Association for Information Systems
AIS Electronic Library (AISeL)

Wirtschaftsinformatik Proceedings 2011 | Wirtschaftsinformatik

2011

When to manage risks in IS projects: An exploratory analysis of longitudinal risk reports

Stefan Hoermann
Technische Universität München, stefan.hoermann@in.tum.de

Michael Schermann
Santa Clara University, michael.schermann@in.tum.de

Helmut Krcmar
Technical Universität Munchen, krcmar@in.tum.de

Follow this and additional works at: http://aisel.aisnet.org/wi2011

Recommended Citation

Hoermann, Stefan; Schermann, Michael; and Krcmar, Helmut, "When to manage risks in IS projects: An exploratory analysis of longitudinal risk reports" (2011). *Wirtschaftsinformatik Proceedings 2011*. 28.
http://aisel.aisnet.org/wi2011/28

This material is brought to you by the Wirtschaftsinformatik at AIS Electronic Library (AISeL). It has been accepted for inclusion in Wirtschaftsinformatik Proceedings 2011 by an authorized administrator of AIS Electronic Library (AISeL). For more information, please contact elibrary@aisnet.org.

When to manage risks in IS projects: An exploratory analysis of longitudinal risk reports

Stefan Hoermann
Technsiche Universitaet Muenchen (TUM)
Boltzmannstr. 3
85748 Garching b. Muenchen
+49 89 289 19546
stefan.hoermann@in.tum.de

Michael Schermann
Technsiche Universitaet Muenchen (TUM)
Boltzmannstr. 3
85748 Garching b. Muenchen
+49 89 289 19507
michael.schermann@in.tum.de

Helmut Krcmar
Technsiche Universitaet Muenchen (TUM)
Boltzmannstr. 3
85748 Garching b. Muenchen
+49 89 289 19532
krcmar@in.tum.de

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.

Keywords

Risk management, project failure, software project management.

10th International Conference on Wirtschaftsinformatik,
16th - 18th February 2011, Zurich, Switzerland

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 and 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 et al., 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. Iversen et al., 2004; Ropponen and Lyytinen, 1997). Following fundamental definitions of risk in reference disciplines (Knight, 2002; March and Shapira, 1987), IS researchers commonly define project risks as events with a perceived probability of occurrence and a perceived negative impact on project objectives (Alter and Sherer, 2004; Boehm, 1991; Charette, 1996; Heemstra and Kusters, 1996). 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 and Kusters, 1996).

Being pivotal to effectively controlling risks in IS projects, many IS researchers focus on the capabilities required for assessing risks (Tiwana and 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. Barki et al., 1993; Boehm, 1991; Kappelman et al., 2006; Keil et al., 1998; Moynihan, 1997; Schmidt et al., 2001). 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. Han and Huang, 2007; Jiang and Klein, 2000; Nidumolu, 1995; Sauer et al., 2007; Wallace et al., 2004). 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 (Barki et al., 2001; Ropponen and Lyytinen, 2000).

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 and Ginzberg, 1978; Gemino et al., 2008; Pinto and Prescott, 1988; Somers and Nelson, 2004). 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: *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.

2. THEORETICAL BACKGROUND

2.1 Dimensions of IS Project Risks

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 et al. (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's (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 et al. (2004) 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 et al. (2007) reinvestigate the risk dimensions identified by Schmidt et al. (2001) and find significant similarities among them. In line with the results of Wallace et al. (2004), the authors reduce the number of dimensions back to six: sponsorship/ownership, funding and scheduling, personnel and staffing, scope, requirements, and relationship management. Sherer et al. (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 1 gives an overview on the dimensions identified in these studies.

Table 1. Overview on Dimensions of IS Project Risks

McFarlan (1981)	(1) Project size, (2) Experience with technology, (3) Project structure
Barki et al. (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 et al. (2004)	(1) Project management, (2) Technical subsystem, (3) Social subsystem
Tesch et al. (2007)	(1) Sponsorship/ownership, (2) Funding and scheduling, (3) Personnel and staffing, (4) Scope, (5) Requirements, (6) Relationship management
Sherer et al. (2004)	(1) Environment, (2) Strategies, (3) Infrastructure, (4) Customers, (5) Products and services, (6) Work practices, (7) Participants, (8) Information, (9) Technology

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, 2004). 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 et al. (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.

2.2 Temporal Aspects of IS Project Risks

In an early study, Alter et al. (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 et al. (1978) map all of these risks to one of the first four project phases and propose several risk-reducing strategies.

Sherer et al. (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 et al. (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.

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 and Prescott, 1988; Somers and 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 and Sherer, 2004; Gemino et al., 2008). Other studies conceptually allocate risks to different phases of a work system life cycle (Sherer and Alter, 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.

3. RESEARCH DESIGN

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 et al. (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 et al. (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.

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 3) 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 2 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.

Table 2. Descriptive Statistics for Key Variables

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

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 3 provides an overview of the risk types assessed by BETA's project managers, including their frequency, their mean risk exposure and their standard deviation.

Table 3. Risk Ranking According to Risk Exposure

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-T&M 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

3.3 Data Analysis

In order to investigate how the perceived importance of risk types changes over time, we 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) depicted in Figure 1. 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' (Hansmann and Neumann, 2005). 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 (e.g. Boehm 1991; Kappelman et al. 2006; Schmidt et al. 2001). Table 4 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 et al. (2004).

Table 4. Top 10 Risk Types by Project Phase

#	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 Environm.(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-T&M 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-T&M 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 (Wallace et al., 2004)

Table 4 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 (e.g., Schmidt et al. (2001) or Kappelman et al. (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 4 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., 2008).

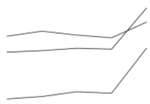
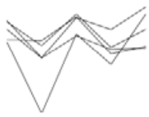
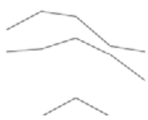
Following the recommendations by Punj et al. (1983), we first identify outliers by using the Single-Linkage (Nearest-Neighbor) approach. The resulting dendogram suggests that seven of the 45 risk types, namely 'Hardware Partner Not Involved', 'Inadequate Technical Infrastructure', 'Language of Development 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 et al. (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 5). 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. RESULTS AND DISCUSSION

Table 5 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.

Table 5. Derived Risk Clusters

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-T&M 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 (Wallace et al., 2004)

Looking at Table 5, 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 2a). 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 and Ginzberg, 1978; Gemino et al., 2008; Sherer and Alter, 2004). 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. Barki et al., 1993; Boehm, 1991; Kappelman et al., 2006; Schmidt et al., 2001; Tiwana and 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 (Kappelman et al., 2006; Schmidt et al., 2001). In contrast, we see a high importance of technical risk types throughout the project phases (see Table 4). 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.

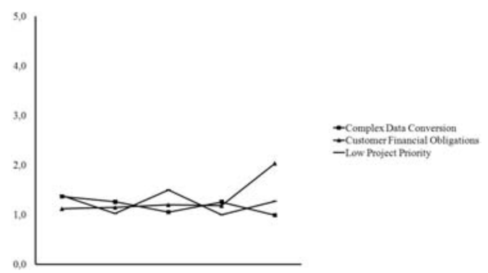


Figure 2a. Varying Risk Exposure

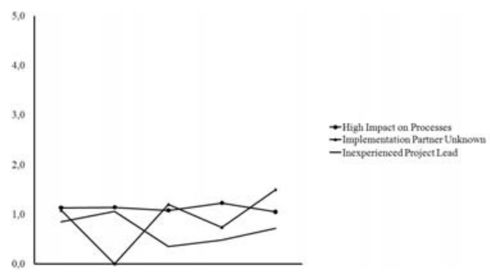


Figure 2b. Heterogeneous Degrees of Volatility

Second, we can observe heterogeneous degrees of volatility of risk exposure across risk types and project phases (see Figure 2b). 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 et al. (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).

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 3a). In contrast, cluster 9 comprises risk types of similar risk exposure levels which slowly decline to a particular level of risk exposure (see Figure 3b). 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 3c). 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 et al. (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 et al. (2004) 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.

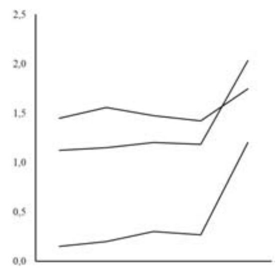


Figure 3a. Risk Cluster 1

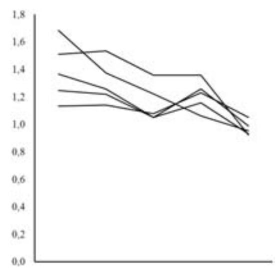


Figure 3b. Risk Cluster 9

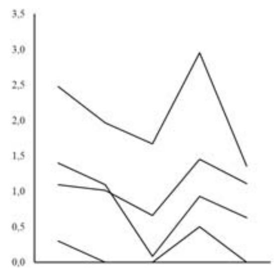


Figure 3c. Risk Cluster 4

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 on 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 et al., 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.

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 and 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 and 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.

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 et al. (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 and Huber (1990). Additionally, we will present our results to the project managers of BETA to identify further candidates for risk archetypes.

8. REFERENCES

[1] Alter, S. (2002) *The work system method for understanding information systems and information systems research,* Communications of the Association for Information Systems, 9 (6), pp. 90-104.

[2] Alter, S. and Ginzberg, M. (1978) *Managing uncertainty in MIS implementation,* Sloan Management Review, 20 (1), pp. 23-31.

[3] Alter, S. and Sherer, S. (2004) *A general, but readily adaptable model of information system risk,* Communications of the Association for Information Systems, 14 (2), pp. 1-28.

[4] Barki, H., Rivard, S. and Talbot, J. (1993) *Toward an assessment of software development risk,* Journal of Management Information Systems, 10 (2), pp. 203-225.

[5] Barki, H., Rivard, S. and Talbot, J. (2001) *An integrative contingency model of software project risk management,* Journal of Management Information Systems, 17 (4), pp. 37-69.

[6] Boehm, B. (1991) *Software risk management: principles and practices,* IEEE Software, 8 (1), pp. 32-41.

[7] Charette, R. (1996) *The mechanics of managing IT risk,* Journal of Information Technology, 11 (4), pp. 373-378.

[8] Gemino, A., Reich, B. and Sauer, C. (2008) *A temporal model of information technology project performance,* Journal of Management Information Systems, 24 (3), pp. 9-44.

[9] Hair, J., Black, W., Babin, B., Anderson, R. and Tatham, R. (2008) *Multivariate data analysis,* Prentice Hall, Upper Saddle River.

[10] Han, W.-M. and Huang, S.-J. (2007) *An empirical analysis of risk components and performance on software projects,* Journal of Systems and Software, 80 (1), pp. 42-50.
[11] Hansmann, H. and Neumann, S. (2005) *Prozessorientierte Einfuehrung von ERP-Systemen,* In ProzessmanagementSpringer, Berlin, pp. 329-372.
[12] Heemstra, F. and Kusters, R. (1996) *Dealing with risk: a practical approach*, Journal of Information Technology, 11 (4), pp. 333-346.
[13] Iversen, J., Mathiassen, L. and Nielsen, P. A. (2004) *Managing risk software process improvement: An action research approach,* MIS Quarterly, 28 (3), pp. 395-433.
[14] Jiang, J. and Klein, G. (2000) *Software development risks to project effectiveness,* The Journal of Systems and Software, 52 (1), pp. 3-10.
[15] Kappelman, L., McKeeman, R. and Zhang, L. (2006) *Early warning signs of IT project failure: the dominant dozen,* IT Project Management, 23 (4), pp. 31-37.
[16] Keil, M., Cule, P., Schmidt, R. and Lyytinen, K. (1998) *A framework for identifying software project risks,* Communications of the ACM, 41 (11), pp. 76-83.
[17] Ketchen, D. and Shook, C. (1996) *The application of cluster analysis,* Strategic Management Journal, 17 (6), pp. 441-458.
[18] Knight, F. H. (2002) *Risk, Uncertainty and Profit,* BeardBooks, Washington, DC, USA.
[19] March, J. and Shapira, Z. (1987) *Managerial perspectives on risk and risk taking,* Management Science, 33 (11), pp. 1404-1419.
[20] McFarlan, W. (1981) *Portfolio approach to information systems*, Harvard Business Review, 59 (5), pp. 142-151.
[21] Moynihan, T. (1997) *How experienced project managers assess risk,* IEEE Software, 14 (3), pp. 35-41.
[22] Nidumolu, S. (1995) *The effect of coordination and uncertainty on software project performance: Residual performance risk as an intervening variable,* Information Systems Research, 6 (3), pp. 191-219.
[23] Pinto, J. and Prescott, J. (1988) *Variations in critical success factors over the stages in the project life cycle,* Journal of Management, 14 (1), pp. 5-18.
[24] Punj, G. and Stewart, D. (1983) *Cluster analysis in marketing research: Review and suggestions for application,* Journal of Marketing Research, 20 (2), pp. 134-148.
[25] Ropponen, J. and Lyytinen, K. (1997) *Can software risk management improve system development: an exploratory study,* European Journal of Information Systems, 6 (1), pp. 41-50.
[26] Ropponen, J. and Lyytinen, K. (2000) *Components of software development risk: how to address them,* IEEE Transactions on Software Engineering, 26 (2), pp. 98-112.
[27] Sauer, C., Gemino, A. and Reich, B. (2007) *The impact of size and volatility on IT project performance,* Communications of the ACM, 50 (11), pp. 79-84.
[28] Schmidt, R., Lyytinen, K., Keil, M. and Cule, P. (2001) *Identifying software project risks: an international delphi study,* Journal of Management Information Systems, 17 (4), pp. 5-36.
[29] Sherer, S. and Alter, S. (2004) *Information system risks and risk factors: Are they mostly about information systems,* Communications of the Association for Information Systems, 14 (2), pp. 29-64.
[30] Sitkin, S. and Weingart, L. (1995) *Determinants of risky decision-making behavior: a test of the mediating role of risk perceptions and propensity,* Academy of Management Review, 38 (6), pp. 1573-1592.
[31] Somers, T. and Nelson, K. (2004) *A taxonomy of players and activities across the ERP project life cycle,* Information & Management, 41 (3), pp. 257-278.
[32] Tesch, D., Kloppenborg, T. and Erolick, M. (2007) *IT project risk factors: the project management professionals perspective,* Journal of Computer Information Systems, 47 (4), pp. 61-69.
[33] Tiwana, A. and Keil, M. (2006) *Functionality risk in information systems development: an empirical investigation,* IEEE Transactions on Engineering Management, 53 (3), pp. 412-425.
[34] van de Ven, A. and Huber, G. (1990) *Longitudinal field research methods for studying processes of organizational change,* Organization Science, 1 (3), pp. 213-219.
[35] Verner, J. and Evanco, W. (2005) *In-house software development: What project management practices lead to success,* IEEE Software, 22 (1), pp. 86-93.
[36] Wallace, L. (2004) *Software project risks and their effect on outcomes,* Communications of the ACM, 47 (4), pp. 68-73.
[37] Wallace, L., Keil, M. and Rai, A. (2004) *How software project risk affects project performance: an investigation of the dimensions of risk and an exploratory model,* Decision Sciences, 35 (2), pp. 289-321.
[38] Zmud, R. (1980) *Management of large software development efforts,* MIS Quarterly, 4 (2), pp. 45-56.