,22
Risk exposure (PxI)	1,23	0	4,95	0,89

N: 3119

Table 23. Descriptive Statistics for Key Variables

The data generated during the risk reviews are stored in spreadsheet files called risk registers. For each risk review conducted during the life cycle of a project one risk register file is created. In total 1548 files representing 1548 risk reviews were available for our study. Thereof we were able to analyze 1222 files comprising 5066 risk assessments from 111 projects. The remaining 326 files were either corrupt or we were not able to identify the according project and/or customer. Where an automated extraction did not work, we manually extracted the data to ensure high data quality.

Assuming that projects with less than three risk reviews were likely to be still under way at the point of data collection and thus no final conclusion could have been drawn on a risk type's temporal pattern, we excluded 1622 risk assessments from those projects from our analysis. After further adjusting for incomplete records, 3119 of the 5066 risk assessments from 44 projects were retained for analysis. Table 24 provides an overview of the risk types assessed by BETA's project managers, including their frequency, their mean risk exposure and their standard deviation.

Rank	Risk	N	Mean	Std. Dev.
1	Inadequate Technical Infrastructure	32	2,14	1,44
2	Customer Expectations	109	1,76	0,88
3	Core Development Dependencies	77	1,61	0,79
4	Complex System Architecture	86	1,53	1,01

5	Post Go Live Approach Not Defined	135	1,51	0,89
6	No Ramp-Up	74	1,41	0,95
7	Non-TM Payment Terms	176	1,36	1,02
8	Customer Inability to Undertake Project	134	1,35	0,92
9	Risk Tolerance	75	1,34	0,83
10	Expected Performance Issues	131	1,34	0,92
11	Functionality Gaps	135	1,33	0,96
12	Implementation and Development Interdependencies	52	1,32	0,75
13	Unrealistic Budget	125	1,31	0,89
14	Non-Conducive Political Environment	79	1,31	1,22
15	Complex Data Conversion	75	1,25	0,73
16	Low Project Priority	106	1,25	0,74
17	No Comparable Installations	102	1,24	0,86
18	Customer Financial Obligations	29	1,23	0,81
19	No Implementation Strategy	40	1,20	0,88
20	No Steering Committee	25	1,19	0,88
21	Undocumented Third Party Services	115	1,18	0,78
22	High Number of Interfaces	88	1,17	0,97
23	Unclear Customer Objectives	113	1,15	0,80
24	Unclear Roles	45	1,14	0,71
25	High Impact on Processes	122	1,13	0,75
26	Unclear Critical Success Factors	77	1,11	1,01
27	Ongoing Escalation Events	56	1,10	0,91
28	Weak Business Commitment	34	1,09	0,74
29	Requirements Not Understood	75	1,08	0,76
30	Implementation Partner Unknown	17	1,00	0,83
31	Production Downtime Impact	133	0,96	0,75
32	Hardware Partner Not Involved	43	0,95	0,77
33	No Quality Assurance or Risk Management	31	0,94	0,71
34	Unclear Governance Model	34	0,93	0,58

35	Language of Development Project	5	0,92	1,51
36	Incomplete Contract Requirements	42	0,86	0,82
37	No Change Management Approach	58	0,83	0,62
38	No Risk Sharing Agreements	42	0,83	0,67
39	High Customer Visibility	95	0,82	0,64
40	Industry Specific Solutions	40	0,77	0,77
41	Inexperienced Project Lead	33	0,73	0,53
42	Penalties and Royalties	9	0,68	0,65
43	Solution Uncertainties	9	0,44	0,61
44	Internal and External Decision Makers	4	0,28	0,21
45	Development Methodology	2	0,25	0,21

Table 24. Risk Ranking According to Risk Exposure

4.3.3 Data Analysis

In order to investigate how the perceived importance of risk types changes over time, we first determine the point of time of each risk assessment and assign the assessment to a particular project phase. As our data set does not contain an assessment date but only the number of each individual assessment as well as the total number of assessments for each project (e.g., risk review 3 of 10), we calculate the proportionate project progress at each risk review relative to the total number of project risk reviews (e.g., 30%) and map it to one of five project phases (e.g., 30% to project phase 2). The mapping procedure is necessary in order to be able to compare risk type assessments on a common temporal basis (as projects have different numbers of risk reviews). Phase models for enterprise software implementations follow a seven phase approach comprising the phases of 'System Selection', 'Planning', 'Analysis', 'Design', 'Realization', 'Implementation', and 'Operations' (Shanks/Parr, 2000). Due to the fact that our data reflect projects from BETA only and during the phase 'Operations' no risk reviews take place, we do not consider system selection and operations in our phase model. The resulting five phase model reflects BETA's approach of conducting projects.

Second, for each project phase we average the risk exposure of each risk type and subsequently rank the risk types by declining risk exposure. In ranking risk types by importance we follow extant research on IS project risks (Boehm, 1991; Schmidt et al., 2001; Kappelman/McKeeman/Zhang, 2006).

Table 25 shows the ten most important risk types by project phase. To gain further insights concerning their domain of origin`, all risk types are additionally assigned to one of the three domains (project management`, technical subsystem`, and social subsystem) suggested by Wallace/Keil/Rai (2004a).

#	**Phase 1** “Bid and Planning”	**Phase 2** “Analysis”	**Phase 3** “Design”	**Phase 4** “Realization”	**Phase 5** “Implementation”
1	Inadequate Technical Infrastructure (T)	Inadequate Technical Infrastructure (T)	Inadequate Technical Infrastructure (T)	Inadequate Technical Infrastructure (T)	Customer Financial Obligations (S)
2	No Implementation Strategy (P)	No Steering Committee (S)	Low Project Priority (S)	Post Go Live Approach Not Defined (P)	Customer Expectations (S)
3	Customer Expectations (S)	Core Development Dependencies (T)	No Steering Committee (S)	Penalties and Royalties (S)	Complex System Architecture (T)
4	Core Development Dependencies (T)	Post Go Live Approach Not Defined (P)	Customer Expectations (S)	Weak Business Commitment (S)	Expected Performance Issues (T)
5	Non-Conducive Political Environment (S)	Risk Tolerance (S)	Complex System Architecture (T)	Complex System Architecture (T)	Customer Inability to Undertake Project (S)
6	Post Go Live Approach Not Defined (P)	No Ramp-Up (T)	Core Development Dependencies (T)	Non-TM Payment Terms (S)	Unrealistic Budget (P)
7	No Ramp-Up (T)	Customer Expectations (S)	Ongoing Escalation Events (S)	Implementation and Dev. Interdep. (T)	Post Go Live Approach Not Defined (P)
8	Non-TM Payment Terms (S)	Complex System Architecture (T)	Unrealistic Budget (P)	Core Development Dependencies (T)	Implementation Partner Unknown (P)
9	Expected Performance Issues (T)	No Comparable Installations (T)	Functionality Gaps (T)	Unrealistic Budget (P)	Core Development Dependencies (T)
10	Complex System Architecture (T)	Customer Inability to Undertake Project (S)	Customer Inability to Undertake Project (S)	Complex Data Conversion (T)	High Number of Interfaces (T)

P: Project Management Risk, T: Technical Subsystem Risk, S: Social Subsystem Risk

Table 25. Top 10 Risk Types by Project Phase

Table 25 reveals two interesting aspects. First, a broad spectrum of risk types occurs, i.e., among the most important risk types are technical, social as well as project management risks. Second, the perceived importance of risk types varies across the projects’ life cycle. Although it is surprising to see that many of the most important risk types are of a technical nature (e.g., ‘Inadequate Technical Infrastructure’, ‘Core Development Dependencies’, or ‘Complex System Architecture’) which contrasts the results of much of the existing literature on IS project risks (Schmidt et al., 2001; Kappelman/McKeeman/Zhang, 2006), we focus on the variation in perceived importance over time.

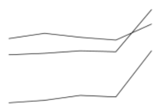
The question arises whether or not patterns in the variations can be identified. For instance, Table 25 indicates that some risk types appear to be important at the beginning of a project but diminish in later phases, such as the risk of having ‘No Implementation Strategy’ or having a ‘Non-Conducive Political Environment’. Instead, a ‘Low Project Priority’ and ‘Weak Business Commitment’ seem to be issues that arise in the middle of a project. In contrast, risk types such as ‘Financial Customer Obligations’ or ‘Implementation Partner Unknown’ seem to materialize at the end of a project. In order to derive a classification based on the temporal risk exposure profile, we employ cluster analysis using PASW Statistics 17.0. Since we aim at grouping risk types with similar temporal profiles of risk exposure rather than grouping types with similar absolute risk exposures, we cluster the risk types based on the change in their mean risk exposure from project phase to project phase. Having five project phases results in four clustering variables which all measure the change in risk exposure from one phase to another. To determine the similarity between risk types or rather their temporal patterns we use the squared Euclidean distance as it is known to be very robust (Hair et al., 2006).

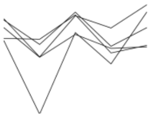
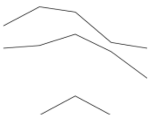
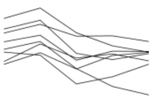
Following the recommendations by Punj/Stewart (1983), we first identify outliers by using the Single-Linkage (Nearest-Neighbor) approach. The resulting dendogram suggests that seven of the 45 risk types, namely ‘Hardware Partner Not Involved’, ‘Inadequate Technical Infrastructure’, ‘Language of Development Project’, ‘No Implementation Strategy’, ‘No Steering Committee’, ‘Implementation Partner Unknown’, and ‘Penalties and Royalties’ have quite dissimilar patterns of risk exposure and thus are hard to classify. Consequently, these risk types are initially not included in our analysis.

After having identified outliers, we employ the Ward approach to derive the clusters. The elbow check as proposed by Ketchen/Shook (1996) indicates that a solution with nine clusters of risk types is the best, since the heterogeneity measure increases disproportionately when moving to a ten cluster solution. The clusters stay relatively stable when using other fusion algorithms, such as the complete linkage algorithm. Six out of nine clusters are identical, the other three show only minor differences. In order to check the validity of the derived clusters we graph the mean risk exposure for each risk type against the five project phases (see Table 26). The high similarity of the graphs suggests that the cluster analysis works well. Where the visual analysis indicates a better solution, we manually re-allocate the risk types to the respective clusters. Furthermore, after re-inspecting the outliers identified above, we are able to assign the risk types ‘Hardware Partner Not Involved’ and ‘Inadequate Technical Infrastructure’ to cluster 4 as well as ‘Implementation Partner Unknown’ to cluster 2.

4.4 Results and Discussion

Table 26 depicts the derived clusters. In sum, 41 risk types can be allocated to nine clusters that show distinct risk exposure characteristics across the project phases.

Cluster	Risk Types (Domain of Origin)	Visualization	Temporal Characteristics
1	Complex System Architecture (T) Customer Financial Obligations (S) Solution Uncertainties (T)		Remain constant initially Dramatically gain importance towards project end

2	Low Project Priority (S) Implementation Partner Unknown (P) Ongoing Escalation Events (S) Unclear Critical Success Factors (P) Unrealistic Budget (P)		Vary considerably in importance over time Gain importance towards project end
3	Inexperienced Project Lead (P) No Quality Assurance or Risk Management (S) Post Go Live Approach Not Defined (P) Risk Tolerance (S)		Peak just after project start Lose importance thereafter Re-gain importance towards project end
4	Inadequate Technical Infrastructure (T) Internal and External Decision Makers (S) Hardware Partner Not Involved (P) Weak Business Commitment (S)		Lose importance initially Peak just before project end Lose importance towards project end
5	Development Methodology (P) High Customer Visibility (S) Undocumented Third Party Services (S)		Gain importance after project start Peak in the middle Lose importance towards project end
6	Core Development Dependencies (T) Customer Inability to Undertake Project (S) Functionality Gaps (T)		Lose importance before project end Re-gain importance towards project end
7	Implementation and Development Interdependencies (T) Incomplete Contract Requirements (P) No Comparable Installations (T) No Ramp-Up (T) No Risk Sharing Agreements (P) Production Downtime Impact (T) Unclear Customer Objectives (T) Unclear Governance Model (S)		Peak just after project start Lose importance thereafter Remain comparatively constant until project end
8	Customer Expectations (S) Expected Performance Issues (T) High Number of Interfaces (T) Industry Specific Solutions (T) No Change Management Approach (P) Requirements Not Understood (T)		Lose importance until just before project end Re-gain importance towards project end

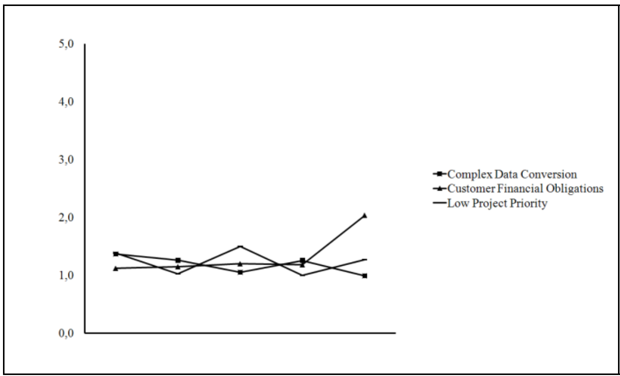
9	Complex Data Conversion (T) High Impact on Processes (S) Non-Conducive Political Environment (S) Non-TM Payment Terms (S) Unclear Roles (P)		Remain comparatively constant over time Tend to lose importance towards project end

T: Technical Subsystem Risk, S: Social Subsystem Risk, P: Project Management

Table 26. Derived Risk Clusters

Looking at Table 26, we deem several aspects worth highlighting: First, risk exposure varies across project phases. We see that some risk types reach the highest level of importance in the later phases or at the end of the project while others are rather important in the middle or in the beginning. For instance, project managers perceive the risk type 'Customer Financial Obligations' as stable throughout the project. However, at the end of the project the perceived importance rises drastically. In contrast, comparable drastic changes occur regularly in the perception of the risk 'Low Project Priority'. Other risk types such as 'Complex Data Conversion' slowly decline over time without any major changes in perception (see Figure 11) This substantiates the suggestions by other researchers that time is an important aspect of IS project risks and has to be considered when managing them (Alter/Ginzberg, 1978; Sherer, 2004; Gemino/Reich/Sauer, 2008). Furthermore, the varying risk exposure across project phases challenges extant research on identifying the most important risk types in IS projects that does not take into account this temporal change. Our data highlights that existing risk rankings fail to acknowledge the practice of structuring projects into project phases (e.g., Boehm, 1991; Barki/Rivard/Talbot, 1993; Schmidt et al., 2001; Kappelman/McKeeman/Zhang, 2006; Tiwana/Keil, 2006). Risk perception and thus risk management activities change from phase to phase. In addition, literature suggests that risks related to project management and the social subsystem play the most important role in IS project risk management, while risks related to the technical subsystem are of lower importance (Schmidt et al., 2001; Kappelman/McKeeman/Zhang, 2006). In contrast, we see a high importance of technical risk types throughout the project phases (see Table 25). This substantiates the notion of different types of project having different risk profiles, e.g., software implementation projects may be subject to different set of risks then software development projects. Overall, our data does not substantiate any ranking of different risk domains as the perceived importance of domains also varies over time.

Second, we can observe heterogeneous degrees of volatility of risk exposure across risk types and project phases (see Figure 12). Frequency and extent of changes in risk assessments vary. For example, the risk type 'Implementation Partner Unknown' varies considerably from phase to phase with regard to its risk exposure. While being relatively important at the beginning, it becomes almost negligible in the second phase, regains importance thereafter, declines again and drastically peaks at the end. In contrast, the risk type 'High Impact on Processes' remains comparatively stable at a high level of importance. The risk type 'Inexperienced Project Lead' rises at the beginning, declines drastically towards the middle and slowly regains importance. This heterogeneity of risk exposure patterns illustrates the high dynamics of IS projects with respect to shifting business objectives and technical change. Hence, our data substantiates the work by Sitkin/Weingart (1995), who show that risk perception is largely a function of the changing problem frame underlying project managers' behavior. The changes in risk assessments also implicate that classifications of IS project risk types based on the perceived importance cannot remain stable over time. For instance, risk types will move across the dimensions of relative importance and controllability proposed by Keil et al. (1998).



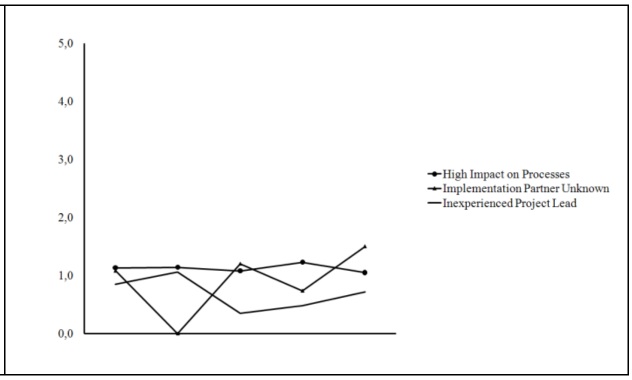


Figure 11. Varying Risk Exposure

Figure 12. Heterogeneous Degrees of Volatility

Third, the cluster analysis suggests distinct temporal patterns of risk exposure, which indicates synchronous changes in risk assessments. For instance, cluster 1 consists of risk types with different levels of risk exposure that remain steady throughout the project and drastically gain importance towards the end (see Figure 13). In contrast, cluster 9 comprises risk types of similar risk exposure levels which slowly decline to a particular level of risk exposure (see Figure 14). Interestingly, the clusters contain risk types from all three risk domains. For example, cluster 4 includes the risk types 'Inadequate Technical Infrastructure', 'Internal and External Decision Makers', 'Weak Business Commitment', as well as 'Hardware Partner Not Involved' (see Figure 15). While the first risk type is of technical nature, the second and the third risk type belong to the social subsystem. The last risk type stems from the project management domain. We agree that classifying risks according to their domain of origin fosters the systematic identification of risks. However, our clusters question the value of this kind of classification for focusing on the most important risks as proposed e.g., by Barki/Rivard/Talbot (1993) and Schmidt et al. (2001). Furthermore, the synchronicity of risk exposure graphs within the clusters supports the notion of dependencies between risk types. While Wallace/Keil/Rai (2004a) show particular dependencies between risks of different domains, our clusters suggest common underlying causes that result in synchronous changes of risk perceptions within one cluster. For instance, one possible underlying cause for cluster 6 ('Core Development Dependencies', 'Customer Inability to Undertake Project', and 'Functionality Gaps') could be a software package based on new technology, which is still partly under development resulting in core development dependencies and gaps in functionality. Furthermore – as the technology is new – the customer does not have the capability or skill set to integrate it into the organization's infrastructure.

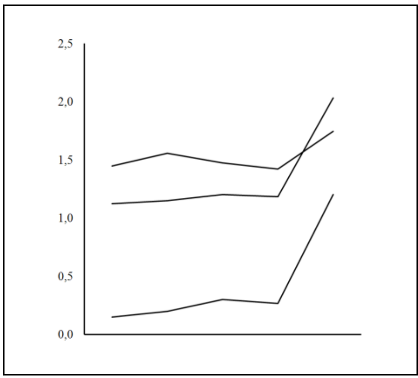


Figure 13. Risk Cluster 1

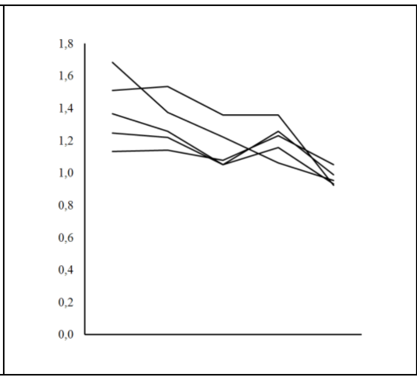


Figure 14. Risk Cluster 9

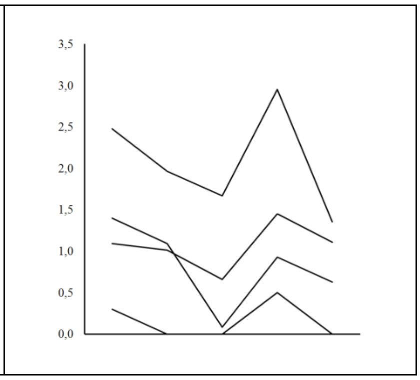


Figure 15. Risk Cluster 4

4.5 Implications

In this paper, we present three results: First, risk exposure and thus the perceived importance of risk types does vary over project phases. Second, the degree of volatility of risk exposure varies over risk types and project phases. Third, temporal patterns of risk exposure can be identified. Despite the initial state of our research, we see several implications for IS researchers as well as for IS practitioners.

On the one hand, for IS professionals the identified variations in risk exposure highlight the importance of constantly performing risk management activities throughout a project's life cycle as new risks may emerge in later project phases (Gemino/Reich/Sauer, 2008) or already identified risk types may vary in importance. Risk management activities may have to be adapted accordingly. In this regard, our results may help IS practitioners be more aware of these possible variations and employ their resources in a more efficient and effective way.

Furthermore, our results suggest that static lists of important IS project risks are of limited value in practical risk management, since they do not provide effective guidance for a given project phase. In addition, the notion that risk types not only vary with regard to risk exposure but also with regard to risk exposure volatility may be of value for IS practitioners. For instance, the volatility of risk exposure may serve as an indicator to what extent risk types are predictable and/or controllable. As a consequence, these highly volatile risk types may deserve more attention from project managers than risk types that tend to be more stable. In this regard, our results which are based on the analysis of a comprehensive portfolio of enterprise software implementation projects may also prove useful for a company's central project risk management unit: By comparing a project manager's individual set of risk types for a certain project phase to the portfolio's set of risk types for the same project phase, the central risk management unit is able to give some guidance as to which risk types typically require the attention of project managers in that phase. Finally, the results of our cluster analysis suggest that risk types in IS projects can be grouped according to their variation in risk exposure over time. In this context, we speculate that synchronous changes in risk assessments may have a common underlying cause. This notion of risk archetypes may prove useful for IS professionals as in a concrete project context project managers may be able to identify and manage root causes of risks instead of symptoms.

On the other hand, IS researchers may benefit from a better understanding of the temporal aspect of IS project risks. We extend existing research on the temporal aspects of IS project risks by providing more detailed insights concerning the evolution of risks over time. While extant research (in most cases implicitly) acknowledges that risk exposure varies over time, our data does not only substantiate this thought but also proposes different volatilities in risk exposure. Furthermore, our results show that risks in IS projects may not only be classified into a priori and emerging risk factors but also into more granular temporal patterns. The derived risk clusters may provide a starting point for more sophisticated cause-and-effect models of IS project risks.

4.6 Limitations

Our study is subject to several limitations. First, because we analyze the risk archive of one company only, there may be issues concerning the representativeness of our results. BETA's organizational context or the particular nature of its projects may result in specific risk assessments which are not comparable to other companies or other IS projects. We especially consider the specific nature of the analyzed projects an issue. As IS projects are heterogeneous (e.g., small internal development projects vs. implementations of large enterprise software systems) their risk profiles are likely to vary.

Second, our results depend on the quality of the analyzed archival data. Some researchers suggest that risk management is often seen as a burden which creates 'extra work and expense' (Verner/Evanco, 2005). Thus, the possibility exists that risk managers do not carefully maintain the risk registers but rather fill in dummy data just to fulfill the requirements. There is no indication however, that the data is maintained in a careless way. Instead, the comprehensiveness of the free text comments in the risk registers indicate that risk assessment is done properly. Furthermore, other authors explicitly highlight the value of comprehensive archival data (e.g., Ropponen/Lyytinen, 1997). Especially for investigating temporal aspects of risks, longitudinal archival data may be better suited than surveys or interviews as they allow for reconstructing chronological events in much more detail. Moreover, possible bias evoked by the researcher is ruled out when analyzing archival data.

A third limitation concerns the possibility that our research approach is impeded from a methodological point of view: First, the approach of mapping risk assessments to project phases, which is necessary due to the different number of risk reviews per project, is problematic for two reasons: (1), the number and configuration of our clusters depends on the number of project phases as the mean risk exposure per phase changes. Even though BETA typically follows a five phase approach when implementing enterprise software systems, we cannot be sure, that this holds true for all projects investigated. (2), as no exact risk assessment date is available we can only approximate the mapping between risk assessments and project phases which adds to uncertainty. Second, the results of cluster analyses are traditionally prone to criticism as the final number and configuration of clusters depend on a series of choices to be made by the researchers and thus are often considered subjective. This potential issue is aggravated by the manual re-adjustment of clusters described above. However, the argument we want to make does to a large extent not depend on the correct number and configuration of clusters but rather on the finding that the importance of risks (as measured by their mean risk exposure) moves in comparable patterns.

4.7 Summary and Conclusion

The purpose of our study is to explore how the perceived importance of IS project risks evolves over time. While much research is available on the domains of risks, little is known about their temporal nature. Gemino/Reich/Sauer (2008) explicitly suggest further investigating the temporal perspective. Based on a review of extant research in this field, we investigate a large archive of risk assessments recorded during the operational project risk management process in enterprise software projects. We employ a five-phase process model in order to investigate variations in risk assessments/importance over project phases. Using cluster analysis, we establish a descriptive and exploratory view on temporal patterns of risk types. In doing so, we provide a first illustration of how risk assessments vary over time.

Our results are relevant to both IS researchers and IS professionals. Extending prior studies on risks in IS projects, we shed more light on temporal aspects and thus help better understand and manage IS project risks. Future research will focus on explaining the variations in risk exposure and identifying dependencies between risk types. In particular, we will explore underlying risk archetypes that result in aligned risk assessments of diverse risk types and domains. To do so, we will follow the guidance provided by Van de Ven/Huber (1990). Additionally, we will present our results to the project managers of BETA to identify further candidates for risk archetypes.

5 Do Vendors Include Transaction Characteristics in Their Risk Estimation? An Empirical Analysis of ERP Projects

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Status	Accepted
Contribution of First Author	Problem Definition, Research Design, Data Collection, Data Analysis, Interpretation, Reporting

Table 27. Fact Sheet Publication P5

Abstract. Using unique archival data on 81 projects from a major ERP vendor, we study whether transaction characteristics are included in the vendor's estimation of risk to project profitability. We hypothesize that project size, contract type, strategic importance, and client familiarity are included in the risk estimations. Regression analysis suggests that, surprisingly, vendors do not include all transaction characteristics in their risk estimation: While we found that larger projects and fixed price (FP) contracts are significantly associated with the vendor's risk estimation, strategic importance and client familiarity are not. Our data set also incorporates data on project profitability that presents us with the opportunity to test the efficiency of the risk estimation. We found that the vendor's risk estimation is efficient with regard to project size and contract type. Finally, the efficiency analysis also suggests that vendors deliberately accept profitability losses when conducting strategic projects.

5.1 Introduction

With a volume of 23.3 billion USD in 2011, outsourced Enterprise Resource Planning (ERP) projects account for a considerable share of outsourced information systems (IS) projects (Gartner Research, 2011). In outsourced ERP projects, vendors support clients in installing, parameterizing, integrating, testing, and upgrading pre-packaged ERP software (Aloini/Dulmin/Mininno, 2007). In this context, the vendor's risk estimation associated with project profitability is important information to support the vendor in taking managerial decisions, such as designing contractual provisions and setting up the governance of the project (Gefen/Wyss/Lichtenstein, 2008).

Prior research shows that transaction characteristics affect risk factors (Yetton et al., 2000; Wallace/Keil/Rai, 2004a; Gemino/Reich/Sauer, 2008), project governance (Lee/Kim, 1999; Poppo/Zenger, 2002; Kalnins/Mayer, 2004; Gefen/Wyss/Lichtenstein, 2008; Chen/Bharadwaj, 2009), and project outcome (Nam et al., 1996; Gopal et al., 2003) of IS projects. However, little work has been published on the effect of transaction characteristics of outsourced IS projects on the vendor's risk estimation. Therefore, our research question is: *Do vendors include transaction characteristics in their risk estimation?* We hypothesize that project size, contract type, strategic importance, and client familiarity affect the vendor's estimation of risk to profitability. We test these hypotheses using a unique data set on 81 projects obtained from a major ERP vendor. In addition, our data set provides us with the opportunity to test whether the vendor's risk estimation is efficient with regard to information available on these transaction characteristics at the time of making the risk estimation.

Our analysis proceeds in two steps. First, we analyze the association between transaction characteristics and the vendor's risk estimation. Surprisingly, not all transaction characteristics are significantly associated with the vendor's risk estimation: While we found that larger projects and fixed price (FP) contracts are associated with higher risk estimations, we found no evidence to support an association between either strategic importance or client familiarity and the vendor's risk estimation. Secondly, following the approach suggested by Gopal et al. (2003), we test the efficiency of the risk estimation by regressing transaction characteristics and the vendor's estimation of risk to profitability. In the presence of the vendor's risk estimation, there seems to be no systematic effect of the two factors influencing the vendor's risk estimation, i.e., project size and contract type, on project profitability. Concerning the two factors not incorporated in the vendor's risk estimation, i.e., strategic importance and client familiarity, only strategic importance is significantly associated with lower project profitability.

Our findings suggest that the vendor does not include all transaction characteristics in its risk estimation: Information about project size and contract type is incorporated into the risk estimation, while information about strategic importance and client familiarity is not. Our findings also suggest that the vendor's risk estimation is efficient with respect to the two factors influencing it, i.e., project size and contract type: The vendor's risk estimation incorporates all information related to project size and contract type available to the vendor at the time of making the estimation. Because strategic importance is not included in the vendor's risk estimation but does have a significant negative effect on project profitability, we suggest that the vendor deliberately accepts lower project profitability when conducting strategic projects.

These results significantly contribute to the literature on outsourced IS projects. While it is accepted, that project size, contract type and client familiarity are important transaction characteristics of outsourced IS projects (Gopal et al., 2003; Kalnins/Mayer, 2004; Gefen/Wyss/Lichtenstein, 2008; Chen/Bharadwaj, 2009), we know of no other study that empirically examines the effect of these transaction characteristics on the vendor's risk estimation. Furthermore, our analysis highlights the strategic importance of a project in determining project profitability, a relationship not previously discussed in this context in the literature.

The remainder of this paper proceeds as follows. In section 2, we present the conceptual background of our research. Section 3 presents and summarizes related work on the effect of transaction characteristics in outsourced IS projects. In section 4, we derive our hypotheses. Section 5 describes the research methodology. Section 6 introduces a model of project profitability to test for the efficiency of the vendor's risk estimation. In section 7, we discuss our results, study limitations, research contributions, and implications for practice. We provide our conclusive remarks in the paper's final section.

5.2 Related Literature on Transaction Characteristics

Figure 16 depicts a commonly seen model of project outcome (e.g., Yetton et al., 2000; Wallace/Keil/Rai, 2004a; Gemino/Reich/Sauer, 2008) in which project outcome is dependent on transaction characteristics, risk factors, and project governance. While transaction characteristics are knowable before the transaction takes place, risk factors and project governance evolve during the transaction. With regard to transaction characteristics, three associations have been of particular interest to researchers: the association between transaction characteristics and risk factors, the association between transaction characteristics and project governance, and the association between transaction characteristics and project outcome.

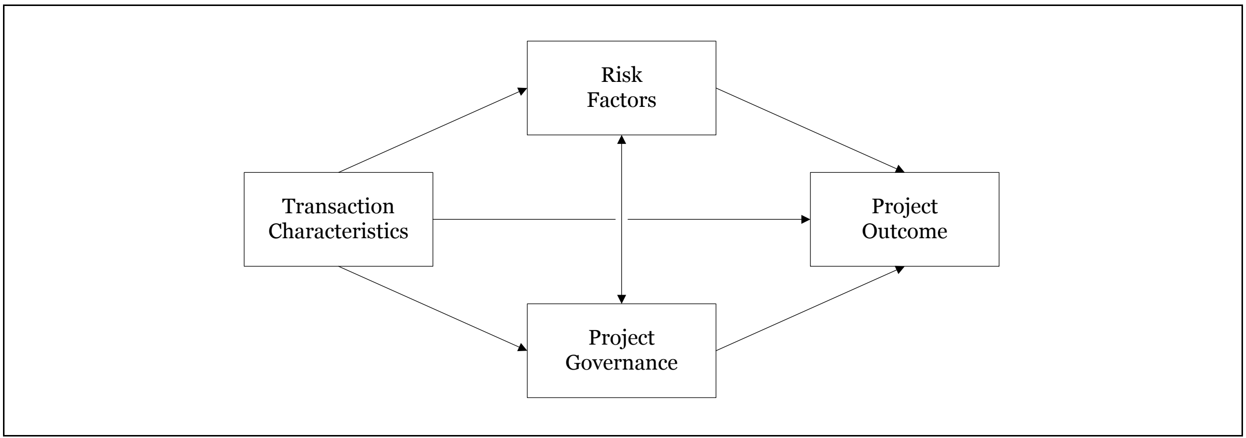

Figure 16. Related Literature on Transaction Characteristics

Concerning the association between transaction characteristics and risk factors, researchers have acknowledged that risk factors evolve on the basis of transaction characteristics. For instance, Gemino/Reich/Sauer (2008) propose a temporal model of IS project outcome and find that transaction characteristics such as size or complexity are positively associated with emergent risk factors such as scope changes or project manager fluctuation. In a similar vein, Wallace/Keil/Rai (2004a) find that characteristics such as the use of new technology results in risk factors associated with project planning and control or the project team.

Concerning the association between transaction characteristics and relational project governance, a study by Poppo/Zenger (2002) investigated how prior relationships are related to relationship quality. Based on responses from 285 IS executives, the authors suggest that a more intense familiarity between client and vendor significantly improves relationship quality. Contrary to this, Lee/Kim (1999) found no significant effect of a longer duration of client/vendor relationship on intention to continue the relationship. Gefen/Wyss/Lichtenstein (2008) examined how the contract type affects contractual project governance in the form of penalty provisions. Based on a sample of 274 outsourcing contracts, regression analysis suggested that fixed price contracts are associated with higher penalties. Chen/Bharadwaj (2009) extended these results by showing that prior relationships are also positively associated with the number of contractual provisions (property rights provisions, dispute resolution provisions, and contingency provisions). Prior relationships between client and vendor seem to be positively linked to contract extensiveness suggesting that prior experience leads to a better understanding of mutual requirements and capabilities which in turn allows the contracting parties to draft a more comprehensive contract (Chen/Bharadwaj, 2009).

Concerning the association between transaction characteristics and project outcome, Gopal et al. (2003) find that prior relationships, project size, and contract type are significantly associated with absolute vendor profits. Whereas larger projects and time and materials contracts seem to drive vendor profits, prior relationships have a negative effect. By showing that prior relationships are positively associated with the intention to continue risky projects, Nam et al. (1996) provide one possible reason for this negative effect of prior relationships on vendor profits.

Having access to a unique data set, we investigate whether vendors include transaction characteristics in their risk estimations and whether these estimations are efficient with regard to information available. In contrast to risk factors, transaction characteristics are knowable prior to a transaction and thus may be valuable indicators of a project's overall risk.

5.3 Conceptual Background

In outsourced ERP projects, vendors support clients in installing, parameterizing, integrating, and testing pre-packaged ERP software or, after implementation, providing services such as maintaining, upgrading, or managing new releases (Aloini/Dulmin/Mininno, 2007). We investigate the association between transaction characteristics of outsourced ERP projects and the vendor's risk estimation regarding project profitability. Figure 17 depicts a highly simplified representation of an outsourced ERP project from a vendor's perspective and illustrates events and information relevant to our research occurring at different points in time during the project.

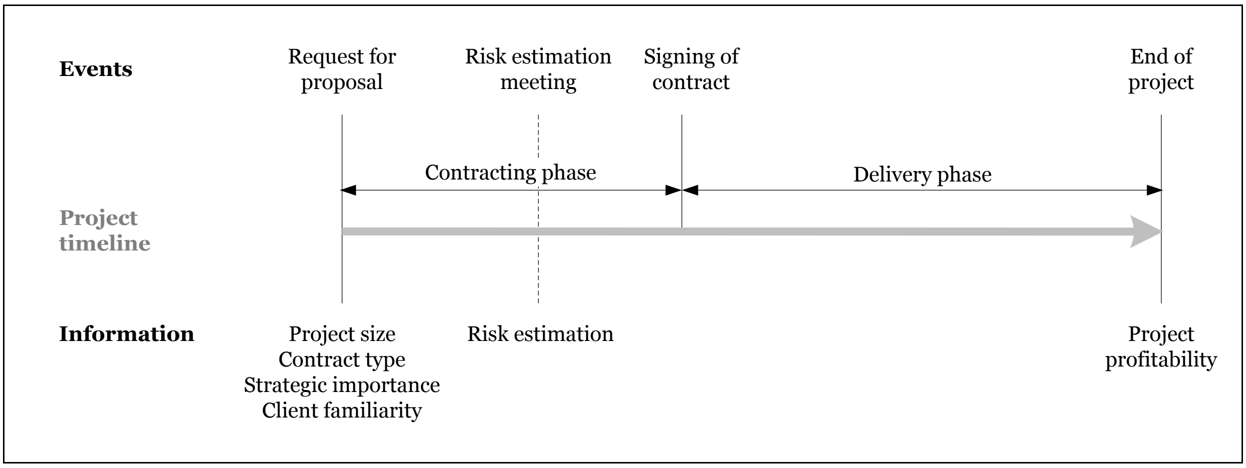

Figure 17. Timeline of Relevant Events and Information During an ERP Project

From a vendor's perspective, a project starts with the client issuing a request for proposal (RFP). Besides the requested scope of the project, the RFP conveys information about the volume of the project and the client's preference for contract type (Gefen/Wyss/Lichtenstein, 2008). The project volume indicates the estimated effort required for project completion and is a reasonable indicator for the size of a project (Sauer/Gemino/Reich, 2007). While the project's contract type is in theory the outcome of a contracting phase where both parties evaluate the risks and benefits associated with different contract types, the contract type is in practice often predetermined by the client in the RFP and not subject to negotiation during the contracting phase. There are two major types of contracts in outsourced IS projects: fixed price (FP) and time and materials (TM) contracts (Banerjee/Duflo, 2000). While variations such as capped price (CP) contracts exist, FP and TM contracts are most common (Gopal et al., 2003). In FP contracts, the vendor agrees to deliver the project as specified by the client for a predefined price. In TM contracts, the vendor is paid on an hourly basis based on agreed rates. The vendor's revenues (and the client's costs, respectively) are not predetermined at the time of contract closure in TM contracts (Kalnins/Mayer, 2004).

Beyond the explicitly stated information on project volume and contract type, the vendor evaluates client familiarity which refers to its knowledge about the client and the client's trustworthiness based on prior relationships (Gulati, 1995; Gefen/Wyss/Lichtenstein, 2008). Using all collected information, the vendor decides if the project is of strategic importance in addition to the project's financial objectives. The strategic importance of the project to the vendor is reflected in objectives such as winning an important reference client, entering a new market, introducing a new technology, or establishing long-term relationships with the client.

This initial understanding of the transaction characteristics of the project marks the starting point of the contracting phase. One important event occurring during the contracting phase is the risk estimation meeting the purpose of which is to estimate the profitability risk of a project. The vendor's risk estimation provides information to support managerial decisions made later during the contracting phase (Gefen/Wyss/Lichtenstein, 2008).

The signing of the contract marks the end of the contracting phase and the beginning of the delivery phase during which the vendor supports the client in implementation or post-implementation activities. At the end of the project, the vendor should be able to calculate project profitability by dividing project profits by project revenues.

5.4 Research Hypotheses

Figure 18 gives an overview of our research hypotheses on how vendors include transaction characteristics in their risk estimations.

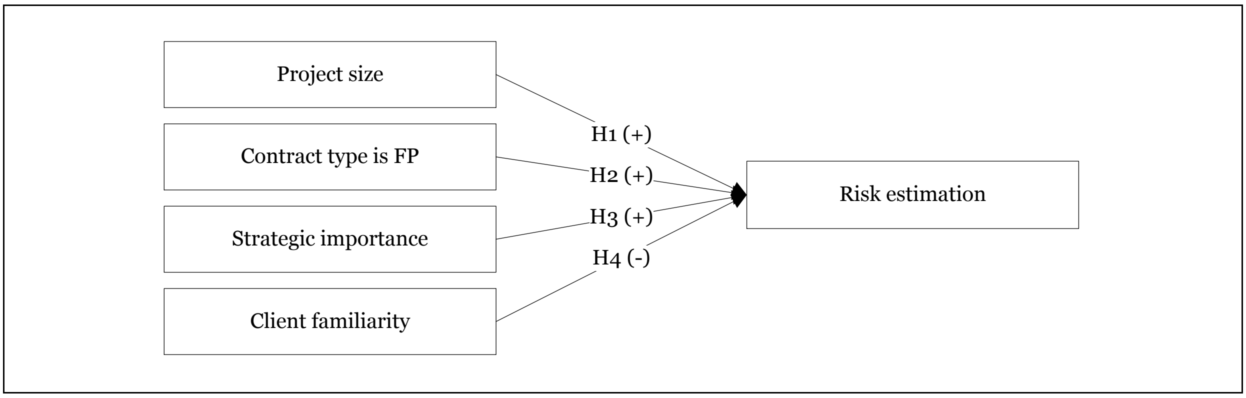

Figure 18. Research Model: Transaction Characteristics and Vendor Risk Estimation

Project size has been identified as an important determinant of IS project risk (McFarlan, 1981) and subsequent empirical evidence has substantiated this claim. Similar to arguments presented by Yetton et al. (2000), Gemino/Reich/Sauer (2008) also argue that project size increases complexity and task interdependence as well as volatility in IS projects and thus negatively affects performance. In their analysis of the effect of four components of project size (effort, duration, volume, team size) on project performance, Sauer/Gemino/Reich (2007) add that the link between size and performance may not be as direct as commonly thought. Their results suggest that: a) regardless of project size a baseline risk exists, b) the various components of size affect performance in a different way, and c) an increase in project size does not necessarily increase the risk of underperformance. Despite these restrictions we argue that larger projects tend to be more difficult to plan and to control and, due to their size, bear greater financial risk for the vendor. Consequently, we hypothesize:

Hypothesis 1 (H1): Larger projects are associated with higher risk estimation.

Formal contracting is an important aspect of client-vendor relationships in outsourced IS projects. A formal contract represents a "written contractual and management-initiated mechanisms designed to guide behavior toward desired objectives" (Goo et al., 2009). Formal contracts determine how risks are shared between vendor and client (Lacity/Hirschheim, 1993), have an impact on how projects are managed (Gopal/Sivaramakrishnan, 2008), and affect project outcome (Ramachandran/Gopal, 2010). In FP contracts, the risk of budget and schedule overruns is borne by the vendor, in TM contracts by the client. Furthermore, although in theory FP contracts offer the vendor the chance to leverage information asymmetries and thus achieve higher profitability, average vendor profits seem to be higher in TM contracts (Gopal et al., 2003). With this in mind, we suggest that FP contracts increase the vendor's risk estimation:

Hypothesis 2 (H2): Fixed price contracts are associated with higher risk estimation.

Investigating the determinants of IS project performance, Yetton et al. (2000) find empirical evidence that risk is a function of the strategic importance of a project. Following Yetton et al. (2000), we conceptualize strategic projects as business-critical projects with other than short-term financial objectives. For instance, vendors may conduct strategic projects in order to win important reference clients, to enter new markets, to test new technologies, or to generate follow-up projects. In these cases - though still important - financial success becomes a second priority. Due to their high visibility in the market, failing to successfully deliver strategic projects may cause long-term damage to reputation and affect the vendor's future business potential. In addition, because of the high criticality of strategic projects, the vendor might be more likely to make concessions during the contracting phase, resulting in more unfavorable terms and conditions. Both factors should drive the vendor's risk estimation. Thus, we hypothesize:

Hypothesis 3 (H3): Strategic projects are associated with higher risk estimation.

In their study on risk mitigation in outsourced IS projects, Gefen/Wyss/Lichtenstein (2008) suggest that familiarity may reduce risk in client-vendor relationships. According to Gefen/Wyss/Lichtenstein (2008), familiarity may influence risk through two aspects, knowledge and trust. The authors argue that the knowledge-related aspect of familiarity reduces information asymmetries and, consequently, risk during the contracting phase (Gefen/Wyss/Lichtenstein, 2008). Through repetitive partnerships, client and vendor get to know each other's capabilities, business environments and cultures which facilitates more exact estimation of cost and better allocation of resources (Kalnins/Mayer, 2004). The trust-related aspect that evolves from familiarity is important as it facilitates cooperation between client and vendor during the delivery phase of the project (Gefen/Wyss/Lichtenstein, 2008). Trust increases the chance that both parties will take constructive steps towards achieving common goals and reduces opportunistic behavior and the need for control (Gulati, 1995). Both the knowledge- and trust-related aspect of familiarity seem to be particularly valuable in ERP projects because these projects are typically knowledge-intensive and require considerable cooperation between client and vendor (Markus/Tanis, 2000). Thus, we hypothesize:

Hypothesis 4 (H4): Greater client familiarity is associated with lower risk estimation.

5.5 Methodological Approach

5.5.1 Research Site and Data Collection

Our industry partner ALPHA is a major vendor in the ERP software market. ALPHA develops and distributes its software and offers implementation and post-implementation services to clients from a broad range of industries. These services are organized as projects.
Project risk management at ALPHA is an integral part of the project management process. The primary goal of project risk management is to promote successful projects with a focus on project profitability. To this end, an independent organizational risk management unit supervises projects exceeding a volume threshold of € 250,000. The objectives of risk management at ALPHA comprise: (a) early detection of project risks, (b) providing transparency on risks to internal project stakeholders, and (c) control and mitigation of risks to keep additional costs at a minimum.

In projects which are subject to ALPHA's project risk management, a risk estimation meeting takes place during the contracting phase (see Figure 17). The risk estimation meeting follows standard risk management practices as proposed by Boehm (1991) or Charette (1996) and comprises identification, assessment, control, and monitoring of project risks. Risk estimation meetings are initiated and moderated by the independent risk management unit. Participants come from various organizational units such as finance and accounting, project management, or legal. Depending on the circumstances, the review meeting is either held via telephone or in person. In either case, the risk estimation meeting is guided by a standardized spreadsheet, which captures transaction characteristics and other risk relevant information about the project. It includes the client's name and industry, a one-paragraph project summary, ALPHA's project objectives, the contract type, and the project volume in Euro. The risk estimation is established by classifying the project as low, medium, or high risk. Most importantly, this risk estimation does not express an individual opinion but rather reflects the results of a systematic group discussion in the risk estimation meeting. The vendor's risk estimation serves as an important management reporting tool in regular internal steering committee meetings.

We tested our hypotheses on data from 81 ERP projects completed by ALPHA between 2005 and 2010 and exceeding € 250,000. Thus, these projects were subject to the supervision by the independent risk management unit as described above. In total, risk estimation meeting spreadsheets from 923 projects were available for our study. As the 923 projects contained projects, which were still in various planning phases or ongoing, we narrowed our data set to 81 completed projects. The risk estimation meeting spreadsheets of these 81 projects provided the basis for our analysis. Our projects stem from 65 different clients spanning a broad range of industries with a focus on automobile and components (12 projects), banks (11 projects), utilities (11 projects), and capital goods (8 projects). Variable descriptions and descriptive statistics are shown in Table 28.

Variables	Descriptions	Unit / scale	Mean (SD)	Min	Max
Project size	The estimated volume of the project as stated in the RFP (Sauer/Gemino/Reich, 2007)	'000s, €	2,234.47 (3,787.28)	81	22,200
Contract type	Indicator of whether the contract type is FP (0) or TM (1)	Binary variable	0.37 -	0	1
Strategic importance	Indicator of whether the project is of strategic importance (1) or not (0)	Binary variable	0.60 -	0	1
Client familiarity	Familiarity between client and vendor as indicated by the number of prior projects with the same client (Gefen/Wyss/Lichtenstein, 2008)	Number of prior projects	2.21 (3.03)	0	15
Project duration	Actual duration of the project in days between the signing of the contract and the end of the project	Number of days	417.5 (309.8)	60	1,705
Risk estimation	Indicator of whether the project is classified as low (1), medium (2), or high (3) risk project	3-point scale	1.40 (0.54)	1	3
Project profitability	Project profits divided by project revenues	Percent	29 (20)	-84	61

SD = Standard deviation.

Table 28. Variable Descriptions and Descriptive Statistics

The project volume in Euro was extracted as explicitly stated in the risk estimation meeting spreadsheet as was the contract type (FP or TM) and the vendor's risk estimation (high, medium or low). With regard to contract type, CP contracts were coded as FP contracts as they also put an upper limit on the project's volume. These characteristics were explicitly stated in the spreadsheets and thus were not subject to our interpretation.

A project's strategic importance to the vendor was assessed separately by two authors based on ALPHA's project objectives and the project summary as recorded on the spreadsheet. For each project ALPHA recorded up to three project objectives ordered by descending priority. Projects were coded as being strategic if, for example, ALPHA aimed at winning back a client from a competitor, entering a new market, or acquiring follow-up projects. In the case of contradictory objectives, we used the primary objective to code the project. Coding examples can be found in Appendix A. After both authors completed the coding, we used Cohen's Kappa (Cohen, 1960) to determine inter-rater reliability. Following the labels attached by Landis/Koch (1977), our initial Cohen's Kappa of 0.62 indicated "substantial" agreement among the authors. The 15 disagreements between the first and the second author could easily be resolved in a second round of coding. In addition, we clarified our coding scheme in a post-hoc discussion with our industry partner. While the industry partner was positive about the coding scheme in general, it was noted that the project objectives are usually entered by the bid team into the risk estimation meeting spreadsheet and thus may represent its specific perspective on the project.

We followed the suggestion by Gefen/Wyss/Lichtenstein (2008) and calculated client familiarity as the number of previous projects ALPHA had with the client at the time of conducting a given project. As we did not have access to projects conducted prior to 2005, our measure should be seen as a lower boundary of client familiarity. Thus, in order to mitigate the bias that inevitably results from this temporal restriction, we took all 923 projects into account when calculating client familiarity (Gefen/Wyss/Lichtenstein, 2008).

To test for the efficiency of the vendor's risk estimation, we collected financial data including all revenues and expenses accumulated during the project and the dates of all orders related to the project. Using this approach, common method bias is minimized as revenues and expenses stem from a different data source than the transaction characteristics (Podsakoff et al., 2003). Project profitability was calculated as the share of total project profits, i.e., total project revenues minus total project expenses, on total project revenue. Notably and in contrast to Gopal et al. (2003), we are able to calculate relative instead of absolute project profits and thus provide a more accurate picture of vendor profitability. Project duration was calculated as the number of days between the signing of the contract and the end of the project.

5.5.2 Data Analysis

Our hypotheses were tested using the following ordered probit specification[8]:

$$\begin{aligned} vendor\ risk\ estimate_i \ = \ & \beta_1 \log(project\ size_i) + \beta_2\, contract\ type_i \\ & + \beta_3 strategic\ importance_i \ + \beta_4 \log(client\ familiarity_i + 1) + \varepsilon_i \end{aligned}$$

where i indexes the individual projects and ε is an error term. Based on the variable distributions, we transformed project size and client familiarity by taking the logarithm. This transformation is a common procedure in empirical IS research to reduce the skewness of variables (e.g., Gefen/Wyss/Lichtenstein, 2008; Ramasubbu et al., 2008; Rai et al., 2012).

The specification was estimated using maximum likelihood. Because the error terms may not be independent as some clients engaged in multiple projects, we clustered the error terms by client. We tested for influential observations using Cook's distance and identified six observations as outliers according to the upper threshold of 4/n recommended by Hamilton (2006). Estimation results are shown in Table 29 and clustered standard errors are given in parentheses. The relationship of transaction characteristics and risk estimations using the full sample size and the results for the outlier-corrected sample are presented in the table. To test for multicollinearity we calculated the variance inflation factors (VIF) for each independent variable. The highest VIF was 1.17, which is lower than the recommended upper threshold of

[8] As an additional robustness check we also estimated the model using an ordinary least squares specification. The results were consistent with those of the ordered probit specification depicted in Table 29.

10 (Hair et al., 2006), indicating acceptable multicollinearity. There was no significant endogeneity[9]

Variables	**Full sample** (n=81)	**Outlier-corrected sample** (n=74)
log(Project size)	0.563*** (0.187)	1.026*** (0.240)
Contract type	-0.875*** (0.315)	-1.480*** (0.409)
Strategic importance	-0.143 (0.263)	-0.048 (0.335)
log(Client familiarity + 1)	-0.900 (0.240)	-0.396 (0.260)
Log likelihood	-50.66	-34.19
Chi-square	13.10**	23.81***
d.f.	4	4
Pseudo-R	0.17	0.18

d.f. = Degrees of freedom. *** = significant at the 1% level, ** = significant at the 5% level, * = significant at the 10% level, for two-tailed tests. Clustered standard errors are in parentheses.

Table 29. Transaction Characteristics and Risk Estimation, Ordered Probit Models

Concerning the model estimated on the full sample a chi-square of 13.10 and a Pseudo-R of 0.17 indicate a good fit of the overall model which is significant at $p < 0.05$. The results provide strong support for our hypotheses H1 (Larger projects are associated with higher estimations of risk) and H2 (Fixed price contracts are associated with higher estimations of risk). Strategic importance and client familiarity seem to have no effect on the vendor's risk estimation, not supporting H3 and H4, respectively. The model estimated on the outlier-corrected sample produces even greater effect sizes and significance levels for project size and contract type, indicating robustness of the results.

[9] As suggested by Gopal/Sivaramakrishnan (2008) and (Gopal et al., 2003), one candidate for endogeneity would appear to be contract type. To test for endogeneity we used Heckman's two stage procedure (Heckman, 1979) as outlined in Hamilton/Nickerson (2003). In the first stage, a probit specification was used to assess the effects of project size, strategic importance, and client familiarity on contract type. Based on these results, we calculated the inverse Mill's ratio. In the second stage, the vendor's risk estimate was estimated as a function of project size, contract type, strategic importance, and client familiarity, as well as the inverse Mill's ratio as an additional variable. The inverse Mill's ratio was not significant indicating no significant endogeneity (Shaver, 1998).

5.6 Efficiency Test of the Vendor's Risk Estimation

Our data set presents us with the unique opportunity to test the efficiency of ALPHA's risk estimation. In this context, the risk estimation of ALPHA is said to be efficient with regard to the transaction characteristics if it incorporates all information related to the transaction characteristics available to ALPHA at the time of estimation. Following the econometric framework outlined in Gopal et al. (2003), any deviation in realized project profitability should result from contingencies that are unanticipated and thus not incorporated in ALPHA's risk estimation. Therefore, we hypothesize that in the presence of the vendor's risk estimation there should be no significant effect of the variables representing the transaction characteristics known at the time of estimation. We used the following linear specification to test this efficiency hypothesis:

$$\begin{aligned} project\ profitability_i \ = \ & a_i + \beta_1 \log(project\ duration_i) + \ \beta_2\ vendor\ risk\ estimate_i \\ & + \beta_3 \log(project\ size_i) + \ \beta_4\ contract\ type_i + \beta_5 strategic\ importance_i \\ & + \beta_6\ \log(client\ familiarity_i + 1) \ + \varepsilon_i \end{aligned}$$

where i indexes the individual projects and ε is an error term. Following Gopal et al. (2003) we included the actual project duration, representing an ex-post "performance" variable, in the model to add power to the tests. We again used logarithmic transformations to reduce the skewness of the variables project duration, project size, and client familiarity. The specification was estimated using ordinary least squares. As outlined in the preceding section we clustered the error terms by client. Using Cook's distance for this model, we identified three observations as outliers according to the upper threshold of 4/n recommended by Hamilton (2006). Estimation results are shown in Table 30 and clustered standard errors are given in parentheses. The effects of project duration, transaction characteristics and risk estimations on realized project profitability using the full sample size and the results for the outlier-corrected sample are presented in the table. To test for multicollinearity we calculated the VIF for each independent variable. The highest VIF was 1.47, which is lower than the recommended upper threshold of 10 (Hair et al., 2006), indicating acceptable multicollinearity. There was no significant endogeneity[10]

[10] As described above we tested contract type for endogeneity using Heckman's two stage procedure (Heckman, 1979) The inverse Mill's ratio was again not significant indicating no significant endogeneity (Shaver, 1998).

Variables	**Full sample** (n=81)	**Outlier-corrected sample** (n=78)
log(Project duration)	-4.898 (3.617)	-3.249 (2.224)
Risk estimation	-12.109** (5.538)	-5.365** (2.359)
log(Project size)	-1.900 (1.810)	-1.370 (1.326)
Contract type	0.776 (3.946)	0.192 (2.929)
Strategic importance	-9.107** (3.733)	-5.324** (2.640)
log(Client familiarity + 1)	0.682 (2.316)	0.766 (1.475)
Constant	105.327** (41.667)	79.659*** (24.563)
F	1.62	2.29**
d.f.	6, 64	6, 61
R	0.27	0.22

d.f. = Degrees of freedom. *** = significant at the 1% level, ** = significant at the 5% level, * = significant at the 10% level, for two-tailed tests for two-tailed tests. Clustered standard errors are in parentheses.

Table 30. Efficiency Test of the Vendor's Risk Estimation, Ordinary Linear Models

Concerning the model estimated on the full sample, a R of 0.27 indicates a good fit. In presence of ALPHA's risk estimation, project size, contract type and client familiarity seem to have no effect on project profitability. A higher risk estimation and projects with strategic importance to the vendor are significantly associated with lower project profitability. Overall the results indicate that the vendor's risk estimation is efficient with regard to project size and contract type. The model estimated on the outlier-corrected sample produces lower effect sizes for the risk estimation and strategic importance but is consistent with the results obtained using the full sample which indicates robustness of the results.

5.7 Discussion

5.7.1 Summary of Results

The underlying rationale of our study was to examine whether vendors include transaction characteristics in their risk estimations. Using a unique archival data set of 81 projects from a major ERP vendor, our results show that not all of the four investigated transaction characteristics are included in the vendor's risk estimations. While larger projects and fixed price contracts are significantly associated with higher estimations of risk, lending support to H1 (Larger projects are associated with higher estimations of risk) and H2 (Fixed price contracts are associated with higher estimations of risk), strategic importance and client familiarity are not included, not supporting H3 (Strategic projects are associated with higher estimations of risk) and H4 (Greater client familiarity is associated with lower estimations of risk), respectively.

Given that project size has been shown to correlate with complexity, volatility, and task interdependence (Yetton et al., 2000; Gemino/Reich/Sauer, 2008) and fixed price contracts transfer the risk of budget overruns to the vendor (Banerjee/Duflo, 2000; Gopal et al., 2003; Ethiraj et al., 2005) respectively, it is not surprising that risk managers at ALPHA regard these characteristics as important threats to profitability.

With regard to strategic importance and client familiarity our findings are more surprising: While Yetton et al. (2000) suggest that strategic importance is positively associated with risk, our results show that strategic importance is not included in the vendor's risk estimations. We argue that when pursuing strategic goals, such as winning reference clients or entering new markets, vendors deliberately accept lower project profitability. Thus, the effect of strategic importance on project profitability is compensated for and subsequently not part of the vendor's risk estimations.

Concerning client familiarity, Gefen/Wyss/Lichtenstein (2008) argue that familiarity between clients and vendors in outsourced IS projects mitigates risk through increased knowledge and trust. Interestingly and contrary to the reasoning presented in Gefen/Wyss/Lichtenstein (2008), we found that client familiarity is not significantly associated with lower estimations of risk. One possible reason for this is that knowledge gained from increased familiarity is not be directly reflected in the vendor's risk estimation but rather affect how future relationships are managed in terms of contractual governance. This is in line with empirical evidence presented in Kalnins/Mayer (2004), and Gopal et al. (2003). Post-hoc interviews substantiated this line of argumentation: ALPHA risk managers are primarily concerned with project profitability, which is a matter of contractual governance and thus not impacted by the degree of familiarity between vendor and client.

Our data set incorporated ex-post data on profitability that presented us with the unique opportunity to test the efficiency of the vendor's risk estimation. Efficiency of the vendor's risk estimation implies that the risk estimation incorporates all available information that relates to the transaction characteristics included in the risk estimation, i.e., project size and contract type, and that is known at the time of estimation. The efficiency test substantiates this hypothesis with regard to these two transaction characteristics. In the presence of the vendor's risk estimation both transaction characteristics do not significantly affect profitability.

The efficiency test also shows that strategic projects are significantly associated with lower project profitability. In line with this, post-hoc interviews substantiated the notion that ALPHA is willing to accept profitability losses in the case of strategic projects.

5.7.2 Limitations

Our study is subject to several limitations. First, because we analyzed data from one company only, there may be issues concerning the representativeness of our results. ALPHA's organizational context may not be comparable to other companies that provide ERP implementation- and post-implementation services. In this regard, particularly the fact that ALPHA does not only offer services to its clients, but also develops and distributes its own ERP software differentiates ALPHA from other ERP service providers. However, we argue that this organizational difference does not affect the generalizability of our findings. We can think of no reason why the nature of the associations between project size, contract type, client familiarity, strategic importance and the risk estimation should change for other ERP service providers. Solely, ALPHA's conceptualization for strategic importance may differ from those of other ERP service providers. For instance, ALPHA may also consider service projects as strategic that are primarily conducted in order to sell software licenses.

Secondly, data are only available for projects exceeding € 250,000 and thus supervised by ALPHA's risk management unit. Our sample is therefore slightly biased towards larger projects. Because of the considerable costs associated with a formal risk management process, the practical implications of our paper may not be applicable to smaller projects.

Thirdly, this study examined outsourced ERP projects as a specific type of outsourced IS projects. Amongst other things, ERP projects are specific with regard to their high degree of client-vendor interaction and organizational change, the need to integrate with legacy systems, and the deployment of pre-packaged software (Markus/Tanis, 2000). Hence, generalization to other types of IS projects, such as outsourced software development projects, may require additional research.

Fourthly, the set of transaction characteristics that are included in this study is restricted by the information given in ALPHA's archival data set. Notwithstanding that we have included heavily discussed transaction characteristics in the IS literature such as project size, contract type, and client familiarity our set of transaction characteristics is not theoretically complete and important transaction characteristics such as task complexity and asset specificity are missing. However, as our research objective was to analyze whether vendors include transaction characteristics in their risk estimation, theoretical completeness of the transaction characteristics is not absolutely essential. Nevertheless, since our analysis revealed that vendors do not include all transaction characteristics in their risk estimation, future research should investigate the inclusion of further transaction characteristics.

Fifthly, as discussed in the data collection section, the project objectives based on which the projects' strategic importance is coded are entered by the bid team that negotiates the project contracts. Post-hoc interviews with ALPHA risk managers revealed that this perspective may in some cases differ from the projects' actual strategic importance: The bid team may overstate the strategic importance in order to justify poorly negotiated contracts with low profitability prospects. This case offers an alternative explanation for our results: Being aware of the bid team's behavior, risk managers would not incorporate the bid team's perspective on a project's strategic importance into their risk estimation. Also, poorly negotiated contracts with an overstated strategic importance would drive the association between strategic importance and lower project profitability. In a subsequent study we will clarify this issue by having ALPHA's risk managers code the projects' strategic importance, providing us with an additional perspective.

Finally, our results were dependent on the quality of ALPHA's archival data. As risk management is often seen as a burden which creates 'extra work and expense' (Verner/Evanco, 2005), the possibility exists that the risk estimation meeting spreadsheets were not carefully maintained by the risk managers, although we found no evidence to support this suspicion. Instead, our post-hoc interviews highlighted the considerable value ALPHA attributes to the risk management process in general and the risk estimation in particular. In addition, the comprehensiveness of comments provided in the free text fields in the spreadsheets suggests a reasonably high quality of data. Other authors explicitly emphasize the value of comprehensive archival data (Ropponen/Lyytinen, 1997), which may be better suited for investigating perceptional data than surveys or interviews due to the avoidance of recall bias (Mitchell/Thompson, 1994).

5.7.3 Contributions to Research

We see two major contributions to research. First, our study is one of the first attempts to empirically analyze transaction characteristics that shape the vendor's risk estimation in the context of outsourced ERP projects. There is considerable research on transaction characteristics and their effect on risk factors (Yetton et al., 2000; Wallace/Keil/Rai, 2004a; Gemino/Reich/Sauer, 2008), project governance (Lee/Kim, 1999; Poppo/Zenger, 2002; Gopal et al., 2003; Kalnins/Mayer, 2004; Gefen/Wyss/Lichtenstein, 2008; Chen/Bharadwaj, 2009), and project outcome (Nam et al., 1996; Gopal et al., 2003). This study adds the vendor's risk estimation as another important aspect affected by transaction characteristics. Furthermore, we tested the efficiency of the vendor's risk estimation by investigating the effect of transaction characteristics and the risk estimation on project profitability.

The second contribution of our research is that we highlight the strategic importance of projects from a vendor's perspective as an important construct in the context of client-vendor relationships. Strategic importance indicates that objectives such as winning important reference clients, entering new markets, testing new technologies, or generating follow-up projects are vital for vendors. Our results substantiate the notion of 'must-have projects' and strategic vendor behavior. To the best of our knowledge, prior research on outsourced IS projects has only partially addressed strategic importance by focusing on aspects such as future business potential (Gopal et al., 2003).

The value of these contributions is substantiated by the unique archival data set on which our analysis is based. Previous studies on outsourced IS projects mainly relied on post-hoc surveys. Using archival data potentially rules out common method bias (Podsakoff et al., 2003) and may provide better estimations of path coefficients and explained variance (Gefen/Wyss/Lichtenstein, 2008). Some authors have examined archival data similar to ours (Kalnins/Mayer, 2004; Gefen/Wyss/Lichtenstein, 2008) from either a client perspective or not in the context of outsourced ERP projects. To the best of our knowledge, this is the first time that vendor profitability was analyzed in terms of the realized margin instead of absolute profits (Gopal et al., 2003; Gopal/Sivaramakrishnan, 2008) or perceptional measures (Ramachandran/Gopal, 2010). Our data set provided also us with the opportunity to assess strategic importance as indicated by ALPHA's project objectives.

5.7.4 Implications for Practice

Our results suggest that project size and contract type are central constituents of the vendor's risk estimation. For vendors, larger projects and fixed price contracts seem to bear more risk. Given ALPHA's overall success in the market, IT managers at other vendors may find it useful to emphasize these aspects when estimating project risk.

The efficiency of the vendor's risk estimation implies that the vendor seems to have a good intuition about risks that stem from project size and contract type. As in ALPHA's case successful managerial decisions were based on the risk estimation, our analysis may serve as an illustration of the potential benefits of formal project risk management (Boehm, 1991; Charette, 1996). This finding may be valuable for other IS project vendors who think about introducing formal risk management.

Finally, our findings provide evidence for strategic vendor behavior during the contracting phase. Although our analysis does not allow us to judge ALPHA's priority concerning the respective strategic objectives, it becomes clear that ALPHA deliberately relaxes profitability requirements when strategic considerations come into play. Again, given ALPHA's overall success in the market, this finding highlights the importance of objectives, other than financial ones, and long-term orientation for IS project vendors.

5.8 Conclusion

Based on the analysis of 81 outsourced ERP projects, we sought to answer the research question: Do vendors include transaction characteristics in their risk estimations? Therefore, we related transaction characteristics to the vendor's risk estimation. Notably, our results show that not all transaction characteristics are included in the vendor's risk estimation. While we found that larger projects and fixed price (FP) contracts are included in the vendor's risk estimation, strategic importance and client familiarity are not. Furthermore, we tested the efficiency of the vendor's risk estimation by linking it to project profitability. Our findings suggest that the vendor's risk estimation is efficient with regard to the two characteristics included in the risk estimation, i.e., project size and contract type.

Finally, we found that strategic importance significantly affects project profitability but is not included in the vendor's risk estimation. This suggests that in strategic projects, vendors deliberately accept lower project profitability and adjust their margin requirements prior to estimating project risk. Future research should look into this particular transaction characteristic in more detail. The investigation of various strategic objectives and how much profitability loss the vendor is willing to take seems especially promising.

6 Explaining the Effect of Risk Factors on Vendor Profitability in ERP Projects: A Multiple Case Study

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Table 31. Fact Sheet Publication P6

Abstract. In this paper, we used a multiple case study to investigate interrelations between risk factors in ERP projects and vendor profitability, which is an essential dimension of project success for a vendor. We structured the vendor's perspective on risk factors using a network based on a triangulation of archival data, interviews, and accompanying documents from five projects of a large German-based ERP vendor. The network organizes the risk factors into four major risk scenarios: high deficits in vendor obligations, high deficits in client obligations, strong disagreement concerning scope and requirements, and high client negotiation power. While the identified risk factors themselves seem to be quite straight-forward reflections of the client's perspective, our analysis reveals that the risk scenario high client negotiation power moderates the impact of risk factors on vendor profitability. Furthermore, our findings show that vendor profitability is under threat when, over time, multiple risk scenarios befall the project. This paper contributes by addressing the essential role of interrelations between risk factors and by exploring the vendor's perspective on risk factors in ERP projects, a so far neglected perspective in IS research.

6.1 Introduction

Enterprise Resource Planning (ERP) software represents both, the largest and one of the most risky segments within the enterprise software market (Scott/Vessey, 2002; Gartner Research, 2012). Organizations expect several benefits from implementing ERP software, primarily tangible ones, such as cost reduction or increased effectiveness, but also intangible ones, such as increased visibility of corporate data or greater responsiveness to market demands (Al-Mashari/Al-Mudimigh/Zairi, 2003). In order to realize these benefits, organizations will typically contract specialized ERP vendors, which assist them in the installation, parameterization, integration, and/or maintenance of the pre-packaged ERP software (Swanson, 2010). Prominent cases of failed ERP projects, however, illustrate that these projects bear substantial risk: In November 2012, the US Air Force decided to cancel an ERP project that had accumulated costs of over one billion dollars since its beginning in 2005 (International Data Group, 2012a). Earlier in November, Avantor, a manufacturer of performance materials, had sued its ERP vendor for several million dollars in damages over a failed ERP implementation (International Data Group, 2012b).

We see two important issues around risk in ERP projects, which have gained little attention so far:

- Little is known about the interrelations between risk factors and ERP project outcome. Literature presents a variety of risk factors that explain critical situations in ERP projects but most of literature assumes that such risk factors work in isolation and do not affect each other (e.g., Markus/Tanis, 2000; Shanks/Parr, 2000; Umble/Haft/Umble, 2003; Somers/Nelson, 2004; Ifinedo, 2006). Only few discuss interrelations between risk factors and ERP project outcome, e.g., reinforcing loops of risk factors in ERP implementations (Akkermans/van Helden, 2002).

- Literature suggests that vendors and clients face differential risk factors (Markus/Tanis, 2000; Gopal/Koka, 2012). Still, little is known about the vendor's perspective on risk factors in ERP projects (Levina/Ross, 2003; Dibbern et al., 2004; Liang/Xue, 2004; Hess et al., 2012). Literature also suggests that ERP projects have unique characteristics that inhibit the adoption of studies on the vendor perspective on other project types, e.g., software development outsourcing (SDO) (Gopal et al., 2003; Ethiraj et al., 2005; Gopal/Sivaramakrishnan, 2008; Gopal/Koka, 2012).

In this paper, we contribute to a more nuanced understanding of the vendor's perspective on risk factors in ERP projects. We specifically investigated interrelations between of risk factors and vendor profitability, which is an essential success dimension from a vendor's perspective (Gopal/Koka, 2012). Our research question was: *How do risk factors affect vendor profitability in ERP projects?*

We answered our research question using a multiple case study. We followed the methodological guidance by Miles/Huberman (1994) and developed a network of risk factors from the vendor's perspective. The network is based on a triangulation of archival data, interviews, and accompanying documents from five ERP projects of a large ERP vendor. We identify four major risk scenarios: High deficits in vendor obligations, high deficits in client obligations, strong disagreement concerning scope and requirements, and high client negotiation power. While the identified risk factors themselves seem to be quite straight-forward reflections of the client's perspective, our analysis reveals that vendor profitability is under threat when, over time, multiple risk scenarios befall the project.

A better understanding of the interrelations between risk factors in ERP projects promises to contribute to theory-building in the domain of project risk management (Whetten, 1989), a domain of research, which is often perceived as being poor on theory (Wallace/Keil/Rai, 2004a). Our results may also guide practitioners in devising more effective risk-sharing mechanisms for client-vendor-relationships, for which understanding both contracting parties' perspective seems to be essential (Gopal/Koka, 2012).

The remainder of the paper is structured as follows: Next, we review the literature on risk factors in ERP projects. We then outline our research design. In the fourth section, we present a network of risk factors from a vendor's perspective. We discuss our results in the fifth section. The last section concludes the paper with an outlook on future research.

6.2 Related Literature

Literature on risk factors in ERP projects from a client's perspective is extensive. There are only a few studies that investigate risk factors from a vendor's perspective. These studies, however, focus on SDO projects. In the following, we briefly review these two distinct streams of literature, before deriving the research gap of this paper.

6.2.1 Risk Factors in ERP Projects From a Client's Perspective

Due to the considerable number of risk factors identified in the literature, we structure our review of risk factors in ERP projects from a client's perspective according to three generic phases of an ERP project (Shanks/Parr, 2000).

The planning phase comprises all pre-project activities, such as the definition of project objectives and the project scope, the setup of project structures, the creation of work plans and the selection of the ERP system. Frequently mentioned risk factors in this phase are an incoherent information systems (IS) strategy (Lee/Myers, 2004; Bernroider, 2008), the lack of a business vision and clear objectives (Akkermans/van Helden, 2002), inadequate planning (Gargeya/Brady, 2005), or a misfit between the selected ERP software and the implementing organization (Plant/Willcocks, 2007).

The project phase comprises specification, the realization, the testing, and the roll-out of the new ERP system. Frequently described risk factors in this phase are a poor system specification (Finney/Corbett, 2007), a technically complex realization, e.g., due to data conversion issues (Umble/Haft/Umble, 2003) or a difficult integration with legacy systems (Bingi/Sharma/Godla, 1999), inadequate testing (Al-Mashari/Al-Mudimigh/Zairi, 2003), and the wrong roll-out strategy (Umble/Haft/Umble, 2003). In addition, risk factors in this phase relate to a poor execution of project management activities, inadequate human resources, communication issues, or external influences. A poor execution of project management activities refers to activities such as project controlling, resource management, scope management, risk management, or integration management (Chen/Law/Yang, 2009). Inadequate human resources relate to the skillset of the project team (Shanks/Parr, 2000) including external experts (Markus et al., 2000), or a lack of management support (Staehr, 2010). Communications issues relate to both, project-external and project-internal communication, i.e., among stakeholders (Finney/Corbett, 2007) but also among the project team (Holland/Light, 1999). Finally, external influences, e.g., the industry or economic climate, tend to cause volatility regarding project objectives, the project scope, or human resources, and thus negatively affect the project outcome (Ifinedo, 2006).

The enhancement phase comprises all post-project activities, such as maintenance or transformations of the ERP system. Although inadequate change management is also a risk factor that has to be addressed during the project phase, it seems particularly important during post-project activities (Umble/Haft/Umble, 2003). Failing to provide effective organizational change management, e.g., through continuous user training, tends to result in low acceptance of the new system within the organization (Sumner, 2000).

6.2.2 Risk Factors in SDO Projects From a Vendor's Perspective

A small stream of research has investigated the vendor's perspective on risk factors in SDO projects, mainly by regressing vendor profits on various risk factors. Profitability is one of the most important outcome criteria for vendors to ensure long term survival (Gopal/Koka, 2012). Although ERP projects feature distinct characteristics (Markus/Tanis, 2000) that make it difficult to apply findings from SDO projects to ERP projects, these studies provide us with starting points for analyzing the vendor's perspective on risk factors in ERP projects. In the following, we briefly review the factors that have been shown to negatively affect vendor profits in these studies.

One important risk factor from a vendor's perspective seems to be the skillset of the vendor's project team. The vendor's project team must be able to understand and implement the client's requirements as well as to estimate the time and resources necessary to complete the project to avoid delays in project completion. A lack of adequately skilled personnel on the vendor's side has been shown to be negatively associated with vendor profits (Ethiraj et al., 2005; Gopal/Koka, 2012). In a similar vein, a lack of adequately skilled personnel on the client's side is also negatively associated with vendor profits (Gopal et al., 2003; Gopal/Koka, 2012): It is suggested, that inadequately skilled client personnel struggles with precise definitions of requirements and contractual terms, causing frequent misunderstandings and costly readjustments. Uncertainty in requirements has been shown to negatively affect vendor profits (Gopal et al., 2003).

With regard to human resources, volatility in the vendor's project team is seen as a major risk factor in SDO projects. While it may be argued that replacing existing team members boosts motivation, this effect seems to be outweighed by the productivity losses caused by the additional training to build up the client-specific knowledge and capabilities the new team members initially lack: Empirical studies show a negative association between volatility in the vendor's project team and vendor profits (Gopal/Sivaramakrishnan, 2008; Gopal/Koka, 2012).

The importance a client attributes to a project tends also to reduce vendor profits (Gopal et al., 2003). More important projects seem to be subject to increased control and coordination which drives vendor costs and thus negatively affects vendor profits (Gopal et al., 2003).

Trust and knowledge that originates from repeated interactions with the same client is suggested to mitigate risk in outsourcing relationships (Gefen/Wyss/Lichtenstein, 2008). Conversely, a lack of familiarity should be a major risk factor in SDO projects and decrease vendor profits as coordination and control costs rise. Empirical evidence, however, suggests otherwise: A lack of familiarity between the transaction partners actually seems to drive vendor profits (Gopal et al., 2003; Ethiraj et al., 2005), suggesting that other risk factors that are associated with repeated interactions, e.g., project complexity, mask the familiarity effect.

While literature sees project size and the increased complexity that comes with it as a major risk factor (Sauer/Gemino/Reich, 2007), project size is of course positively associated with absolute vendor profits: Larger projects tend to generate larger absolute vendor profits irrespective of their profitability (Gopal et al., 2003; Ethiraj et al., 2005; Gopal/Sivaramakrishnan, 2008; Gopal/Koka, 2012).

Finally, the effect of risk factors in SDO projects is mitigated by the formal contract between the transaction partners. As fixed price (FP) contracts transfer the risk of budget and schedule overruns to the vendor (Banerjee/Duflo, 2000) the effect of risk factors will naturally be stronger in projects based on FP contracts. Empirical evidence supports this: Requirements uncertainty, volatility in the project team, and a lack of adequately skilled personnel seem to have more severe consequences on vendor profits in FP contracts than in time and material (TM) contracts (Gopal/Koka, 2012). On average, vendor profits seem to be higher in projects based on TM contracts (Gopal et al., 2003; Ethiraj et al., 2005).

6.2.3 Research Gap

We see two aspects that promise to enhance our understanding of risk factors in ERP projects: First, investigating risk factors from a vendor's perspective helps complementing the predominant research on the client's perspective; second, investigating interrelations between risk factors and ERP project outcome promises to illustrate how risk factors evolve during the project.

Extant lists of risk factors in ERP projects provide useful guidance for clients, but little is known on the vendor's perspective on risk factors in ERP projects. As risk factors are likely to have differential causes and effects for client and vendors (Gopal/Koka, 2012), it is questionable whether extant results hold true from a vendor's perspective. In addition, most research on risk factors on ERP projects is of descriptive nature, i.e., it does not aim at explaining how risk factors evolve and affect project outcome. The few exceptions which look at interrelations of risk factors in ERP projects again do so from a client's perspective (Akkermans/van Helden, 2002).

In contrast to literature on ERP projects, literature on SDO projects provides some evidence on how risk factors may affect project outcome from a vendor's perspective. Using cross-sectional data from Indian software vendors, these studies estimate effects of several risk factors on vendor profits. Given their cross-sectional nature, however, the insights from these studies as to how risk factors evolve and how project outcome is affected by these risk factors are limited. For instance, the findings on the positive effect of "unfamiliarity" between the transaction partners on vendor profits are counter-intuitive and require further investigation. In addition, findings from offshore SDO projects in general may not be transferable to the domain of ERP projects, due to the specific characteristics (Markus/Tanis, 2000) and risk profiles of ERP projects (Sumner, 2000).

Given the high relevance of ERP projects and their high risk of failure, we argue for a more nuanced understanding of risk factors in ERP projects. Thus, we conduct a multiple case study of five ERP projects from a multinational ERP vendor. In contrast to extant list of risk factors in ERP projects, we focus on interrelations between risk factors and project outcome from a vendor's perspective, in particular vendor profitability.

6.3 Research Method

Case studies are particularly useful for analyzing contemporary phenomena in a real world context and for developing new theory (Yin, 2009). Although "case study research is not sampling research" (Dube/Pare, 2003), and consequently does not aim at statistical generalizability, analyzing multiple cases instead of a single case is thought to "deepen understanding and explanation" (Miles/Huberman, 1994) and will likely lead to more compelling and robust results (Yin, 2009). As such, multiple case studies are particularly apt for advancing theory (Miles/Huberman, 1994). Therefore, we chose to analyze and cross-compare five cases from a German-based but internationally operating ERP vendor[11]. Focusing on a single vendor allows us to control for organizational culture. Each case concerns the implementation of an ERP system by EPSILON at one of its clients.

6.3.1 Case Selection and Data Collection

Together with managers from EPSILON's central risk management unit, which oversees all projects above a given value threshold, we selected five projects from EPSILON's portfolio of completed projects with its German clients. To ensure comparability between the projects, projects had to deal with ERP implementations and had to be initiated at around the same time. In addition, we focused on projects based on fixed price (FP) or capped price (CP) contracts[12]. To allow for both, theoretical (cases show different results) and literal (cases

[11] For reasons of anonymity, we name this vendor EPSILON.

[12] In contrast to time and materials (TM) contracts, where the vendor is paid based on the amount of effort necessary to complete the project, FP and CP contracts require the vendor to deliver the project as specified by the client at a predefined price (Lacity/Hirschheim, 1993). As FP and CP contracts transfer the risk of budget and schedule overruns to the vendor, they seem particularly apt for our purpose.

show same results) replication (Yin, 2009), we chose three projects with low, one project with medium and one project with high profitability measured against EPSILON'S profitability targets. Table 32 gives an overview on the selected projects.

	P1	P2	P3	P4	P5
Project description	Implementation of an ERP system to support finance and human resource processes. The client's purpose of the implementation was to replace its legacy systems and lay the foundations for an enterprise wide integrated system. The project was considered a "lighthouse" project by EPSILON as the client represented a high profile public institution. EPSILON and another vendor jointly conducted the project. EPSILON acted as a general contractor.	Implementation of an ERP system to support individual-related and endowment contract-related grants management. The system was aimed to replace legacy systems and reduce process costs. For EPSILON, the project represented another reference in the public sector with a focus on data migration.	Implementation of an ERP system to support retail business processes. The project was divided in a prototype phase, a pilot phase, and a roll-out phase. The client's purpose was to replace its legacy systems to support further business growth. Given the client's high reputation in the fashion industry, the project represented an opportunity to enter the fashion market. Besides EPSILON, a second vendor was employed by the client. EPSILON acted as the general contractor. After the pilot phase, EPSILON opted to switch to a TM contract as it incurred losses under the FP regime.	Implementation of an ERP system to support core banking processes. The system was aimed to extend an existing ERP system and integrate all internal processes into one ERP system. Being a major player in the European banking industry, the client represented an important opportunity for EPSILON to gain footprint in the banking industry. Furthermore, EPSILON pitched against one of its main competitors.	Implementation of an ERP system to support core banking processes. The client had to replace its legacy system which was to be phased out within one year's time. By implementing EPSILON's system, the client wanted to further differentiate itself from its competitors. EPSILON agreed to client obligations of 45% of the total estimated effort. After project completion, client and vendor submitted to arbitration due to disagreements concerning the financial details.
Industry	Public sector	Public sector	Retail (Fashion)	Financial services	Financial services
Contract	FP	FP	FP and TM	FP	CP
Volume	27 mEUR	1 mEUR	32 mEUR	13 mEUR	38 mEUR
Duration	4years and 1 months	3 years and 1 months	3years and 8months	4 years and 5 months	2 years and six months
Profitability	Moderate	Low	High	Low	Low

Table 32. General Information on the Selected Projects

We collected our data in two consecutive multi-day visits at the research site in 2011 and 2012. The purpose of the second visit was to conduct follow-up interviews and to discuss our findings from the first visit with risk managers from EPSILON. For each project data, we triangulated data from three different sources: Archival records, semi-structured interviews, and documents (Patton, 2002; Yin, 2009). The archival records consist of structured risk register spreadsheets used by EPSILON for project-level risk management. Each spreadsheet is the outcome of a risk assessment workshop with various project stakeholders, such as the project manager, members from the financial controlling unit, or the risk management unit. The spreadsheets contain detailed information on the project risk factors at the time of assessment as well as a management summary for reporting purposes. As various risk assessment workshops are typically done throughout the project lifecycle, several spreadsheets are available for analysis for each project. We based the interviews on guidelines that contained open ended questions about general project information and the risk factors that occurred during the project. To avoid bias stemming from key informants, we interviewed the project manager and the project risk manager of each project, when possible (Kumar/Stern/Anderson, 1993). In total, we conducted eight interviews lasting between 32 minutes and 125 minutes. All interviews were conducted face-to-face. The interview language was German for all interviews. Finally, the accompanying documents comprise of project materials, e.g., contracts, e-mail correspondence, meeting minutes, and status reports. Table 33 gives an overview on the data available for each project.

	P1	**P2**	**P3**	**P4**	**P5**
# of risk registers	18	15	14	20	30
Interviews	P (86min) R (79min)	P (43min) R (46min)	R (117min)	P (32min) R (65min)	R (125min)
# of documents	120	37	183	31	267

R: Risk manager, P: Project manager

Table 33. Data Sources and Data Availability by Project

6.3.2 Data Analysis Procedure

Based on the five projects described above, we developed a network following the recommendations by Miles/Huberman (1994) in order to identify interrelations between project risk factors and vendor profitability. A network depicts independent, intermediating, and dependent variables and the links among them. Our analysis proceeded in two steps: In step 1, we developed an individual network for each project (within-case analysis). In step 2, we compared the individual networks and derived an integrated network (cross-case analysis) showing the most influential risk factors to vendor profitability.

Step 1: Within-case analysis:

For each project, we first created chronologically ordered listings of each project's risks based on the archival records. In addition to the information when a risk occurred, the risk register spreadsheets also provided us with information about how important a risk was perceived. Second, we coded the text passages from the interviews that revealed information about risk factors using the software ATLAS.ti. Third, we integrated the findings from the archival records and the interviews to derive a final listing of risk factors including the perceived importance of each risk factor. Together with a base model of vendor profitability, these risk factors and their ratings provided the building blocks for the individual networks. The interrelations were derived based on "reasonable mechanisms" (Miles/Huberman, 1994) between the risk factors as indicated by their consistent, joint appearance throughout the project or based on direct statements about interrelations by the interviewees. In addition, we performed plausibility checks of the identified interrelations using the chronologically ordered risk listings. Finally, we cross-checked the validity of the individual networks by justifying our arguments with the accompanying documents.

Step 2: Cross-case analysis:

We started the cross-case analysis by isolating chains of risk factors, so called causal streams, from the individual networks that lead to variations in vendor profitability. We compared the streams across cases and looked for patterns of risk factors with identical perceived importance. Streams which proved consistent across the majority of projects qualified for the integrated network. Consistency of the streams was assessed based on the following rules (Miles/Huberman, 1994): (1) The majority of risk factors on the stream are the same, (2) the two risk factors closest to the outcome measure (in our case: deficits in client obligations, deficits in vendor obligations, disagreement concerning scope and requirements, and client negotiation power) are the same and are in the same sequence, (3) the common risk factors have the same perceived importance, (4) the outcome theme is the same, (5) the project narrative confirms the similarity of the outcome theme, (6) the outcome theme is different in cases with differently rated outcome variable, (7) in these differently rated cases, the risk factors closest to the outcome variable are different, or at least rated differently. We grouped the consistent streams into four risk scenarios, i.e., groups of consistent causal streams that share the same outcome variable. Finally, we discussed our findings with risk managers at EPSILON throughout the analysis and integrated their feedback into the causal model. While the identified scenarios themself seemed to be quite robust, the feedback of EPSILON's risk managers proofed very helpful in explaining the links between the risk scenarios and our base model.

6.4 Results

6.4.1 Overview: A Model of Vendor Profitability

Figure 19 depicts a high-level overview of the integrated network, depicting the outcome variables of our four risk scenarios as determinants of vendor profitability. The four risk scenarios that derived from our cross-case analysis are: (1) "Deficits in vendor obligations", (2) "Deficits in client obligations", (3) "Disagreement concerning scope and requirements", and (4) "Client negotiation power" (see Figure 19). Deficits in vendor obligations relating to either schedule or functionality intuitively result in additional, non-billable consulting days and thus, in higher costs for the vendor: The vendor has to compensate for self-inflicted productivity losses, i.e., has to increase its effort to achieve the specified functionality within the specified time. Deficits in client obligations also seem to be positively associated with additional, non-billable consulting days for the vendor and thus, higher costs for the vendor: Due to dependencies between the client's and the vendor's work packages, the vendor is oftentimes forced to wait for the client before being able to proceed with the project. Though in principle the client may be charged for these productivity losses, the vendor may opt not to do so in order not to strain the client-vendor relationship:

> "Either I charge the client for the idle week – and risk a lot of complaints – or I try to compensate for it myself somehow." (Vendor risk manager, P2).

Deficits in client obligations are especially critical in cases where the vendor acts as a general contractor and consequently is responsible for the whole project:

> "We acted as a general contractor in the project. That did not work out well because we expected too much from the client in terms of what he can deliver." (Vendor risk manager, P3).

Furthermore, disagreement concerning the scope and requirements also tends to increase vendor costs as the number of additional, non-billable consulting days increases. In cases where the vendor and the client have a different understanding of the scope and the requirements of the project, additional effort is required to resolve these discrepancies. Typically, this additional effort is shared between the client and the vendor:

> "It was simply a misunderstanding. [...] We had to reach a compromise that was equally unpleasant for both of us." (Vendor project manager, P1).

Finally, the client's negotiation power within a project seems to be associated with discounts on the bid price, thereby decreasing vendor revenues and, all else equal, vendor profitability. The higher the client's negotiation power, the more likely is the vendor to offer favorable terms to the client and forego short-term profitability objectives:

> "It was a strategic offer. We made concessions because we saw huge business potential in the follow-up projects." (Vendor risk manager, P3).

In addition, client negotiation power seems to moderate the negative effect of other risk scenarios on vendor profitability: High deficits in vendor obligations, high deficits in client obligations, or strong disagreements concerning scope and requirements, lead to readjustment of the original project plan and renegotiations concerning the additional effort. The negative effect of these risk scenarios on vendor profitability depends on the client's power in these negotiations:

> "There are still open issues concerning the scope of the migration. A meeting with the legal department has been scheduled to evaluate our negotiation position. […] All these

issues are not included in the project calculation and would have to be borne by EPSILON alone." (Risk register spreadsheet 3, P3).

"The project scope has been clarified and the uncertainty for the project team has been reduced. However, EPSILON made considerable financial concessions which dramatically affect the financial situation in the project." (Risk register spreadsheet 5, P3).

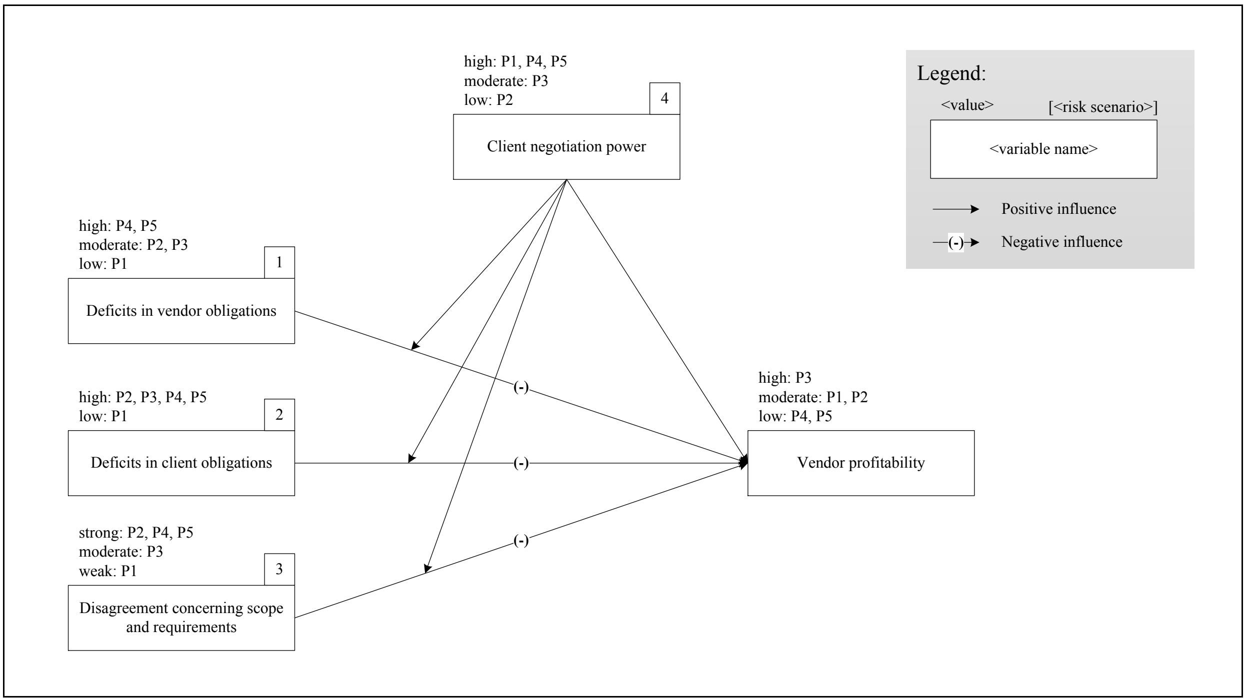

Figure 19. High-level Overview of the Integrated Network

Each of these four variables represents one risk scenario in the integrated network. As mentioned above, each risk scenario in turn comprises several causal streams of risk factors that cause variations in the scenario's outcome variable. In total, the integrated network comprises 51 variables, their links, and their values. Due to page restrictions, we describe only the second scenario in more detail. We chose the second scenario as it was clearly present in all cases and seems to explain considerable variation in vendor profitability.

6.4.2 Risk Scenario: High Deficits in Client Obligations

We found high deficits in client obligations to decrease vendor profitability by causing additional, non-billable consulting days in four of the five projects analyzed. Deficits in client obligations can relate to either schedule overruns or shortcomings in the quality or functionality concerning the work packages the client is responsible for. In both cases, the vendor has to wait for the client to deliver according to plan, potentially resulting in additional, non-billable consulting days for the vendor. Figure 20 depicts the complete risk scenario.

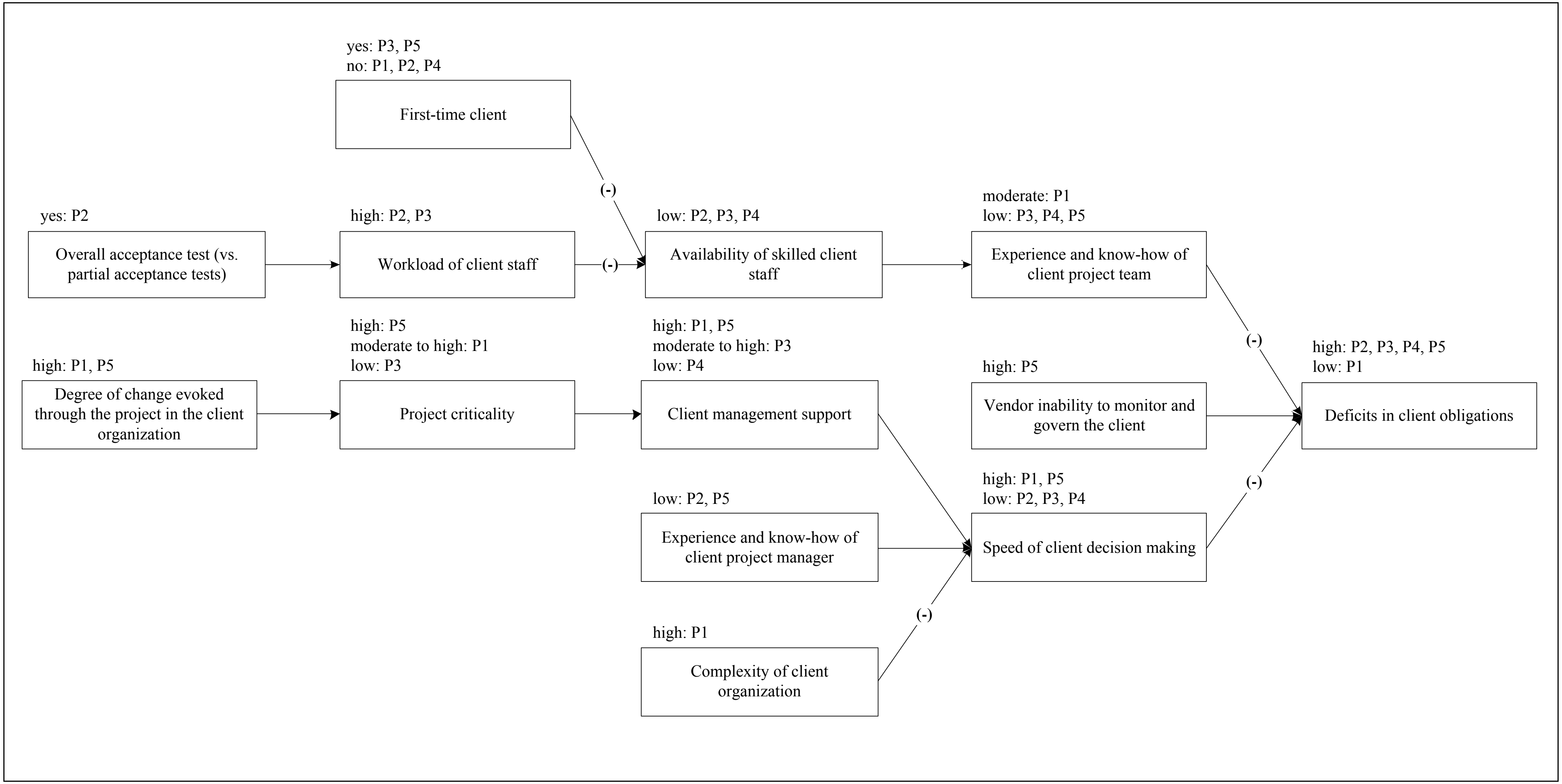

Figure 20. Risk Scenario "High Deficits in Client Obligations"

One of the main drivers of high deficits in client obligations seems to be the *low experience and know-how of the client project team*. This was experienced in three of five projects. For instance, the risk manager in P3 argued that

> "[…] the client was not known for delivering good projects. All parts where we had to collaborate with the client took extremely long. Our project manager almost got mad because they didn't make any progress." (Vendor risk manager, P3).

Similar issues were observed in P4:

> "The client obligations definitely were a risk because of the lack of know-how on the client side. We had considerably delays and our costs sky-rocketed." (Vendor risk manager, P4).

A *low availability of skilled resources* in general reinforces this risk. When not enough skilled resources are available, it becomes difficult for the client to staff the project team. As one project manager observed:

> "They didn't have the right people. You just had to look where they came from: We had this one guy who had been concierge in some hotel. […] It's very difficult to elaborate process blueprints [for the financial services industry] with guys like this." (Vendor project manager, P4).

Especially *first-time clients* seem to struggle with the availability of skilled resources:

> "For them it was new territory. They had no experience with enterprise-wide systems and consequently underestimated the complexity of the project. In general, this seems to be an issue we have with first-time clients." (Vendor risk manager, P4).

In addition, the *workload of the client staff* affects the availability of skilled resources. In contrast to the vendor's team members who work on the project on a full-time basis, the client's team members typically have additional responsibilities in the client company's day-to-day business. Oftentimes the day-to-day business is of higher priority than the project work, withdrawing the necessary human resources from the project. In the case of P3, the client team was bound by the fashion industry's cyclical business, resulting in considerable delays:

> "We underestimated that the client is bound by its fashion cycles. As a consequence we could not progress in the way we wanted to. Depending on the season, there were always times where the client had no time to work on the project." (Vendor risk manager, P3).

This risk is especially problematic in project phases when the workload for the client peaks, such as design phase or the testing phase. In P2 for instance, the client and the vendor agreed to an *overall acceptance test instead of several partial acceptance tests*. As a consequence, the client workload peaked towards the end of the project as all the testing had to be done within one overall acceptance test, further increasing the tension between day-to-day-business and project work. The above mentioned effect of low experience and know-how of the client project team seems to be reinforced in cases where *the vendor is not able to monitor and to govern the client*. In P5, the vendor acted as a general contractor, i.e., was responsible for the overall project. At the same time, the client stipulated to deliver considerable parts of the project himself. Despite having the responsibility for the overall project, the vendor did not manage to continuously monitor and govern the client who could not deliver as promised, causing additional delays:

> "It did not work out as planned, because the client did not deliver. This is not unusual. In this case however, we had no control over the client. On the one hand, we did not know whether the client did what he had promised. We also did not know who exactly was responsible on the client side. […] We could not influence anything, because the client always told us he would take care of it. We could not take any disciplinary measures." (Vendor risk manager, P5).

Another driver of high deficits in client obligations turned out to be the *speed of client decision making*. As ERP implementations involve many business and project related decisions, deferring these decisions can cause substantial delays in client obligations. The *experience and know-how of the client project manager* seems to be directly related to the speed of client decision making:

> "An inexperienced client project manager tends to have no feeling when certain decisions have to be made. Or he has no understanding concerning the dependencies between decisions. Sometimes they also do not want to make decisions because they lack experience. This way a project can get into severe troubles because the central theme gets lost and the project lurches into several directions." (Vendor risk manager, P2).

Also, as many decisions cannot be made by the project manager, maintaining *client management support* is important to make sure, that also high-level decisions are made in a timely manner. For instance, P1 reported directly to the client company's senior management, which made sure that also important decisions were taken quickly:

> "In the first phase, the project reported directly to the CEO, afterwards to the CFO. Interestingly, the project did not report to someone in the IT department, which was beneficial as many business decisions cannot be taken within IT-department. […] It's important to have the responsible manager on the client's side placed as high as possible in the organization, especially in projects as big as this one, where decisions tend to have a huge financial impact. The higher the client's manager position, the easier it is to get these decisions." (Vendor project manager, P1).

Our analysis suggests that the level of client management support is related to the extent of *criticality* client perceives the project to have. In the case of P5, the project was critical to the client from the beginning as the system to be replaced was to be turned off within a one-year timeframe. The project sponsor on the client side was a member of the board and was frequently involved in the project, speeding up several processes, such as renegotiations during the project, as a consequence. The positive effect of client management support on the speed of decision making, however, may be countered by the *complexity of the client organization*: In P1, despite the fact that the project was supported by the client's senior management, the complexity of the client organization slowed down the project:

> "Some decisions on the client side took a long time: Should the controlling process look like this or should it look like that? We said we need a decision until the end of the month. But these are decision processes in big organizations with many stakeholders, where everybody wants to have his say. In the end it took them two months to decide." (Project manager, P1)

6.5 Discussion

In contrast to literature, which has mainly identified and described risk factors from a client's perspective, this study investigates interrelations between risk factors and project profitability from a vendor's perspective. We developed a network of four risk scenarios including various risk factors that cause variation in vendor profitability: High deficits in vendor obligations, high deficits in client obligations, strong disagreement concerning scope and requirements, and high client negotiation power. While the first three scenarios negatively affect vendor profitability by increasing vendor costs in the form of additional, non-billable consulting days, the fourth scenario, high client negotiation power, affects vendor profitability in two ways: First, the vendor is likely to offer high discounts on the bid price prior to project start which decrease the vendor's revenues, and, all else equal, the vendor's profitability. Second, the vendor is likely to make larger concessions in renegotiations during the project caused by the other risk scenarios. Client negotiation power thus can be seen as a moderator variable: High client negotiation power tends to reinforce the negative effect of the other risk scenarios, while low client negotiation power tends to mitigate it. Furthermore, our analysis reveals that low vendor profitability was never caused by a single risk scenario or risk factor, but by a combination of several. For instance, in P5 EPSILON faced high deficits in client obligations, high client bargaining power, and strong disagreements concerning scope and requirements. While each of the risk scenarios itself would have been manageable, the unlikely combination of all three proved to be disastrous in terms of profitability, representing a "black swan" for the vendor (Flyvbjerg/Budzier, 2011; Buhl, 2012).

6.5.1 Limitations

Our study is subject to several limitations. First, the study findings are based on projects from only one organization. Though this seems not to be unusual in studies on the vendor's perspective on risk (e.g., Gopal et al., 2003; Ethiraj et al., 2005; Gopal/Sivaramakrishnan, 2008; Gopal/Koka, 2012), our findings are potentially subject to biases stemming from a unique organizational setting. Thus, our approach needs to be augmented by further studies. However, the risk factors we identify are to a large extent consistent with previous research and thus enhance our confidence in our understanding of ERP projects.

Second, we focus on profitability as a critical but not the sole project outcome for a vendor. Future research needs to address other outcomes: vendors may deem projects successful that increased their reputation in the market, enabled them to engage in long-term relationships with their clients, or helped them to train their staff (Dibbern/Winkler/Heinzl, 2008). As the importance of risk factors relates closely to the dimensions of success, different risk scenarios may evolve from our data when looking at different success criteria (our model captures some of these alternative success criteria, such as reputational benefits or cross- and up-selling potential, in the risk scenario high client negotiation power). However, profitability is an essential dimension of project success for vendors. Thus, we argue that our risk scenarios still provide valuable insights for vendors and clients.

Third, we studied domestic ERP projects from a German vendor. Our findings may therefore be subject to cultural bias and should be treated with caution when studying client-vendor relationships in different cultural settings. For instance, it has been shown that negotiation and conflict resolution styles vary across cultures (Tse/Francis/Walls, 1994), possibly altering the moderating role of client negotiation power in our model. Again, this needs to be addressed in future studies.

6.5.2 Implications for Practice

Our findings have several implications for practitioners. First, the risk factors and risk scenarios provide guidance for ERP vendors to develop a proactive rather than a reactive risk management culture.

Second, we found that vendor profitability tends to be affected irrespective of whether the client or the vendor is responsible for the risk factors. High deficits in client obligations or strong disagreements concerning the scope of requirements, which contractually tend to belong to the client domain, also result in renegotiations and profitability losses for the vendor. Given the importance of renegotiations in determining vendor profitability, vendors may invest resources in establishing governance structures such as dedicated negotiation teams in their projects in order to resolve the contingencies that arise during a project in the vendor's best interest.

Third, we also observe that EPSILON deliberately decided to make huge financial concessions concerning the bid price out of strategic reasons. Governing these strategic projects according to profitability objectives may prove counterproductive: Frequent and tedious renegotiations are likely to result in low client satisfaction, possibly decreasing the cross- and upselling potential or resulting in negative reputational effects. Instead, strategic projects should be managed emphasizing above all non-financial objectives.

Finally, better understanding the effects of risk factors and scenarios, in particular deficits in client obligations, on vendor profitability may also provide valuable insights for clients: As vendors may have incentives to shirk on quality (Gopal/Koka, 2012) when their profitability is under threat, understanding how and why vendor profitability is affected is also valuable for clients when deciding on governance mechanisms for transactions.

6.5.3 Contributions to Theory

To the best of the authors' knowledge, our paper is one of the first studies on the vendor's perspective on risk factors in ERP projects. As such and despite the above mentioned limitations, our paper makes essentially two contributions to theory (Whetten, 1989):

First, by identifying risk factors in ERP projects from a vendor's perspective, we provide a starting point for selecting factors that should be included when seeking to explain variations in vendor profitability. Although some of our risk factors are not fundamentally different from risk factors from a client's perspective (e.g., Sumner, 2000; Aloini/Dulmin/Mininno, 2007), we also find several factors that seem to exert considerable influence on vendor profitability, e.g., the client's bargaining power, which have not been acknowledged in the project risk management literature. In this regard, our clear conceptualization of project success from a vendor's perspective allows for a quite clear conceptualization of risk, a concept which is often difficult to define precisely (Sherer/Alter, 2004). Though we acknowledge that there are several ways of conceptualizing project success, profitability is one of the most important success criteria for vendors.

Second, we contribute by exploring interrelations between risk factors and vendor profitability. While previous research has compiled lists of risk factors, interrelations are scarcely investigated (Akkermans/van Helden, 2002). We illustrate how risk factors in ERP projects may relate to each other and provide narrative evidence of why they do so. We thereby help to explain how vendor profitability varies in certain circumstances and contribute to theory building in the domain of project risk management. In particular, we identify renegotiations (Hart/Moore, 1988) and thus client negotiation power as a central mechanism in explaining variations in vendor profitability. In this regard, our cases also illustrate that relational flexibility (Gopal/Koka, 2012), i.e., the client's willingness to work out adjustments to the formal contract, is not necessarily prevalent in high risk exchanges.

6.6 Conclusion

We used a multiple case study to investigate interrelations between risk factors in ERP projects and vendor profitability, which is an essential success dimension of a vendor. The identified risk factors seem to be quite straight-forward reflections of the client's perspective. However, our analysis suggests that the client's negotiation power moderates the impact of risk factors on vendor profitability. Our findings also show that vendor profitability is under threat when, over time, multiple risk scenarios befall the project. Our paper contributes by addressing the essential role of interrelations between risk factors and by exploring the vendor's perspective on risk factors in ERP projects, a so far neglected perspective in IS research. Given our study limitations and its findings, future research may further elaborate on the model and use it as a foundation for quantitative studies to examine the effect of risk factors on vendor profitability. Also investigating how counter measures address the risk factors in the network or break the causal relationships between them seems a promising starting point for future research.

7 Determinants of Vendor Profitability in Two Contractual Regimes: An Empirical Analysis of Enterprise Resource Planning Projects

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Table 34. Fact Sheet Publication P7

Abstract. In this paper, we investigate the effects of four determinants of vendor profitability in enterprise resource planning (ERP) projects under two contractual regimes: fixed price (FP) contracts and time and material (TM) contracts. From a transaction cost economics perspective, we hypothesize that project size and project uncertainty are negatively associated with vendor profitability. From a knowledge-based view of the firm perspective, we hypothesize that industry knowledge and client knowledge are positively associated with vendor profitability. We also hypothesize that effect sizes are larger under FP contracts than under TM contracts. We tested these hypotheses on a comprehensive archival data set which included 33,908 projects from a major vendor in the ERP software market. Surprisingly, we found client knowledge to be negatively associated with vendor profitability. Results were mixed with regard to the association between project size and vendor profitability depending on the contractual regime underlying the project. Our results suggest that vendor profitability is negatively affected by project uncertainty and positively affected by industry knowledge. Our analysis confirms the existence of two contractual regimes: The effect sizes are indeed much larger in FP contracts than in TM contracts. By analyzing determinants of the vendor's profit margin in domestic ERP outsourcing projects, our study offers a more nuanced understanding of vendor profitability in information systems (IS) outsourcing projects.

7.1 Introduction

Worldwide spending on enterprise resource planning (ERP) software is expected to grow to 24.9 billion USD, making ERP software the largest segment of the enterprise application software market (Gartner Research, 2012). In contrast to stand-alone applications, ERP software features an enterprise-wide integrated database and various integrated applications that enable entering, recording, processing, monitoring, and reporting of all business transactions (Ragowsky/Somers/Adams, 2005). Organizations implement ERP software for a variety of reasons which range from technical, such as reducing maintenance costs, to business reasons, such as improving business processes (Markus/Tanis, 2000). When conducting ERP projects, organizations typically outsource the project or parts of it to specialized vendors (Lacity/Hirschheim, 1993). While having considerable potential to create business value (Davenport, 1998; Ragowsky/Somers/Adams, 2005), ERP outsourcing projects often fail (Sumner, 2000), consuming substantial organizational resources and sometimes even resulting in bankruptcy (Scott, 1999). The recent case of Avantor, in which Avantor sued its ERP vendor IBM for several million dollars in damages, highlights the risk that is inherent in these projects for both, clients and vendors.

Given the high risk of failure in information systems (IS) outsourcing projects, it is not surprising that much of the literature on IS outsourcing has examined determinants of project success using a wide array of dependent and independent variables and various levels of analysis (Lacity et al., 2010). A frequently raised concern in the IS outsourcing discipline, however, is that much of the literature exclusively examines the client's perspective on project success. The determinants of project success from a vendor's perspective have hardly been explored (Levina/Ross, 2003; Dibbern et al., 2004; Lacity et al., 2010), resulting in a single-sided view on the success of outsourcing projects. Notable exceptions to this include the studies by Gopal et al. (2003), Ethiraj et al. (2005), Gopal/Sivaramakrishnan (2008) and Gopal/Koka (2012), who analyze vendor profitability - arguably one of the most important criteria of success from a vendor's perspective - in offshore software development outsourcing (SDO) projects.

Building on this small body of research on offshore SDO projects, we investigate determinants of vendor profitability in domestic packaged software implementation outsourcing projects using the example of ERP projects under different contractual regimes. Following the rationale outlined in Gopal/Sivaramakrishnan (2008), we assume two different contractual regimes, i.e., fixed price (FP) contracts and time and material (TM) contracts, that govern the effect of these determinants. Based on the logic of transaction cost economics and knowledge based view, we hypothesize that vendor profitability is negatively affected by project size and project uncertainty, while vendor profitability is positively affected by client knowledge and industry knowledge. The effects on vendor profitability should be stronger in FP contracts as the vendor bears the major part of the risk in these contracts. We tested our hypotheses on a comprehensive data set from a major vendor in the ERP software market. Our data set comprises 33,908 ERP projects from 2,227 clients. The results of our analysis confirmed the existence of two contractual regimes, that govern the effects of our determinants on vendor profitability (Gopal/Sivaramakrishnan, 2008). The effects on vendor profitability are much greater in FP contracts than in TM contracts. Surprisingly, we found a negative association between client knowledge and vendor profitability. Results were mixed with regard to the association between project size and vendor profitability depending on the contractual regime underlying the project. As expected, our results suggest a negative effect of project uncertainty and a positive effect of industry knowledge on vendor profitability.

Our paper contributes in two ways to what is already known in the subject: First, we confirm some of the existing findings on the determinants of vendor profitability presented in the literature on offshore SDO projects. And in doing so, we strengthen the confidence in these findings as applied across different forms of outsourcing. Second, we extend previous research in several ways. To the best of our knowledge, our study is the first to analyze determinants of vendor profitability in domestic packaged software implementation outsourcing projects using the example of ERP projects. In contrast to previous studies, our data set also provided us with the unique opportunity to analyze the vendor’s profit margin thereby offering a more nuanced perspective on vendor profitability. Based on the knowledge based view, we also add industry knowledge as an important determinant of vendor profitability in ERP projects.

The remainder of this paper is organized as follows: Section two describes the paper’s conceptual background on contractual regimes in IS outsourcing projects. Section three defines the research hypotheses on vendor profitability. In section four, we describe the research site and illustrate our approach to data collection and data analysis. In section five we present the results of our analysis. The paper concludes with a discussion of the study limitations, the contributions to existing research, and the implications of our study for practice.

7.2 Conceptual Background

Formal contracts play an important role in determining the distribution of risk in a project (Lacity/Hirschheim, 1993). There are two major types of contracts in IS outsourcing projects: FP contracts and TM contracts. While hybrid forms such as capped price contracts exist, pure FP and TM contracts seem to prevail in practice (Banerjee/Duflo, 2000). In FP contracts, the vendor is responsible for delivering the project as specified by the client and is paid a fixed fee. Consequently, the major risk in FP contracts is borne by the vendor (Gopal et al., 2003). In TM contracts, the client maintains responsibility for the project and pays the vendor an agreed fee per unit of effort the vendor delivers. The vendor’s revenue for the project is not predetermined in this case. As a result, the client bears the risk of budget and schedule overruns in TM projects (Gopal et al., 2003). From a vendor’s perspective, the type of contract used for the project embodies a trade-off between risk protection (in TM contracts) and profitability potential (in FP contracts) (Gopal/Sivaramakrishnan, 2008).

Based on variations in risk distribution (and given the primacy of profit maximization), each contract type presents different incentives for the vendor: FP contracts, which limit the vendor’s revenues from a project, incentivize the vendor to minimize project costs. TM contracts, which limit the vendor’s profit margin, incentivize the vendor to maximize effort and, thus, project revenues. Recent research has shown that vendors indeed manage FP contracts differently than TM contracts (Gopal/Sivaramakrishnan, 2008). For instance, vendors assign more highly-trained staff to FP-based projects and monitor and control the project more rigorously (Kalnins/Mayer, 2004). Conversely, vendors tend to over-deliver in TM contracts and accept change requests by the client more readily (Bajari/Tadelis, 2001). The distinct risk distributions, incentive structures, and management mechanisms across the two contract types, make it reasonable to assume two contractual regimes with distinct profitability equations. We adopt the proposition by Gopal/Sivaramakrishnan (2008) that the effect sizes of the determinants of vendor profitability will differ depending on the contract type. Accordingly, instead of integrating the contract type as a binary variable in an overall profitability equation (Gopal et al., 2003; Kalnins/Mayer, 2004; Ethiraj et al., 2005), we estimate two distinct profitability equations, one for FP contracts, and one for TM contracts (Gopal/Sivaramakrishnan, 2008).

7.3 Research Hypotheses

Our research model builds on transaction cost economics and knowledge based view which are two commonly used theories in IS outsourcing (Dibbern/Winkler/Heinzl, 2008). Based on the assumptions of bounded rationality and opportunism, transaction cost economics suggests that the most efficient structure for governing a transaction depends on the costs that arise for "planning, adapting, and monitoring task completion" (Williamson, 1981, p. 552). These transaction costs derive from characteristics of the transaction itself, such as the frequency, the specificity, or the uncertainty of the transaction (Williamson, 1979). Our data set allows us to relate two key transaction characteristics, i.e., project uncertainty and project size, to vendor profitability. As described below in more detail, we argue that these characteristics will result in additional transaction costs and thus negatively affect vendor profitability.

Knowledge based view originates from the resource-based view (RBV) of the firm (Penrose, 1959; Barney, 1991) and regards knowledge as "the most strategically important of a firm's resources" (Grant, 1996, p. 110). A firm's knowledge evolves over time through individual learning (Grant, 1996). Knowledge forms the basis for a firm's unique organizational capabilities that are, in turn, the source of its competitive advantage and its ability to generate rents (Grant, 1996; Ethiraj et al., 2005). In this paper, we distinguish between industry-specific knowledge and client-specific knowledge, both of which are suggested to be a function of repeated transactions in the same industry and with the same client, respectively (Ethiraj et al., 2005). We argue that both forms of knowledge allow vendors to operate more efficiently and thus positively affect vendor profitability.

The effect of these determinants on vendor profitability depends on the contract type. As stated above, the risk in FP contracts is borne by the vendor. The effect of the determinants on vendor profitability should, consequently, be greater in FP contracts than in TM contracts.[13]

[13] The question arises why vendor profitability should be subject to variations in TM contracts, in which the client pays the vendor an agreed fee per unit of effort and hence bears the risk of budget and schedule overruns. While the contract allocates the major risks to either vendor (in FP contracts) or client (in TM contracts), it does not allocate all the risk to one of the contracting parties exclusively. As contracts are necessarily incomplete (Hart/Moore, 1988), contingencies that arise during the project are frequently resolved in settlements with both parties bearing some of the additional costs. Thus, even in TM contracts, the vendor may incur additional costs.

We control for several variables that are known to have an effect on vendor profitability: the size of the client, the vendor's relative market share at the time of the project, the client's area of business, and the year in which the project takes place. The size of the client has been found to be negatively associated with the vendor's bargaining power (Mjoen/Tallman, 1997). In a similar vein, the vendor's relative market share at the time of the transaction indicates the vendor's market position, which may affect the vendor's bargaining power and thus vendor profitability (Gopal et al., 2003). Finally, we control for variations in vendor profitability across industries and over time (Ethiraj et al., 2005). Figure 21 depicts our research model.

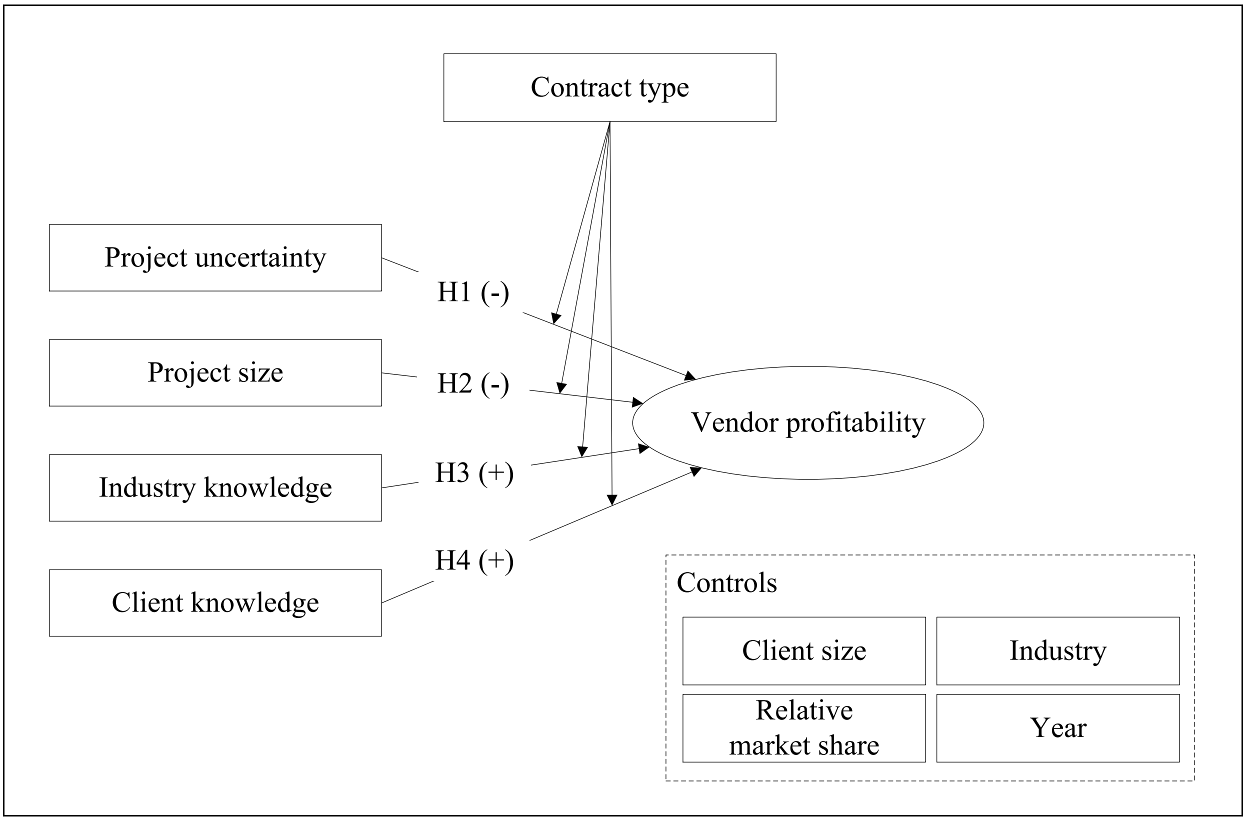

Figure 21. Research Model: Determinants of Vendor Profitability

Uncertainty is one of the critical dimensions for describing transactions in transaction cost economics (Williamson, 1979) and it is also a well-known risk factor in the IS project management literature (Zmud, 1980; McFarlan, 1981; Nidumolu, 1995). According to Zmud (1980, p. 46), "most difficulties can be traced to the uncertainty that pervades software development. Software development is an information-intensive activity, and decision points are continually reached where the decision maker possesses inadequate information". Similar to software development projects, packaged software implementation projects, and particularly ERP projects, comprise many information-intensive activities, such as creating process or organizational models (Scheer/Habermann, 2000). High degrees of uncertainty relating to the requirements and the technology used in the project have been shown to negatively affect project performance (Nidumolu, 1995). In the case of uncertain transactions, contractual gaps will be larger, increasing the number of adaptations, and making it necessary for the contracting parties to devise more sophisticated coordination mechanisms to "work things out" (Williamson, 1979, p. 254). This need for additional coordination mechanisms will increase transaction costs and thus negatively affect vendor profitability. As the vendor bears the major part of the risk in FP contracts, we hypothesize:

Hypothesis 1 (H1): There will be a greater negative association between project uncertainty and vendor profitability in FP contracts than in TM contracts.

In addition to uncertainty, project size is an important and well-researched characteristic of IS projects. Literature on IS project management frequently mentions the size or extent of a project as one of the major risk factors in IS projects (McFarlan, 1981; Ropponen/Lyytinen, 2000). Complexity and task interdependence typically increase with project size (Yetton et al., 2000) leading to greater volatility (Gemino/Reich/Sauer, 2008) and a higher risk of underperforming (Sauer/Gemino/Reich, 2007). Given this risk, costs for planning, adapting, and monitoring will increase for larger projects. These additional transaction costs will be shared in some form between the client and the vendor (Williamson, 1979), negatively affecting the vendor's profitability. Again, as the vendor bears the major part of the risk in FP projects, we hypothesize:

Hypothesis 2 (H2): There will be a greater negative association between project size and vendor profitability in FP contracts than in TM contracts.

Knowledge is widely regarded as a valuable resource for a firm that is hard to imitate and leads to competitive advantages (Prahalad/Hamel, 1990). In particular, knowledge based view regards knowledge as "the most strategically important of the firm's resources" (Grant, 1996, p. 110). Knowledge accumulates over time through learning by doing and is embedded in the firm's organizational capabilities (Ethiraj et al., 2005). With increasing knowledge, firms tend to become more effective and efficient in the activities they engage in. Conversely, a lack of knowledge has been frequently found to negatively affect project performance (Jiang/Klein, 2000; Gemino/Reich/Sauer, 2008; Jun/Qiuzhen/Qingguo, 2011). In the case of IS outsourcing projects, vendors accumulate technical knowledge (Bharadwaj, 2000) in the design and implementation of their solutions. As ERP software, e.g., core banking software, is highly industry-specific (Davenport, 1998; Markus/Tanis, 2000), we argue that learning will occur with repeated interactions within the same industry, increasing an ERP vendor's technical knowledge. Knowledge-enabled efficiency gains and price premia should positively affect vendor profitability. Given the two different contractual regimes, this association should be stronger in FP contracts. Thus, we hypothesize:

Hypothesis 3 (H3): There will be a greater positive association between industry knowledge and vendor profitability in FP contracts than in TM contracts.

In addition to industry-specific knowledge, vendors will also accumulate client-specific knowledge through repeated interactions with the same client (Ethiraj et al., 2005; Gefen/Wyss/Lichtenstein, 2008). While industry-specific knowledge relates mainly to technical knowledge, client-specific knowledge relates to knowledge of the client's business environment and its operating routines (Ethiraj et al., 2005). Literature sources argue that client-specific knowledge enables vendors to reduce risk in IS outsourcing projects by allocating the right resources to the client (Gefen/Wyss/Lichtenstein, 2008) and simplifying communication between the client and the vendor (Williamson, 1979). In the case of ERP projects, knowledge about the client's legacy systems might prove particularly valuable for the vendor: As the design of interfaces to legacy systems is often considered a major risk factor in ERP projects (Markus/Tanis, 2000; Sumner, 2000), knowing the characteristics of the client's legacy systems, will help the vendor to avoid completion delays and the associated higher costs. Closely linked to the concept of client-specific knowledge is the concept of trust that develops through repeated interactions with the same client (Gefen/Wyss/Lichtenstein, 2008). Trust reduces the necessity of specifying costly governance mechanisms, e.g., extensively detailed contracts (Gefen/Wyss/Lichtenstein, 2008). Both client-specific knowledge and the trust that comes with it will allow the vendor to operate more efficiently and to demand higher prices (Ethiraj et al., 2005). Again, given two contractual regimes, the effects of client-specific knowledge should be greater in FP contracts. We hypothesize:

Hypothesis 4 (H4): There will be a greater positive association between client knowledge and vendor profitability in FP contracts than in TM contracts.

7.4 Methodological Approach

7.4.1 Research Site and Data Collection

Our industry partner ALPHA is a major vendor in the ERP software market. ALPHA develops and distributes its own ERP software. Additionally, it offers implementation as well as post-implementation services to clients from a vast range of industries. These services are conducted as projects. We follow the definition of Pressman (2005) in defining an IS project as a separate and identifiable series of tasks or activities undertaken to achieve a specific IS objective within certain technical specifications, with relatively well-defined start and end dates.

We tested our hypotheses on an archival dataset of ALPHA, containing all projects of ALPHA's German consulting unit conducted between 2004 and 2011. The raw data consisted of 42,704 records. Because of our focus on domestic outsourcing, we excluded projects with clients from Austria and Switzerland and ALPHA internal projects (n=2,434 records). We also excluded records which did not match our definition of a project, e.g., workshops without any technical specifications and projects conducted with hybrid contract type (n=2,478). We excluded projects for which we could not identify the client, and consequently could not determine employee or industry values (n=3,194). Following the recommendations by Eriksson et al. (2006), we corrected for outliers by discarding one per cent of each, the highest, and the lowest profitability values (n=690). The remaining dataset comprises 33,908 projects from 2,227 different clients. A TM contract was used for 30,507 projects and 3,401 projects were conducted using a FP contract. The projects cover a broad range of industries with a focus on manufacturing (45%), services (17%), and finance, insurance and real estate (17%). The variable descriptions are given in Table 35.

Variable	Description and measurement
Vendor profitability	The share of project profits on project revenues times hundred.
Project uncertainty	The absolute value of the share of realized project revenues on planned project revenues multiplied by one hundred.
Project duration	The time between project start and project end measured in days.
Project budget	The net project budget in EUR as stated at project start.
Industry knowledge	The number of previous projects conducted by ALPHA within the same industry.
Client knowledge	The number of previous projects conducted by ALPHA with the same client.
Client size	The number of employees the client has in the year the project was begun.
Relative market share	ALPHA's revenues divided by the revenues of ALPHA's biggest competitor in a given year.
Year	The year in which the project was started.
Industry	The SIC major group to which a client is assigned.

Table 35. Descriptions of Variables

ALPHA monitors their projects very closely. Most of our data is project-level data from ALPHA's controlling system, which is used to keep track of project revenues and costs. We extracted the client's name, the planned and realized project revenues, the project duration, the year of project begin and the profit margin directly from the system. The client's industry and size as well as ALPHA's relative market share at the time of each project were obtained using external company databases. Based on these values we calculated proxies for industry knowledge, client knowledge and uncertainty. The descriptive statistics of the metric variables are given in Table 36 and Table 37.

FP sample (N = 3,401)					
Variable	**Unit/ Scale**	**Min**	**Max**	**Mean**	**SD**
Vendor profitability[1]	%	-11.50	78.64	37.38	16.59
Project uncertainty	%	0.00	674.23	1.11	13.73
Project duration	# of days	1.00	1,368.00	170.99	161.14
Project budget	‘000 EUR	1.04	9,647.05	84.26	367.42
Industry knowledge	# of projects	0.00	6,283.00	1,474.01	1,385.02
Client knowledge	# of projects	0.00	1,154.00	143.25	223.86
Client size	# of employees	1.00	511,292.00	67,912.00	113,144.00
Relative market share	%	28.53	32.75	31.11	1.41

[1] For reasons of confidentiality we multiplied the values for the profit margin by a constant factor.

Table 36. Descriptive Statistics for FP Contracts

TM sample (N = 30,507)					
Variable	**Unit/ Scale**	**Min**	**Max**	**Mean**	**SD**
Vendor profitability[1]	%	-11.99	77.79	28.82	9.68
Project uncertainty	%	0.00	2,565.19	26.51	40.18
Project duration	# of days	1.00	2,191.00	172.36	180.78
Project budget	‘000 EUR	1.02	27,183.00	58.04	280.93
Industry knowledge	# of projects	0.00	6,287.00	1,170.35	1,328.19
Client knowledge	# of projects	0.00	1,147.00	85.53	145.24
Client size	# of employees	1.00	511,292.00	54,855.78	106,202.40
Relative market share	%	28.53	32.76	31.38	1.23

[1] For reasons of confidentiality we multiplied the values for the profit margin by a constant factor.

Table 37. Descriptive Statistics for TM Contracts

In contrast to previous studies (Gopal et al., 2003; Ethiraj et al., 2005; Gopal/Sivaramakrishnan, 2008), our data set allows us to employ a project's profit margin instead of absolute vendor profits as a measure of vendor profitability. The profit margin was extracted directly from the system and is calculated by multiplying the share of project profits on project revenues by 100. ALPHA's relative market share in a given year was calculated by dividing ALPHA's revenues by the revenues of ALPHA's biggest competitor. ALPHA's competitors and their revenues were obtained using yearly rankings of the Top-25 ERP vendors in Germany (Luenendonk, 2012). Industry knowledge was calculated as the number of previous projects conducted by ALPHA within the same industry according to the major group level of the Standard Industry Classification (SIC). In a similar way, we approximated client knowledge by calculating the number of previous projects conducted by ALPHA with the same client (Gopal et al., 2003; Ethiraj et al., 2005; Gopal/Sivaramakrishnan, 2008). As we did not have access to projects conducted prior to 2004, it should be noted that our approximations with regard to industry and client knowledge have to be seen as lower boundaries. Client size was measured using the client's number of employees at the beginning of the project (Gopal et al., 2003; Gopal/Sivaramakrishnan, 2008) which we obtained using external company databases. Project uncertainty was approximated using the absolute value of the share of realized project revenues on planned project revenues times 100 (Ethiraj et al., 2005; Sauer/Gemino/Reich, 2007). Deviations of realized project revenues from planned project revenues are frequently the result of scope changes during the projects and thus a good proxy for volatility and project uncertainty (Sauer/Gemino/Reich, 2007).

7.4.2 Data Analysis

We tested our hypotheses using the following ordinary least squares specification:

$$\textit{Vendor profitability}_i = \alpha_i + \beta_1 \textit{ project uncertainty}_i + \beta_2 \ln(\textit{project budget}_i) + \beta_3 \ln(\textit{project duration}_i) + \beta_4 \ln(\textit{industry knowledge}_i{+}1) + \beta_5 \ln(\textit{client knowledge}_i{+}1) + \beta_6 \ln(\textit{client size}_i) + \beta_7 \textit{ relative market share}_i + \beta_8 \textit{ year}_i + \beta_9 \textit{ industry}_i + \beta_{10} \lambda_i + \varepsilon_i$$

where i indexes the individual projects and ε_i is an error term. To reduce skewness, the variables project budget, project duration, industry knowledge, client knowledge, and client size were log-transformed (Hair et al., 2006). It is important to note that contract type is potentially endogenous (Gopal et al., 2003; Gopal/Sivaramakrishnan, 2008). In the presence of endogeneity, ordinary least squares estimates are known to be biased and inconsistent (Maddala, 1983). We therefore corrected for endogeneity using the two stage procedure proposed by Heckman (1979) and outlined in Hamilton/Nickerson (2003). In the first stage, a probit specification was used to capture the effects of the independent variables on contract type. Using these results, we then calculated the inverse Mill's ratio. In the second stage, the inverse Mill's ratio was included in the profitability equation as an additional variable (λ_i). The inverse Mill's ratio was not significant in both models, suggesting no significant endogeneity (Shaver, 1998). Nonetheless, we included the inverse Mill's ratio in the models to correct for the bias that could potentially arise from an endogenous contract choice (Gopal/Sivaramakrishnan, 2008).

Estimation results are shown in Table 38. As proposed by Shaver (1998), we contrasted the endogeneity-corrected results with the uncorrected results as an additional check for robustness. Because some clients engaged in multiple projects, we used clustered standard errors. No assumptions underlying ordinary least squares were rejected: There was no sign of heteroscedasticity. The highest variance inflation factor (VIF) was 2.81, which is below the commonly used thresholds (Hair et al., 2006), suggesting no multicollinearity (Belsey/Kuh/Welsch, 1980). Because the detrimental effects of non-normality are reduced in large samples, we had no reason to be concerned about the slight deviation from normality in the TM-model (Hair et al., 2006).

	FP subsample (N = 3,401)		**TM subsample** (N = 30,507)	
Independent variables	**OLS coefficients**	**Endogeneity-corrected coefficients**	**OLS coefficients**	**Endogeneity-corrected coefficients**
Intercept	80.037* (31.226)	79.902* (32.96)	65.764*** (9.074)	66.294*** (9.071)
Project uncertainty	-0.021 (0.023)	-0.021 (0.025)	-0.007*** (0.002)	-0.008*** (0.002)
ln(Project budget)	-3.654*** (0.386)	-3.654*** (0.294)	-0.875*** (0.113)	-0.876*** (0.114)
ln(Project duration)	3.070*** (0.558)	3.070*** (0.378)	-0.727*** (0.096)	-0.728*** (0.096)
ln(Industry knowledge+1)	1.031* (0.487)	1.103** (0.340)	0.451** (0.156)	0.452** (0.156)
ln(Client knowledge+1)	-0.604 (0.752)	-0.604† (0.310)	-0.427* (0.204)	-0.427* (0.204)
ln(Client size)	-0.864** (0.311)	-0.864*** (0.222)	-0.100 (0.136)	-0.100 (0.136)
Relative market share	-1.840* (0.920)	-1.843† (1.035)	-0.962*** (0.258)	-0.961*** (0.258)
Year	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$
Industry	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.01$
λ	–	0.094 (3.205)	–	1.865 (1.225)
F (d.f.)	20.52*** (22; 3,377)	19.64*** (23; 3,376)	89.85*** (22; 30,484)	86.05*** (23; 30,483)
R^2 (adj.)	0.118 (0.112)	0.118 (0.112)	0.061 (0.060)	0.061 (0.060)

d.f. = degrees of freedom, *** = significant at the 0.1% level, ** = significant at the 1% level, * = significant at the 5% level, † = significant at the 10% level. Clustered standard errors.

Table 38. Split-Sample Results by Contract Type

The adjusted R^2 for the FP-model is 0.112. Uncertainty seems to have no effect on profitability. Project budget and client knowledge are significantly negatively associated with vendor profitability. Project duration and industry knowledge are significantly positively associated with vendor profitability. The inverse Mill's Ratio is not significant indicating no significant endogeneity (Shaver, 1998).

The adjusted R^2 for the TM-model is 0.060. Uncertainty, project budget, project duration, and client knowledge are significantly negatively associated with vendor profitability. Industry knowledge is significantly positively associated with vendor profitability. The inverse Mill's Ratio is again not significant indicating no significant endogeneity (Shaver, 1998).

Both models are highly significant at the 0.1% level. In both endogeneity-corrected models neither the signs nor the significance of the coefficients change compared to the standard models, suggesting robust results.

7.5 Discussion

7.5.1 Summary of Results

The rationale of our analysis was to investigate the effect of theoretically grounded determinants of vendor profitability in ERP projects under two different contractual regimes. We tested our hypotheses on a unique archival dataset of 33,908 projects from a major ERP vendor. Our results suggest that there indeed exist two different contractual regimes with greater effect sizes in FP contracts than in TM contracts.

We find tentative support for our hypothesis H1 (*There will be a greater negative association between project uncertainty and vendor profitability in FP contracts than in TM contracts*). While FP contracts are more negatively affected by project uncertainty than TM contracts, the association is only significant in the TM sample. We argue that ALPHA is able to manage uncertainty particularly well in FP projects, probably because ALPHA assigns more experienced project managers to these projects. This is in line with the rationale provided by Kalnins/Mayer (2004).

We find mixed support for our hypothesis H2 (*There will be a greater negative association between project size and vendor profitability in FP contracts than in TM contracts*). Our findings show a highly significant negative effect of project budget on vendor profitability, which is greater in FP contracts, thus fully supporting H2. However, while project duration significantly negatively affects vendor profitability in TM-based projects, we find a highly significant positive effect of project duration on vendor profitability in FP contracts, which does not support H2. A possible explanation for this surprising result is that project budget and project duration are indeed two different dimensions of project size (Sauer/Gemino/Reich, 2007). While project budget seems to increase complexity and task interdependence (Yetton et al., 2000; Gemino/Reich/Sauer, 2008), project duration might actually provide additional flexibility in that vendors can better react to unforeseen contingencies and fully leverage their pools of resources. Vendors might be able to effectively convince the client to pay higher prices in FP contracts because external influences become more apparent as project duration increases. This line of reasoning may not be put forward by the vendor in TM contracts where the client bears the major risk.

In strong support of hypothesis H3 (*There will be a greater positive association between industry knowledge and vendor profitability in FP contracts than in TM contracts*) we find a significant positive effect of industry knowledge on vendor profitability in both types of contract. The effect size is around three times larger in FP-based projects than in TM-based projects. Our results suggest that with repeated interactions within one industry, ALPHA accumulates technical knowledge that allows for more efficient project operations. Industry knowledge is likely to be particularly valuable for the vendor in the case of ERP software, which is specifically designed to fit the needs of a given industry (Markus/Tanis, 2000).

Our results do not support H4 (*There will be a greater positive association between client knowledge and vendor profitability in FP contracts than in TM contracts*). While the effect size of client knowledge is greater in the FP sample, we find significant negative effects of client knowledge on vendor profitability in both contractual regimes. Given the strong theoretical underpinning that repeated interactions with the same client should lead to knowledge and trust-related benefits for the vendor (Gefen/Wyss/Lichtenstein, 2008), this result is surprising. Our findings are, however, consistent with the empirical evidence presented in Gopal et al. (2003). Post-hoc interviews with ALPHA's risk managers suggested a plausible explanation for this: in repeated interactions with the same client, the rising technical complexity of more specialized ERP modules outweighs the knowledge and trust-related benefits. Apart from that, it seems likely that as the client becomes more familiar with the vendor's capabilities and cost structures, the vendor's potential to seek rents from private information decreases (Gefen/Wyss/Lichtenstein, 2008).

7.5.2 Study Limitations

We acknowledge two study limitations. Firstly, because our data stems from one ERP vendor only, issues concerning the generalizability of our results have to be taken into account. Although, ALPHA's considerable market share makes our sample reasonably representative of German ERP outsourcing projects, our findings might not be transferable to other ERP vendors. ALPHA's distinct set of resources might enable it to more efficiently handle contingencies related to project uncertainty or project size or to better exploit industry- and client-specific knowledge than other vendors. This might result in idiosyncratic effects for the analyzed determinants of vendor profitability. In this regard, ALPHA's advanced project management and technical capabilities might distinguish it from other ERP vendors.

Secondly, our selection of independent variables is almost certainly theoretically incomplete. The low adjusted R^2 values of both our models suggest that only a small portion of the variance in vendor profitability can be explained by our independent variables. Other important determinants of vendor profitability may include the specificity of the ERP project or control variables such as the competitive situation during the bid phase. However, low values of adjusted R^2 are not uncommon in social sciences (Wooldridge, 2002a). As our focus in this paper is not to predict vendor profitability but rather to test theoretically grounded relationships, we are more interested in reliable estimates of the ceteris paribus effects of our independent variables (Wooldridge, 2002a).

7.5.3 Contributions to Research

This paper advances the understanding of vendor profitability in IS outsourcing projects by confirming and extending previous research. Our research confirms the existence of two distinct contractual regimes as proposed by Gopal/Sivaramakrishnan (2008). The effect of our independent variables on vendor profitability differs considerably if the contract is of the FP or TM type.

In particular, our results confirm the finding by Ethiraj et al. (2005) that uncertainty in projects, as indicated by the difference between actual and estimated budget, negatively affects vendor profitability in both contractual regimes. Ethiraj et al. (2005) interpret differences between actual and estimated budget as a consequence of missing project management capabilities on the vendor's side. Given ALPHA's distinct project management capabilities, it is not surprising that the effect of uncertainty on vendor profitability is quite small in our sample.

Our findings are consistent with previous research (Gopal et al., 2003) in showing that client knowledge tends to be negatively associated with vendor profitability. While this is counter-intuitive at first glance, post-hoc interviews with risk managers at ALPHA offered a plausible explanation. In repeated interactions with the same client, projects tend to become more complex. The increased technical complexity in these projects seems to outweigh the benefits that occur through increased trust and knowledge in repeated interactions. This explanation in particular holds true for ERP projects in which an initial implementation of an ERP platform is followed by more customized and more complex modules.

To the best of our knowledge, our study is the first to analyze determinants of vendor profitability in domestic packaged software implementation outsourcing as called for by Gopal et al. (2003). Previous research exclusively focused on offshore software development outsourcing (Gopal et al., 2003; Ethiraj et al., 2005; Gopal/Sivaramakrishnan, 2008; Gopal/Koka, 2012).

Our results contribute to the existing literature by re-conceptualizing vendor profitability. In contrast to previous studies (Gopal et al., 2003; Ethiraj et al., 2005; Gopal/Sivaramakrishnan, 2008; Gopal/Koka, 2012), which use absolute profits as a proxy for vendor profitability, we employed the ratio of project profits to project revenues, i.e., the profit margin, as our dependent variable. The profit margin is in some respect a more precise indication of vendor profitability than absolute profits as it comprises the notion of efficient resource allocation. Given our re-conceptualization of vendor profitability, we arrived at different results concerning the association between project size and vendor profitability. It is not surprising that project size drives absolute vendor profits (Gopal et al., 2003; Ethiraj et al., 2005; Gopal/Sivaramakrishnan, 2008; Gopal/Koka, 2012): Absolute vendor profits are naturally higher in larger and longer projects. However, it is less intuitive that project size should drive vendor profitability in terms of the profit margin. Project size is known to increase organizational complexity and drive budget and schedule overruns (Sauer/Gemino/Reich, 2007) and therefore should reduce the vendor's profit margin. Furthermore, the benefits that the vendor tends to gain from large projects, e.g., reputational gains or long-term utilization of staff, should induce the vendor to offer price discounts which further decrease the vendor's profit margin. Our data strongly support this hypothesis. In contrast to previous studies (Gopal et al., 2003; Ethiraj et al., 2005; Gopal/Sivaramakrishnan, 2008; Gopal/Koka, 2012), we find a negative effect of project size (in terms of effort) on vendor profitability. Surprisingly, our results are mixed with regard to the association between project size in terms of project duration and vendor profitability. While in FP-based projects, duration seems to have a positive effect on vendor profitability, we find a negative effect in TM-based projects. We see two plausible explanations for this: First, the vendor might be able to react more flexibly to unforeseen contingencies in longer-term FP contracts. Because the vendor bears the lion's share of the financial risk in FP contracts, the vendor benefits from the increased flexibility that comes with longer project durations in FP projects only. Second, longer FP contracts might allow the vendor to negotiate particularly large financial reserves to cope with unforeseen contingencies. Again, this explanation applies to FP contracts only as the vendor's need for financial reserves is considerably lower in TM contracts.

Finally, following the rationale of knowledge based view, our results introduce industry knowledge as an important determinant of vendor profitability in ERP projects. We argue that industry knowledge is particularly important for ERP vendors, as ERP software tends to be standardized within one industry which enables considerable learning effects across clients within the same industry. While there might be positive effects of industry knowledge in software development projects, these effects are likely to be weaker due to their more idiosyncratic nature (Markus/Tanis, 2000).

Our contributions to existing knowledge are strengthened by the unique archival data set used in our analysis. In general, analyses based on archival data avoid common method bias (Podsakoff et al., 2003) and may thus provide better estimations of coefficients and explained variance (Gefen/Wyss/Lichtenstein, 2008). The value of archival data seems to be acknowledged when analyzing vendor profitability in outsourced IS projects (Gopal et al., 2003; Ethiraj et al., 2005; Gopal/Sivaramakrishnan, 2008; Gopal/Koka, 2012). When compared to previously used archival data sets, our data set stands out in terms of its size, its breadth, and its up-to-datedness. With a sample size of 33,908 projects, we are able to find considerable variation in our independent variables, allowing for more precise estimations of their coefficients (Wooldridge, 2002a). The detailed financial data available on revenues and costs of the projects enabled us to investigate vendor profitability in terms of profit margin instead of absolute profits. As previously stated, profit margin is likely to be a more precise indication of vendor profitability than absolute profit. Finally, our data set is based on projects conducted between 2004 and 2011. Thus, it provides us with a fairly recent perspective on the determinants of vendor profitability.

7.5.4 Implications for Practice

By analyzing the effect of project size, project uncertainty, industry knowledge and client knowledge on vendor profitability for two different contractual regimes, our paper provides several managerial implications for vendors.

Given the negative effect of project size (in terms of effort) on vendor profitability in both types of contracts, vendors should try to split larger projects into several smaller ones in order to decrease organizational complexity. Though the association between size and profitability might also stem from discounts on the bid price that the vendor offers to the client in the case of large projects, the complexity effect seems plausible given the frequent budget and schedule overruns in large IS projects (Yetton et al., 2000; Sauer/Gemino/Reich, 2007). As project duration in projects running under a FP contract is positively associated with vendor profitability, vendors should pay attention to negotiate sufficiently ample schedules in order to maintain valuable flexibility in these projects. Alternatively, projects of shorter duration with fixed deadlines should include higher risk premia. In TM-based projects, where the client tends to be responsible for the project management, vendors might try to push for more stringent project control in order to avoid costly schedule overruns. Our analysis points out that reducing project uncertainty tends to result in higher profit margins for the vendor irrespective of contract regime. Even in TM-based projects, where the financial risk is transferred to the client, reducing uncertainty by ensuring clear requirements and project objectives should benefit vendor profitability.

We find modest evidence that vendor profitability decreases in repeat projects with the same client. As increases in complexity might be one reason for this, raising risk premia or establishing a more effective project governance could be options to sustain the profit margin. Finally, our analysis suggests considerable learning effects in repeat projects within the same industry, illustrating the high value of industry-specific knowledge in ERP outsourcing projects for vendors.

7.6 Conclusion

This paper answers the call for more studies on the vendor's perspective in the domain of IS outsourcing (Levina/Ross, 2003; Dibbern et al., 2004). Extending previous research, we investigated the effect of project uncertainty, project size, industry knowledge and client knowledge on the vendor's profit margin in FP and TM contractual regimes. We find that the effect sizes of the determinants of vendor profitability vary considerably across the two contractual regimes. In addition, while project uncertainty, project budget, and client knowledge seem to negatively affect vendor profitability, we find a positive effect with regard to industry knowledge. The effect of project duration is positive in FP contracts and negative in TM contracts. Our findings contribute to the IS outsourcing literature by confirming the existence of two contractual regimes (Gopal/Sivaramakrishnan, 2008) and by providing a more nuanced view on the determinants of vendor profitability in domestic packaged software implementation projects (Gopal et al., 2003).

Future research should look into further determinants of vendor profitability. In particular, investigating the relationship between repeated interactions with the same client, client knowledge and technical complexity would build on the knowledge foundation we have created. Given the considerable importance of the contractual regime in determining vendor profitability, analyzing the effects of other contractual provisions, such as dispute resolutions or rewards and sanctions, on vendor profitability would be of benefits for clients and vendors.

Part C

1 Summary of Results

Based on the assumption that a poor understanding of risks is a major cause for the high failure rates in IS projects, this thesis addresses several research gaps in the field of IS project risk management. We obtained the following research results:

(1) **Differences in risk profiles between ISD and PSI projects:** In addition to national culture, hierarchical roles, and personal experience, the project type also seems to exert considerable influence on a project's risk profile. In P1, we explore this proposition using a Delphi study approach with two different panels representing individual software development (ISD) projects and packaged software implementation (PSI) projects. Our results suggest that ISD projects tend to be more heterogeneous and face a greater variety of risks than the more straightforward PSI projects as indicated by the greater number of risks identified/selected by ISD project managers in phase 1/phase 2 or the greater difficulty of reaching a consensus among ISD project managers in phase 3 of our study. ISD projects in particular seem to be prone to risks related to sponsorship, requirements, and project organization. Furthermore, ISD projects face more risks related to the development process than PSI projects, reflecting the different nature of software development, e.g., a focus on requirements and the way the software is created, when compared to software implementation. In contrast, PSI projects tend to be subject to risks related to technology, project planning, and project completion. These particularities in the risk profile may be due to the fact that PSI projects are often underestimated with regard to technological risks and risks related to project planning because of the use of presumably mature packaged software and their more manageable size, respectively. Irrespective of the type of the project, we find a surprisingly high prominence of technology- and testing-related risks compared to other studies. We see two explanations for this: Either, we can observe a general trend towards more complex information systems, which should be especially true in the financial services industry. Or, the prominence of testing and technology related risks partly reflects a cultural particularity by German engineers, who tend to focus more on technical issues than for example their American or Chinese colleagues.

(2) **Overview on risk and success factors in ERP projects:** In P2 we identified 80 success factors and 68 risk factors in ERP projects. In order to analyze differences in these two fields of research we mapped the factors to twelve categories: Existing environment and systems, planning and strategy, selection and adaption of the ERP system, change management, communication, team work and team composition, external expertise, performance measurement, project champion, project management, roll out and configuration, and top management support. Though some topics are equally important in risk and success factor research, the literature on risk factors emphasizes topics that relate to achieving budget, schedule and functionality targets. In particular, literature on risk factors highlights the category roll out and configuration, which comprises many technology-related risks, such as complex data conversion or heterogeneous legacy systems. In contrast, the literature on success factors seems to concentrate more on strategic and organizational topics. By drawing

an analogy to Herzberg's (1968) Two-Factor-Theory about motivation at work we propose a perspective that helps understand the different foci of these two streams of research: While risk factor literature may emphasize factors related to achieving project success, success factor literature may emphasize factors related to achieving business success.

(3) **Ranking of risk factors in ERP projects from a vendor's perspective:** In P3, we compile a relative ranking of risk factors based on an archive of project risk reports from a major ERP vendor and compare it to extant rankings. In contrast to previous research that ranks project management and the social subsystem as most important risk domains (Schmidt et al., 2001; Wallace/Keil/Rai, 2004a), our analysis emphasizes technology-related risk factors, substantiating the results of P1 and P2. Amongst the important technology-related risk factors are: An inadequate technical infrastructure at the client's site, unstable software components of the pre-packaged software solution, a complex system architecture at the client's site, expected performance issues due to high transaction volumes, and functionality gaps in the pre-packaged software solution. Further important risk factors that highlight the specific perspective of the vendor comprise customer financial obligations and non-TM payment terms. In addition to the ranking, we explore two mechanisms that influence the priority of risk factors in our data: controllability and micro-political bias. We speculate that the prominence of technology-related risks may be driven by these two mechanisms because they allow the project managers to absolve themselves from responsibility for project failure.

(4) **Temporal characteristics of risks in ERP projects from a vendor's perspective:** The purpose of P4 is to explore how the perceived importance of ERP project risks evolves over time. While much research is available on the domains of risks, little is known about their temporal nature. Gemino/Reich/Sauer (2008) explicitly suggest further investigating the temporal perspective. Based on a review of extant research in this field, P4 analyzes a large archive of risk assessments recorded during the project risk management process in ERP projects. We employ a five-phase process model in order to investigate variations in risk assessments/importance over project phases. Our findings are threefold: First, we find that risk exposure indeed varies across project phases, i.e., risks vary in importance over time. Second, there exist quite heterogeneous degrees of volatility, i.e., some risks vary more than others. Third, risks exhibit synchronous changes in risk exposure over time, i.e., they "move" in similar patterns. This latter finding substantiates the notion of interdependencies between risks that is investigated in more detail in P6. In sum, P4 establishes a descriptive and exploratory view on the temporal characteristics of risks in ERP projects from a vendor's perspective.

(5) **Determinants of the vendor's risk estimation in ERP projects:** P5 seeks to investigate the role of transaction characteristics in determining the vendor's risk estimation. Based on a subset of the archival data set used in P3 and P4 (81 outsourced ERP projects), we regress the vendor's overall estimation of a project's risk to a selection of transaction characteristics. Notably, our results show that not all transaction characteristics are included in the vendor's risk estimation. While we

found that the transaction characteristics project size and contract type are included in the vendor's risk estimation, strategic importance and client familiarity are not: On average, the vendor perceives larger projects and projects with a FP contractual regime as riskier. On the contrary, the strategic importance and client familiarity have no effect on the vendor's risk estimation. Furthermore, we tested the efficiency of the vendor's risk estimation by linking it to project profitability. Our findings suggest that the vendor's risk estimation is efficient with regard to the two characteristics included in the risk estimation, i.e., project size and contract type. Finally, we found that – while having no effect on the vendor's risk estimation – strategic importance significantly affects project profitability. This suggests that in strategic projects vendors deliberately accept lower project profitability and adjust their margin requirements prior to estimating project risk.

(6) Risk scenarios affecting vendor profitability in ERP projects: In P6, we use a multiple case study approach to investigate interrelations between risk factors in ERP projects and vendor profitability, which is an essential success dimension of a vendor. Our analysis is based on archival records, semi-structured interviews, and documents from five purposefully selected ERP projects from a major ERP vendor. Using causal networks and cross-case analysis (Miles/Huberman, 1994), we derive four different risk scenarios that threaten the vendor's profitability: (1) Deficits in vendor obligations, (2) deficits in client obligations, (3) disagreement concerning scope and requirements, and (4) client negotiation power. The four risk scenarios illustrate interrelations between risk factors that eventually negatively affect vendor profitability. Furthermore, our analysis suggests that one of the risk scenarios – the client's negotiation power – moderates the impact of risk factors on vendor profitability: In cases of high client negotiation power, the negative effect of risk factors on vendor profitability is reinforced. Contrary, in cases of low client negotiation power the effect is attenuated. The moderating role of client negotiation power originates in the fact that the project contract can not specify responsibilities for each and every contingency. Instead, these responsibilities frequently have to be negotiated during the project. Finally, not surprisingly, our findings also show that vendor profitability is particularly under threat when, over time, multiple risk scenarios affect the project.

(7) Determinants of vendor profitability in ERP projects: P7 investigates the effect of project uncertainty, project size, industry knowledge and client knowledge on the vendor's profit margin in FP and TM contractual regimes. Again leveraging the comprehensive data archive used in the previous publications, we regress the vendor's project profit margin to the above mentioned determinants of vendor profitability. Our results show that the effect sizes of the determinants of vendor profitability vary considerably across FP and TM contracts. This is in line with previous research on contractual regimes (Gopal/Sivaramakrishnan, 2008). Gopal/Sivaramakrishnan (2008) suggest that FP and TM contracts exhibit fundamentally different characteristics and, thus, are also governed in different ways by the contracting parties. As expected, in both contractual regimes project uncertainty and project size (in terms of the project budget) negatively affect vendor profitability while industry knowledge positively affects vendor profitability. Surprisingly and in contrast to our hypotheses, however, our results show that vendor profitability a) is significantly negatively affected by client familiarity in both contractual regimes and b) is significantly positively affected by project duration in FP contracts and significantly negatively affected by project duration in TM contracts.

Table 39 gives an overview on the key findings of this thesis.

Publication	Findings

P1	• Differences in risk profiles between ISD and PSI projects
	  o ISD projects face a greater variety of risks
	  o ISD projects are particularly prone to risks related to the requirements, the development process, to the project organization, and to sponsorship
	  o PSI projects are particularly prone to risks related to technology, project planning, and project completion
	• High prominence of technology- and testing-related risks in general

P2	• Overview on risk and success factors in ERP projects (80 success factors, 60 risk factors, categorized into 12 categories)
	• Differences between risk and success factor research
	  o Literature on risk factors focuses on technology-related factors (category roll out and configuration)
	  o Literature on success factors emphasizes more strategic and organizational factors (categories planning and strategy, top management support)
	• Commonalities between risk and success factor research
	  o Factors related to the selection and adaption and to change management are considered highly important
	  o Factors related to communication, the project champion, performance measurement, and the existing environment are considered less important

P3	• Empirical ranking of risk factors in ERP projects from a vendor's perspective o Ranking emphasizes technology-related risk factors instead of process and people related risk factors • Speculation about two mechanisms, controllability and micro-political bias, that provide explanations for discrepancies in risk rankings

P4	• Temporal characteristics of risk factors
	  o Risk exposure varies across project phases
	  o Risk exposure varies with different degrees of volatility depending on the risk factor
	  o Groups of risk factors exhibit synchronous changes in risk exposure over time

P5	• Effects of transaction characteristics on the vendor's risk estimation
	  o Project size and contract type are included in the vendor's risk estimation
	  o Strategic importance and client familiarity are not included in the vendor's risk estimation
	• Efficiency test of the vendor's risk estimation
	  o The vendor's risk estimation is efficient with regard to contract type and project size

	○ There exist strategic projects where the vendor deliberately accepts lower profitability
P6	• Four scenarios how risks interrelate and eventually affect vendor profitability ○ The scenarios relate to high deficits in vendor obligations, high deficits in client obligations, strong disagreement concerning scope and requirements, and high client negotiation power ○ Client negotiation power seems to moderate the effect of the three other scenarios on vendor profitability
P7	• Effects of five hypothesized determinants of vendor profitability in two contractual regimes • Differences between the contractual regimes ○ Project uncertainty negatively affects vendor profitability in TM contracts only, there is no effect in FP contracts ○ Project duration negatively affects vendor profitability in TM contracts, and positively in FP contracts • Commonalities between the contractual regimes ○ Project volume negatively affects vendor profitability ○ Industry knowledge positively affects vendor profitability ○ Client knowledge negatively affects vendor profitability

Table 39. Overview on Key Results

2 Contributions

On a general level, this thesis contributes to the field of ISPRM by addressing four challenges that are not addressed by extant research, i.e., by (1) specifically investigating ERP projects instead of IS projects in general, by (2) focusing on the vendor's perspective instead of the client's perspective, by (3) leveraging secondary instead of primary data, and by (4) leveraging longitudinal instead of cross-sectional data. In the following, more specific contributions to theory and practice are discussed.

2.1 To Theory

In his paper on what constitutes a theoretical contribution, Whetten (1989) proposes four building blocks of theory development: (1) the variables that should be included in explaining a phenomenon of interest, (2) the relationships between these variables, (3) the reasoning behind these relationships, and finally, (4) the subject-related, geographical, and temporal boundaries under which a theory is valid. In the following, we summarize the theoretical contribution of this thesis and its embedded publications alongside these building blocks[14].

– **Variables:** Publication P1 highlights the project type as an important variable that shapes IS project risk profiles. By providing an integrated perspective, comparing both project types in one study, P1 extends prior work on specific checklists for either ISD (e.g., Boehm, 1991; Barki/Rivard/Talbot, 1993; Moynihan, 1997; Reed, 2012) or PSI projects (e.g., Sumner, 2000; Finney/Corbett, 2007; Chen/Law/Yang, 2009). Publication P2 suggests that the problem framing (positive vs. negative) (Sitkin/Weingart, 1995) is another variable that shapes the perception of the determinants of IS project success, i.e., risk factors and success factors. Assuming that risk factor research is based on a rather negative problem framing (as suggested by the term risk) and success factor research is based on a rather positive problem framing (as suggested by the term success), P2 elaborates on the different foci of these research streams. Publication P5 introduces the vendor's risk estimation as an important variable that is influenced by transaction characteristics that are knowable before the transaction takes place. Prior research has investigated the effect of transaction characteristics on relationship quality (e.g., Poppo/Zenger, 2002; Gefen/Wyss/Lichtenstein, 2008) and risk factors (e.g., Wallace/Keil/Rai, 2004a; Gemino/Reich/Sauer, 2008). To the best of the author's knowledge P5 is the first empirical study that investigates the association between transaction characteristics and the vendor's risk estimation. P5 also suggests that the vendor's risk estimation is

[14] It is important to note that there seems to be no academic consensus as to how an explicit theory of project management should look like and whether there exists one at the moment (Turner, 2006b; Turner, 2006c; Turner, 2006a; Turner, 2006d; Sauer/Reich, 2007). As a consequence, publications P1 to P6 do not contribute to one specific theory but rather to the general project management body of knowledge. An exception to this is publication P7, which takes a more strategic perspective than publications P1 to P6. In contrast to literature on project management, literature on strategic management offers various theories as reference frames for researchers (Sauer/Reich, 2007). P7 builds on and contributes to RBV / KBV and TCE.

efficient with regard to two transaction characteristics project size and contract type, i.e., includes all the information available to the vendor at the time of estimation. Building on work by Whang (1995), P5 also explores the role of strategic importance in determining vendor profitability. Publication P6 further elaborates on these results, slightly shifting the focus to client negotiation power, a variable closely related to a project's strategic importance as perceived by the vendor. P6 substantiates the role of client negotiation power as an important determinant of vendor profitability (Gopal et al., 2003; Gopal/Sivaramakrishnan, 2008). Finally, publication P7 supports prior research on determinants of project success, i.e., the importance of contract type (e.g., Lacity/Hirschheim, 1993; Gopal et al., 2003), project size (e.g., McFarlan, 1981; Ropponen/Lyytinen, 2000; Sauer/Gemino/Reich, 2007), project uncertainty (e.g., Zmud, 1980; McFarlan, 1981; Nidumolu, 1995), and client knowledge (e.g., Ethiraj et al., 2005; Gefen/Wyss/Lichtenstein, 2008). Drawing on KBV, P7 introduces industry knowledge as an important driver of vendor profitability in ERP projects.

– **Relationships:** Publication P1 illustrates how characteristics of two different types of IS projects, i.e., ISD and PSI projects, influence the risk profiles of these two project types. For instance, P1 suggests that ISD projects, in which new software is developed from scratch, are more prone to requirements risks than PSI projects, which implement pre-packaged software. Publication P2 highlights how the different problem framings (Sitkin/Weingart, 1995) of two streams of research that investigate determinants of project success, i.e., risk factor and success factor research, may affect the prioritization of these determinants. A rather negative problem framing as commonly applied in risk factor research tends to emphasize issues related to achieving budget, schedule and functionality targets; risk factor research may thus be said to focus on avoiding project failure; in contrast, a rather positive problem framing as applied in the success factor research tends to emphasize issues related to strategic and organizational issues, thus focusing on achieving project success. Publication P3 illustrates how a change of perspective, i.e., from the client's perspective to the vendor's perspective, may affect the risk profile of a project. In contrast to clients, ERP vendors in particular seem to perceive technical issues, e.g., related to the client's legacy systems, their own pre-packaged software solution, or the new system, and contractual issues, e.g., the type of contract or the client's ability to meet its financial obligations, as threat to project success. Taking up the notion of dynamic project risks (Gemino/Reich/Sauer, 2008), publication P4 reveals various temporal characteristics of ERP project risks from a vendor's perspective: risks tend to vary in risk exposure over time and also exhibit different volatilities. In addition, P4 identifies nine clusters that group risks that behave similarly over time. In sum, P4 illustrates how time affects the perceived importance of project risks. Publication P5 further elaborates on the relationship between project size and contract type and the vendor's risk estimation: not surprisingly, both, larger projects and FP contracts tend to be positively associated with the vendor's risk estimation. P5 also illustrates the negative effect of strategic importance on vendor profitability providing empirical support for vendor low balling strategies in the ERP outsourcing market (Whang, 1995): in strategically important projects, ERP vendors seem to forgo profitability targets in favor of more strategic ones, such as entering new markets or crowding out competitors. Publication P6 explores how various risks in ERP projects from a vendor's perspective are interrelated and thus advances theory building in the discipline of IS project risk management (Akkermans/van Helden, 2002). P6 groups the causal streams of risks that emerged from a cross-case analysis into four risk scenarios that illustrate how risks eventually negatively affect vendor profitability. P6 also demonstrates how client negotiation power moderates the effect of three risk scenarios on vendor profitability: In cases of high client negotiation power the negative effects of risk scenarios on vendor profitability tend to get reinforced. Publication P7 illustrates how the effects of selected determinants of vendor profitability differ according to the contractual regime underlying the project, thus extending prior empirical work on contractual regimes in the domain of software development outsourcing (Gopal/Sivaramakrishnan, 2008). P7 confirms the negative association between the TCE-based variable project uncertainty and vendor profitability. Furthermore, P7 generates new insights with regard to the association of project size and vendor profitability: While larger projects in terms of volume seem to be negatively associated with vendor profitability, the project duration is positively associated with vendor profitability in FP contracts, and negatively associated with vendor profitability in TM contracts. Contributing to RBV, P7 also suggests that the vendor's knowledge of the industry is positively associated with the vendor's profitability, a relationship not explored in prior research. This probably reflects a characteristic of the ERP outsourcing market where industry-specific but client-generic software solutions exists. Finally, P7 also confirms the counter-intuitive negative association between client knowledge on vendor profitability, suggesting that with repeated interactions with the same client, other variables, such as technical complexity or client negotiation power, also gain importance in determining vendor profitability.

- **Reasoning:** Publication P4 provides rationales for the associations between risks and vendor profitability by substantiating many of the interrelations with interview quotes that indicate why the interrelations exist. Thus, P4 further increases our understanding of the causes and effects of risks in ERP projects from a vendor's perspective. Much of the previous research on risks has – with few exceptions (e.g., Akkermans/van Helden, 2002) – simply assumed that risks work in isolation.

- **Boundaries:** In addition to the above mentioned contributions, publications P3 and P4 also provide some insights on the boundaries of research on risks in IS projects: P3 substantiates the notion that perspective, i.e., who analyzes project risks, matters. Extending the research by Liu et al. (2010) and Warkentin et al. (2009), who investigated differences in risk perception between senior executives, software developers, and project managers, P3 provides a prioritized ranking of risks in ERP projects from a vendor's risk manager's perspective. Thereby, P3 illustrates a subject-related boundary of previous rankings that mainly reflect the client's perspective. In a similar vein, P4 illustrates a temporal boundary under which previous rankings of IS project risks are valid. Much of the previous research on risks in IS projects is of cross-sectional nature. Extant rankings of risks mostly reflect the status-quo after project completion. P4 questions the value of one-time, static lists of risks and suggests that the priority of risks varies depending on the point in time during the project life-cycle. In doing so, P4 further elaborates on the assumptions by

Gemino/Reich/Sauer (2008) that risks vary over time and provides a starting point for more sophisticated cause-and-effect models of IS project risks.

2.2 To Practice

Based on the results of this thesis, we derive the following guidelines for vendor risk and project managers in IS projects:

- **Manage risks:** The results of publication P5 suggest that experienced risk managers are able to efficiently estimate overall project risk stemming from certain transaction characteristics, such as project size or contract type. Efficiency implies that risk managers include all information available with regard to these characteristics at the time of estimation; while the results of P5 provide no evidence that risk management improves project outcomes, they do suggest that risk managers at least have a good intuition where the risks in a project are and thus are in principle also capable of managing them. The results of P6 and P7 illustrate that some of the well-known risks can have severe effects on vendor profitability. Thus, managing these risks may be worth the effort.

- **Manage risks continuously:** Our results underline the importance of continuous risk management throughout the project lifecycle. The analysis conducted in publication P4 suggests that project risks vary in importance over time and do so with different degrees of volatility. This means that risks that are not perceived as important at the beginning of the project can become critical at some point in time during the project. As a consequence, risk managers should start managing risks early in the project lifecycle (ideally during project initiation) and continue to do so until the project is completed. Frequently used prioritized checklists of risks should be used with caution as they can only provide a snapshot of a project's risk profile.

- **Beware of standardized checklists:** In a similar vein, checklists in most cases are developed to be applicable to a broad range of IS projects. Our analysis in publication P1 shows, however, that there is no one-size-fits-all risk profile for IS projects, but risks tend to vary in existence and importance depending amongst other things on the type of IS project. Not surprisingly, for instance, risk profiles of ISD projects emphasize risks related to requirements, whereas risk profiles of PSI projects emphasize risks related to technology. It is therefore important to recognize that standardized lists should only be used as a guideline and in most cases have to be adapted to the specific project type that is being analyzed.

- **Focus on project success and business success:** When analyzing two distinct streams of research (publication P2) that are concerned with project success in a broader sense, i.e., research on risk factors and research on success factors, it turned out that both streams emphasize different topics. We argue that this is due to different problem framings underlying the research streams. While risk factors mostly seem to be about achieving project success, success factors are concerned with achieving business success. Both perspectives, however, seem to be justified and can hold valuable insights for risk managers as to which factors are important for overall project success depending on which dimension of success is important for the respective project. Truly successful projects probably manage to focus on both, achieving project success in terms of budget and schedule targets and achieving business success in terms of more strategic and organizational targets.

– **Integrate important stakeholders:** Closely connected to the multidimensional nature of project success, is the multidimensional nature of project risk. As suggested by publication P3, the prioritization of these dimensions differs considerably when changing perspective. In contrast to clients, vendors seem to emphasize risks related to technology and the contract. Most likely, these differences do not only occur when changing the perspective from the client to the vendor but also when changing the perspective from the project manager to the project member or to the senior executive. In fact, prior research substantiates this thought (Warkentin et al., 2009; Liu et al., 2010). Consequently, risk managers should aim at integrating different stakeholders (or at least the important ones) into the risk management process in order to capture a variety of perspective and risks.

– **Tackle root causes instead of symptoms:** Much of the academic literature for the sake of simplicity assumes that risks work in isolation (Akkermans/van Helden, 2002). In contrast, publication P6 illustrates how risks may interrelate and endanger vendor project profitability. Risk managers should therefore aim at identifying possible cause-and-effect chains in order to be able to tackle root causes instead of only fighting symptoms. Tackling root causes also implies starting risk management as early as possible during the project lifecycle.

– **Do not neglect technological risks:** While extant lists of risks tend to focus on risks related to project management and the social subsystem (e.g., Schmidt et al., 2001; Kappelman/McKeeman/Zhang, 2006) our analyses reveal the considerable importance of technological risks. For instance, among the ten most important risks in the ranking compiled in publication P3 five risks relate to technological issues, such as an inadequate technical infrastructure or a complex system architecture. Similarly, the Delphi study conducted in publication P1 suggests that technological risks are more important than much of the recent advice to project managers suggests. Again risks that concern interfaces and the system architecture rank high. In line with Wallace/Keil/Rai (2004a), we speculate that many project management and social subsystem risks emanate from technological ones. We thus advise risk managers not to blindly follow the doctrine that IS projects "almost never fail because of technical causes" (Kappelman/McKeeman/Zhang, 2006, p. 32).

– **Beware of different contractual regimes:** The distribution of risk depends on the type of contract underlying the project. FP contracts transfer major parts of the risk to the vendor. Not surprisingly, the effects of risks on vendor profitability are much stronger in FP contracts than in TM contracts. However, while many of the risks simply affect vendor project profitability more negatively in FP contracts, there are also exceptions to this rule. For instance, publication P7 suggests that FP contracts on average are more profitable when they last longer (possibly because longer projects provide the vendor with more flexibility to react to unforeseen contingencies). In contrast, TM contracts are on average more profitable when they last shorter. As these mechanisms are hardly understood in detail, vendors should govern FP contracts with great care and include sufficiently high risk premia. In line with this, the risk ranking in P3 illustrates the high importance of contract type from a vendor's perspective.

- **Set up smaller projects:** The advice that "small is beautiful" is not new in the project management literature (e.g., McFarlan, 1981). Because our analyses illustrates that many projects are still too big in terms of volume (at least from a vendor's point of view), we repeat this advice in this thesis. Project size correlates with organizational complexity and makes projects harder to manage. The results of publication P7 show that projects that are smaller in terms of volume are on average considerably more profitable for vendors. Vendor project managers therefore should aim at splitting large projects into smaller ones in order to decrease organizational complexity. Substantiating this line of thought, the results of publication P5 show that project size positively affects the vendor's risk estimation.

- **Do not underestimate repeat projects:** Intuition suggests that risk decreases in repeat projects with the same client. However, in line with previous empirical evidence (Gopal et al., 2003), we observe in publication P7 that on average vendor project profitability decreases with the number of prior projects with the same client. One reason for this result would be that these projects may be underestimated in terms of their risk, putting perhaps too much trust in the experience gained from prior projects. However, drawing on the results of P5, we see that client familiarity seems not to affect vendor risk estimation, questioning this explanation. We therefore suggest that other mechanisms, such as increasing technical complexity or client negotiation power may be responsible for the profitability loss. As long as these mechanisms are not fully understood, we can only caution vendor project managers against underestimating repeat projects with the same client.

- **Beware of renegotiations:** As our cross-case analysis in publication P6 suggests, project contracts are frequently renegotiated throughout the project as not all contingencies can be foreseen and incorporated into the contract. In this regard, negotiation power is particularly important as in many instances responsibilities for risks are not clearly defined and subject to negotiations. In cases of high client negotiation power, vendor project profitability is under threat because the vendor has to take responsibility for many of the unforeseen contingencies. This generates additional effort in the form of non-billable consulting days. Vendors should therefore spend resources on building up dedicated negotiation teams with the necessary negotiation capabilities. However, while this may help to maximize project profitability, negotiating too tough will almost certainly have negative effects on client satisfaction. Finding the right balance in this regard seems particularly important to us in strategic projects where other than financial objectives have priority.

3 Study Limitations

This cumulative dissertation addresses several limitations in the discipline of IS project risk management and in doing so advances our understanding of risks. However, it is of course subject to limitations to validity of its own. A detailed discussion of these limitations is provided at the end of each publication in part B of this thesis. In the following, we summarize the major limitations along two types of validity suggested by Shadish/Cook/Campbell (2002): Internal validity and external validity[15]. In this regard, it is important to note that researchers belonging to the qualitative school often have a different understanding of validity or sometimes entirely reject the concept of validity (Shadish/Cook/Campbell, 2002; Creswell, 2009). Given our pragmatic epistemological position (see section 3.1), we follow Shadish/Cook/Campbell (2002) in that we believe that validity is a concept independent of specific methods but rather pertains to every procedure that aims at generating knowledge. As such, concerns of validity also apply to qualitative approaches. Where necessary, we will broaden the rather narrow understanding of internal and external validity frequently applied in quantitative-confirmatory research. Finally, as much of this thesis, in particular publications P1, P2, P3, P4, and P6 are of a rather exploratory nature, one has to keep in mind that exploratory research sometimes eludes assessment by standards that derived from a confirmatory perspective (Stebbins, 2001).

3.1 Threats to Internal Validity

The notion of internal validity refers to the question of causality, i.e., whether or not changes in one variable are actually caused by changes in another variable (Shadish/Cook/Campbell, 2002). Internally valid inferences require covariation between cause and effect, the temporal precedence of the cause, and the refutation of plausible alternative explanations (Bhattacherjee, 2011). With regard to this thesis, internal validity is particularly of interest in P5, P6, and P7 which explicitly investigate causal relationships between transaction characteristics and the vendor's risk estimation (P5) and risks and vendor profitability (P6 and P7). In light of the above mentioned criteria for internally valid causal inferences, the results of P5, P6, and P7 have to be treated with caution. While in all three publications we can observe covariation and temporal precedence, we cannot observe and rule out some possible rival explanations. As these analyses are based on archival data of one of our industry partners, we do not have control over events. This renders many of the strategies for coping with threats to internal validity inapplicable, such as manipulation or randomization, (Creswell, 2009; Bhattacherjee, 2011). We have, however, included control variables in our statistical analysis (P6 and P7), such as year or industry dummies, and restricted our case analysis (P5) to a specific set of projects to hold constant extraneous variables, such as the contract type, as recommended by Bhattacherjee (2011). While we cannot rule out all

[15] Shadish/Cook/Campbell (2002) also discusses construct validity and statistical conclusion validity. As these two types of validity tend to apply to quantitative studies only, we do not include them in this overall discussion about validity. Threats to construct and statistical conclusion validity are, however, mentioned in the quantitative-confirmatory publications of this thesis, namely P5 and P7. In fact, the dyadic use of external and internal validity corresponds to early versions of this typology (Campbell/Stanley, 1963).

alternative explanations, the overall plausibility of our explanations and the recurrent discussions with our industry partners give us confidence in the internal validity of our results.

From a more exploratory perspective, as represented by the publications P1, P2, P3, and P4, interpretive validity (Maxwell, 1992) seems to be more apt an approach for assessing the validity of our findings. On the one hand, interpretive validity refers to the researcher's correct interpretation of the meaning ascribed to situations, events, objects, action, etc. by the study participants. In this regard, the question has to be asked whether the archival data used in P3 and P4 objectively reflect the project managers' estimation of risk as we assume in this thesis. Alternatively, the data may reflect micro-political mechanisms (as speculated in P3). However, while this may be the case in few exceptions, post-hoc interviews with the project managers suggested that the data in most cases reflects actual risks to project success. Another threat to interpretive validity in P2 is the categorization of risk and success factors into categories. Though we categorized the risk and success factors with great care, our categorization remains subjective. Similar issues occur in P4 regarding the number of clusters, which is to some extent, also highly subjective. In sum, we have to acknowledge that despite our efforts to ensure accurate and credible results, exploratory research will always be only partially successful in achieving a similar degree of validity to what is known from confirmatory research (Stebbins, 2001).

3.2 Threats to External Validity

External validity concerns the ability to generalize the findings from the sample to the population of interest (population validity) or to different contexts (ecological validity) (Bhattacherjee, 2011). In this thesis, we define the populations of interests as all units of analysis in the respective organization the data was collected from[16]. Consequently, population validity refers to all risks (P1, P3, P4) or projects (P5, P6, P7) in the organization under study. Given this definition, we see two systematic biases that threaten population validity: First, the study reported in P1 selected experienced project managers "with a visible interest in the research topic". The results therefore can only reflect this perspective, neglecting the possibly different view on risks of less experienced project managers. Second, the risk management process at our second industry partner only applies to projects above a certain volume threshold. The data on which P3, P4, P5, and P6 is based thus is biased towards larger projects. From a practical perspective, however, risk management is in most cases reasonable in projects of a certain volume only, relativizing this issue.

With regard to ecological validity, we are confident that our findings are generalizable on an abstract level to other contexts, i.e., to other organizations or industries. For instance, in the

[16] We collected data from two organizations: The participants of our Delphi study in P1 were recruited from the pool of IS project managers of a major German-based financial service provider. The data on which the analyses of P3, P4, P5, P6, and P7 are based on was collected from a major German-based vendor of ERP software and services. Though involving issues with regard to external validity, research designs based on single organizations are quite common in studies on vendor profitability (Gopal et al., 2003; Kalnins/Mayer, 2004; Ethiraj et al., 2005; Gopal/Sivaramakrishnan, 2008; Gopal/Koka, 2012).

case of P1, while other financial service providers will almost certainly face different risk profiles in PSI and ISD projects, we can think of no reason why the more abstract findings, i.e., that differences between these two kinds of projects exist and that we observe a high prominence of technology-related risks, should not be generalizable to other financial service providers or even to other industries. Similarly, for example, in the case of P7, we consider it plausible that other vendors and consultancies will acknowledge two different contractual regimes that affect the way projects are governed. On a more detailed level, however, ecological validity will almost certainly be threatened by organization and industry idiosyncrasies. With regard to organization idiosyncrasies, for instance, our first industry partner faced an insufficient availability of testing infrastructure at the time the data collection for P1 was conducted, possibly affecting the risk profiles of the industry partner's ISD and PSI projects. Similar organization idiosyncrasies exist at our second industry partner. For example, our second industry partner is software vendor and consultancy at the same time. This fact likely influences the industry partner's conceptualization of a project's strategic importance and risk as the consulting projects in our data set may be tied to license sales. Pure consultancies that are not affected by license considerations may have a different conceptualization of strategic importance and risk. The conceptualization of risk furthermore is likely to depend on an organization's set of resources and capabilities. As both of our industry partners are major players in their industries, they likely have access to a vast pool of resources and capabilities. Consequently, our findings may not be transferable to smaller and less experienced organizations. As mentioned in section 2.2, the conceptualization of risk also depends on the conceptualization of success. Our second industry partner was strongly governed by profitability targets, which also shaped its definition and prioritization of risks. Though profitability is a major criterion for success for most vendors and consultancies (Gopal/Koka, 2012), there exist different conceptualizations of success and consequently of risk. Finally, both of our industry partners are based in Germany. As the conceptualization of risk is also known to be affected by culture (Hofstede, 1980; Schmidt et al., 2001), generalization to other cultural backgrounds is difficult. With regard to industry idiosyncrasies, the financial service industry is known for quite specific demands concerning information systems. As a consequence, the risk profiles of ISD and PSI projects that are described in P1 may not be transferable to other industries. In sum, we are confident that our analysis exhibits high population validity. Ecological validity may be given to some extent, but has to be treated with more caution.

4 Future Research

Given the results and the limitations of this thesis, we see several avenues for future research. In general, as many of our analyses are based on data from one company only, the validity of our results would benefit from replicating our studies in different settings, i.e., for different vendors and in different industries. In the following, we provide more specific avenues for future research:

- **Deriving a typology of IS projects:** Researchers acknowledge that projects are not uniform activities. Attempts to create typologies of projects have been proposed, for instance, by Bannerman (2008), Shenhar/Dvir (1996), and Dvir et al. (1998). However, there is still no academic consensus on the important dimensions of a project typology, in particular in the case of IS projects. With regard to the latter, we explore the project task, i.e., developing new software from scratch vs. implementing pre-packaged software modules, as one possible dimension for such a typology. Without doubt, there exist many more dimensions to classify projects that would allow for more effective project management. For instance, a project typology based on risk profiles promises more custom-fit risk management practices than the one-size-fits-all approach currently applied by many practitioners.

- **Comparing client and vendor perspectives on risk:** While much of this thesis – in line with academic discussion (Markus/Tanis, 2000; Gopal/Koka, 2012) – indirectly suggests that vendors in general face different risks than clients, we do not directly compare these two perspectives. Studying both perspectives in the same project might reveal more concise differences in the risk perceptions of clients and vendors and foster mutual understanding. We argue that mutual understanding of each party's perspective on risk will be beneficial to achieving overall project success. In a similar vein, we acknowledge that risk perception also changes depending on other, more operational perspectives. In this study, we primarily investigate the risk managers' and project managers' point of view. Future studies may extend our research to other point of views.

- **Demonstrating the benefits of project risk management:** Publication P5 suggests that risk managers are able to efficiently estimate overall project risk with regard to project size and contract type. While correct risk analysis is the prerequisite of effective risk control, we have not yet investigated whether risk managers at our industry partners are able to actually manage risks down. There also exist doubts in academic literature with regard to the value of risk management (Bannerman, 2008; Kutsch/Hall, 2009; de Bakker/Boonstra/Wortmann, 2010). Consequently, empirically demonstrating the benefits of risk management would address a much debated issue among practitioners and academics.

- **Investigating interrelationships between risks and project outcome:** We see another interesting avenue for future research in further investigating interrelationships between risks and project outcome. While we have explored this avenue to some extent in publication P4 and in publication P6 in a qualitative way, further quantitative analysis based on longitudinal data and correlations may yield more robust results. While longitudinal data may help to establish temporal precedence, it has to be mentioned, however, that using longitudinal data will come with challenges of its own. Such challenges include, for example, identifying suitable time intervals for analyzing correlations between two risks, or acquiring longitudinal data in the first place. Despite these challenges we see the temporal nature of project risks as an interesting field for future research because hardly any study to date is able to address this issue. In particular, analyzing how responses to risks affect the correlations seems worthwhile to know for risk managers.

- **Analyzing the effect of contract characteristics on project outcome:** Formal contracts are the foundation for client-vendor relationships. The archival data set underlying many analyses of this thesis only allowed us to analyze the type of contract. Analyzing further characteristics of contracts, such as the degree of customization, the availability of penalty clauses etc., and their effects on risks and project outcomes in more detail promises to yield further insights how formal contracts affect client-vendor relationships. In general, further determinants of project outcome, particularly vendor profitability, should be studied. The low R^2 value of the statistic model in publication P7 suggests that many more determinants of vendor profitability exist.

- **Broadening the definition of vendor risks:** In this thesis we restrict our definition of risks in most cases to financial risks, i.e., situations or events that possibly negatively affect vendor profitability. While profitability is arguably one of the most important dimensions of success from a vendor's perspective, there exist many other dimensions of project success besides project profitability, such as client satisfaction, market entrance, follow-up projects, etc. Analyzing risks to these non-financial success dimensions may yield further insights how vendors perceive risks. In particular, it seems interesting to analyze how much profitability the vendor is willing to sacrifice for these non-financial success dimensions.

- **Integrating further contractual regimes:** For the sake of simplicity, we also restricted our analysis of contractual regimes to two different types of contracts, TM and FP contracts. In practice, however, hybrid forms such as capped price contracts exist. A separate analysis of how risks affect vendor profitability in these hybrid types would therefore deepen our understanding of contractual regimes.

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Appendix A: Interview Guideline

General Part

- Which part of the organization do you belong to?
- What is your current role?
- Which kind of projects have you been managing?
- How much experience do you have with IS projects
- How much experience do you have in managing projects?

Specific Part

- Which risks were identified in your last / current project during the project?
- Why were these risks identified? Which consequences did these risks have / were thought to have?
- Which risks were prevalent in other projects that were of the same project type (either ISD or PSI) as your last / current one?
- With which risks have you been confronted in other IS projects that were of the same project type (either ISD or PSI) as your last / current one? Relating to the:
    - …project environment: corporate environment, sponsorship, relationship mgmt.
    - …technical aspects: requirements, technology, testing
- …project management: development process, project planning, project organization, project completion, third parties, team)

Table A1: Interview Guideline

Appendix B: Top 10 Risks for ISD Projects

Risk	Sub-category	Rank
Dependencies on other projects	Project organization	1
Unavailability of testing infrastructure	Testing	2
Unclear requirements	Requirements	3
Unrealistic external deadlines	External influences	3
Complex interfaces	Technology	5
Lack of skilled resources	Team	6
Inter-divisional decisions	Relationship management	7
Unrealistic sponsor expectations	Sponsorship / ownership	8
Low project priority	External influences	9
Unclear roles and responsibilities	Team	10

Table B1. Top 10 Risks for ISD Projects

Appendix C: Top 10 Risks for PSI Projects

Risk	Sub-category	Rank
Lack of skilled resources	Team	1
Complex interfaces	Technology	2
Low project priority	External influences	3
Unavailability of testing infrastructure	Testing	4
High technical complexity	Technology	5
Unstable requirements	Requirements	6
Optimistic project planning	Planning	7
No implementation strategy	Project completion	8
Budget cuts	External influences	9
Unrealistic project scope	Requirements	10

Table C1. Top 10 Risks for PSI Projects

Appendix D: Correlation Matrix

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
(1) Client familiarity	1.000					
(2) Contract type	-0.151	1.000				
(3) Project size	-0.155	0.252**	1.000			
(4) Strategic importance	-0.019	-0.008	0.258**	1.000		
(5) Risk estimation	-0.087	-0.183	0.387***	0.077	1.000	
(6) Project profitability	0.094	0.054	-0.286**	-0.273**	-0.412***	1.000
(7) Project duration	-0.119	-0.031	-0.008	-0.009	0.141	-0.224**

*** = significant at the 1% level, **= significant at the 5% level, * = significant at the 10% level for two-tailed tests.

Table D1. Correlation Matrix

Appendix E: Coding Scheme for Strategic Importance

Level	Description	Examples
0	Non-strategic projects as characterized as business-by the following keywords in ALPHA project objectives or project summary: revenue, profitability, commercial goals, and utilization.	• "Revenues and contribution" • "Generate revenues with a margin above x% and utilize associates" • "Financial success"
1	Strategic projects as characterized by the following keywords in ALPHA project objectives or project summary: market entrance, market development, reference client, win-back, lighthouse project, follow-up projects, product development, and reputation.	• "Lighthouse project in the healthcare industry, potential role model for other clients" • "Strategic positioning for larger projects" • "Securing a considerable license deal"

Table E1. Coding Scheme for Strategic Importance