RESEARCH

Thorsten Frey

Governance Arrangements for IT Project Portfolio Management

Qualitative Insights and a Quantitative Modeling Approach

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With a foreword by Prof. Dr. Peter Buxmann

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Foreword

Today, innovations are key to survival in many companies. As more and more innovations are IT-enabled, corporate IT departments have to cope with a growing number of IT projects proposed by different organizational units. At the same time, funds for new IT investments are typically very scarce. Thus, procedures and mechanisms for selecting the most valuable projects in alignment with the corporate and the IT strategy are required. In this context, other factors like mandatory projects and the risk at the portfolio level need to be considered as well. For this purpose, the concept of IT project portfolio management has received growing attention in recent years.

In the current thesis, Thorsten Frey demonstrates how companies are struggling with the right balance between local autonomy and centralized control in the context of IT project portfolio management. This struggle is reflected in the governance arrangements employed. Thus, the primary research objectives addressed in this dissertation are to describe governance arrangements for IT project portfolio management as they are employed in practice and to identify antecedents for and performance impacts of distinct governance arrangements on the composition of IT project portfolios in different contexts. In order to address these research objectives, Thorsten Frey employs qualitative empirical methods as well as a quantitative analytical approach.

The first part of this book contains a comprehensive summary and analysis of theoretical backgrounds for the two covered research disciplines. With regard to IT governance research, relevant terms and concepts from organizational theory are introduced. While previous research on IT governance is only briefly summarized due to the pervasiveness of existing reviews, the state-of-the-art of IT project portfolio management research is analyzed in detail. Based on an extensive review of scientific papers covering IT project portfolio management, Thorsten Frey identifies key concepts of IT project portfolio management research. He especially highlights the emergence of two different streams of research and the beginning merge of these two streams. Based on his structured analysis, he identifies opportunities for future research. Thereby, Thorsten Frey makes a significant contribution to the advancement of this important new research discipline.

The second part of this book focusses on the design of governance arrangements for IT project portfolio management. For this purpose, outcomes of a qualitative empirical study are presented. Based on an extensive analysis of governance arrangements in ten case companies, Thorsten Frey identifies major concepts that are combined into a comprehensive framework. This framework explains relationships between different contingency factors and different governance designs for IT project portfolio management. Impacts of distinct governance arrangements on the composition of IT project portfolios are also analyzed. Based on insightful descriptions and citations, Thorsten Frey vividly demonstrates why different governance arrangements for IT project portfolio management exist in practice and how companies cope with the inherent conflict between local autonomy and centralized control. The developed framework provides an important instrument for governance experts in order to evaluate the appropriateness of distinct kinds of governance arrangements in a given context.

In the third part of this book, coordination mechanisms for budget allocation and IT project portfolio management are investigated based on a mathematical analytical conception. This general conception allows for an analysis of the impact of various factors influencing the composition of IT project portfolios. In particular, the impact of different governance designs on synergy exploitation is formally analyzed in the current dissertation. This is of high relevance for IT project portfolio management research due to the pervasiveness of different kinds of interdependencies between IT projects. The conception is also of high relevance for practitioners as it can be used in order to analyze the appropriateness of a particular governance arrangement in a given organizational context. Thereby, costly failures of reorganization projects can be avoided.

In the final part of the thesis the practical use of the findings and the theoretical frameworks described in the previous parts of the book are discussed. In this context, Thorsten Frey also outlines the steps IT governance experts should take in order to design appropriate governance arrangements for IT project portfolio management.

Due to the provisioning of a comprehensive framework for governance arrangements for IT project portfolio management, the presentation of insightful examples from practice and the development of an adaptable analytical approach, this dissertation is of high value for researchers and practitioners alike. Therefore, I hope that this book will find a wide circulation in research and practice.

Darmstadt, January 2014 Prof. Dr. Peter Buxmann

Acknowledgements

This thesis has been written during my work as research assistant at the chair of Information Systems | Software Business & Information Management at Darmstadt University of Technology.

I am especially grateful to my supervisor Prof. Dr. Peter Buxmann, who always greatly supported me and gave me many helpful suggestions. Likewise, I want to thank my second referee Prof. Dr. Alexander Benlian for his valuable support.

My knowledge concerning IT project portfolio management has significantly broadened during the case study research described in this dissertation. In this context, I want to thank all interview partners who participated in this project. Likewise, I want to thank all other experts consulted during the dissertation project for their openness and the fruitful exchange of ideas.

During my time at the department, I had the pleasure to supervise the theses of a large number of excellent students. Like the respective students, I have gained valuable insights during many lively discussions and the joint development of new artifacts and concepts. Unfortunately, I cannot list all their names here, but I particularly want to mention Peter Dietrich, Maximilian Gräf, and Sebastian Weimer.

I want to express my special gratefulness to Stefan Harnisch for his valuable feedback with regard to the contents of this dissertation. I also want to thank my friends and colleagues Alexander Schütz, André Loske, Anton Pussep, Christoph Burkard, Helena Wenninger, Henriette Heidbrink, Janina Matz, Jasmin Kaiser, Jin Gerlach, Jochen Strube, Markus Eckrich, Markus Schief, Martin Kowalczyk, Nicole Eling, Patrick Johnscher, Ruth Haiß, Sonja Lehmann, Stefan Harnisch, Sven Schade, Thomas Miklitz, Thomas Widjaja, Tobias Ackermann, and Tobias Draisbach, for their support and the enjoyable and inspiring time at the department.

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Darmstadt, January 2014 *Thorsten Frey*

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Symbol	Description	Section[1]
O	Set of organizational units the investigated company is composed of	5.4.3.1
$B_o \in \mathbb{R}^+$	Budget of organizational unit $o \in O$	5.4.3.1
$ct_o \in \mathbb{R}^+$	Cost threshold for organizational unit $o \in O$	5.4.3.1
$su_o \in O$	Direct superior unit of organizational unit $o \in O$	5.4.3.1
$pu_i \in O$	Organizational unit proposing candidate project $i \in P$	5.4.3.2
$P_o \subseteq P$	The decision domain of unit $o \in O$ (i.e., the set of project proposals falling within the decision-making competency of organizational unit o)	5.4.3.2
P	Set of all candidate projects in the entire organization	5.4.3.2
$b_i \in \mathbb{R}^+$	Expected benefit provided by candidate project $i \in P$	5.4.3.2
$c_i \in \mathbb{R}^+$	Expected costs (resource requirements) for candidate project $i \in P$	5.4.3.2
$v_{ij} \in [-1, \infty]$	Benefit interdependency between project $i \in P$ and project $j \in P$	5.4.3.3
$r_{ij} \in [-1, \infty]$	Resource (cost) interdependency between project $i \in P$ and project $j \in P$	5.4.3.3
$x_i \in \{0,1\}$	Binary solution variable. The variable is 1 if project $i \in P$ is selected and 0 if not.	5.4.4
$y_{ij} \in \{0,1\}$	Binary auxiliary variable. The variable is 1 if projects $i \in P$ and $j \in P$ are both selected. Else, the variable is 0.	5.4.4
$F_o(x) \in \mathbb{R}^+$	Financial return of the portfolio selected by unit o	5.4.4
$Z^c_{ef} \in \mathbb{R}^+$	Result obtained in the centralized decision-making arrangement for outcome type o and factor combination f	5.5.2
$Z^d_{ef} \in \mathbb{R}^+$	Result obtained in the decentralized decision-making arrangement for outcome type o and factor combination f	5.5.2

[1] This corresponds to the section where the respective symbol is introduced.

Z_{ef}	The relative difference between the results obtained in the centralized and in the decentralized arrangement for outcome type o and factor combination f	5.5.2
$C_o(\boldsymbol{x})$	Overall costs of a given portfolio composed of candidate projects falling into the decision domain of organizational unit o ∈ O	5.6.2

Acronyms

ACIS	Australasian Conference on Information Systems
AIS	Association for Information Systems
AISeL	AIS Electronic Library
AMCIS	Americas Conference on Information Systems
BU	Business Unit
CEO	Chief Executive Officer
CIO	Chief Information Officer
COO	Chief Operating Officer
COBIT	Control Objectives for Information and related Technology
CRM	Customer Relationship Management
DIO	Division Information Officer
DM	Decision Maker
DSS	Decision Support System
EBSCO	Elton B Stephens Company
ECIS	European Conference on Information Systems
ERP	Enterprise Resource Planning
GBD	Global Business Divisions
HICSS	Hawaii International Conference on Systems Science
ICIS	International Conference on Information Systems
IRR	Internal Rate of Return
IS	Information System
ISI	Institute for Scientific Information
IT	Information Technology
ITIL	Information Technology Infrastructure Library
JSTOR	Journal STORage
KPI	Key Performance Indicator
LoB	Lines of Business
MGMP	Management of a group of multiple projects
MIS	Management Information System
MIT	Massachusetts Institute of Technology
MPM	Multiple Project Management
NPV	Net Present Value
PACIS	Pacific Asia Conference on Information Systems
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PPM	Project Portfolio Management

R&D	Research and Development
ROI	Return on Investment
RM	Business/IT Relationship Manager
SaaS	Software as a Service
SBU	Strategic Business Unit
SPM	Single-project Management
SWOT	Strength, Weaknesses, Opportunities, and Threats

Abstract

In recent years, the importance of project-based work has strongly increased in many organizations. As a large fraction of corporate expenditures falls into the category of IT investments, organizations particularly have to manage a growing number of IT projects. While the requirements for efficient project implementation have long been discussed in the project management literature, the need for effective project evaluation, project selection, and resource allocation has moved into the focus of research only recently. These aspects fall into the domain of IT project portfolio management (IT PPM).

Different conceptions for IT project portfolio management are currently discussed in the scientific literature as well as in practical contributions. In this context, it is often argued that in particular the governance, i.e. the appropriate organizational embedding of IT project portfolio management, is of eminent importance. The current dissertation is devoted to this topic. To this end, existing concepts from the domain of IT governance research are employed in order to examine the antecedents and impacts of the use of different governance arrangements for IT project portfolio management. Methodically, the present work is based on a structured literature review, case study research and a mathematical modeling approach.

As part of the structured literature review, the existing state of research in the field of IT project portfolio management is identified and discussed. In this context, it is highlighted that the discipline is based on two different research strands. The first research strand is concerned with quantitative mathematical models that provide decision support for project portfolio selection and resource allocation. The second strand includes empirical and conceptual work relating to the organizational integration and design of (IT) project portfolio management arrangements. Based on the literature review, recent developments in the two research strands are discussed and remaining research gaps are presented.

In a case study investigation with ten participating companies, deeper insights into the design of governance arrangements for IT project portfolio management in practice are provided. In this context, different fields of activities and different contingency factors influencing the governance of IT project portfolio management are investigated. It is also demonstrated how different governance mechanisms in different fields of activity complement each other. Moreover, the consequences arising from the use of different governance mechanisms are discussed.

Based on the findings of the case study analysis, a mathematical modeling approach is derived in order to study the impact of different governance arrangements on outcomes of IT project portfolio management. The approach is based on a generic coordination mechanism identified during the case study research. The approach is illustrated by simulation experiments. In particular, the influence of different types of project interdependencies on the outcomes of IT project portfolio selection in different decision-making constellations is examined. For example, it is illustrated to which degree decentralized decision-making can lead to a lack of synergy exploitation, redundancies, and budget overruns.

The results of this thesis contribute to a better understanding of the importance of adequate governance arrangements for IT project portfolio management. In particular, the factors that influence the design of these arrangements are explicitly described. At the same time, the generic mathematical approach presented in this dissertation enables an examination of the preferability of different decision-making arrangements in different contexts. Based on this approach, hypotheses for future research can be derived.

Zusammenfassung

In den letzten Jahren hat die Projektarbeit in vielen Organisationen stark an Bedeutung gewonnen. Da heutzutage ein großer Teil der betrieblichen Ausgaben auf IT-Investitionen entfällt, ergibt sich insbesondere die Notwendigkeit eine steigende Anzahl an IT-Projekten effektiv zu steuern. Während die Anforderungen, die an eine effiziente Projektdurchführung zu stellen sind, seit langem in der Projektmanagement-Literatur diskutiert werden, rückt derzeit die Notwendigkeit einer geeigneten Projektevaluierung, Projektauswahl und Ressourcenzuteilung in den Blickpunkt. Diese Aspekte fallen in den Bereich des IT-Projektportfoliomanagements.

Konzeptionen für das IT-Projektportfoliomanagement werden zunehmend in der wissenschaftlichen wie auch der praxisorientierten Literatur diskutiert. In diesem Zusammenhang wird häufig betont, dass insbesondere der Governance, d. h. der adäquaten organisatorischen Einbettung des IT-Projektportfoliomanagements, eine große Bedeutung zukommt. Die vorliegende Dissertation widmet sich diesem Themenkomplex. Dabei wird auf Konzepte aus der IT-Governance-Forschung zurückgegriffen, um Einflussfaktoren und Konsequenzen unterschiedlicher organisatorischer Ausgestaltungen des IT-Projektportfoliomanagements zu untersuchen. Methodisch beruht die vorliegende Arbeit auf einer strukturierten Literaturanalyse, einer Fallstudienuntersuchung sowie auf einem mathematischen Modellierungsansatz.

Im Rahmen der strukturierten Literaturanalyse wird der bestehende Stand der Forschung im Bereich IT-Projektportfoliomanagement erfasst und aufbereitet. Dabei wird herausgestellt, dass die Disziplin auf zwei unterschiedlichen Forschungssträngen beruht. Der erste Strang befasst sich mit quantitativen mathematischen Modellen, die Entscheidungsunterstützung für die Projektportfolioselektion und die Ressourcenallokation bieten sollen. Der zweite Strang umfasst empirische und konzeptionelle Arbeiten, welche sich mit der organisatorischen Einbettung und Ausgestaltung des (IT-) Projektportfoliomanagements befassen. Aufbauend auf der Literaturanalyse werden aktuelle Entwicklungen in beiden Forschungssträngen diskutiert und verbleibende Forschungslücken aufgezeigt.

Im Rahmen einer Fallstudienuntersuchung mit zehn beteiligten Unternehmen werden tiefergehende Einblicke in die konkrete Ausgestaltung von Governance-Strukturen für das IT-Projektportfoliomanagement in der Praxis gegeben. In diesem Kontext werden unterschiedliche Aktivitätsfelder und verschiedene Kontingenzfaktoren hinsichtlich der Ausgestaltung der Governance des IT-Projektportfoliomanagements betrachtet. Dabei wird auch verdeutlicht, wie sich verschiedene Governance-Mechanismen in unterschiedlichen

Aktivitätsfeldern ergänzen. Ferner wird diskutiert, welche Konsequenzen sich aus dem Einsatz unterschiedlicher Governance-Mechanismen ergeben.

Basierend auf den Erkenntnissen der Fallstudienuntersuchung wird ein mathematischer Modellierungsansatz für die Untersuchung des Einflusses unterschiedlicher Governance-Strukturen im Rahmen des IT-Projektportfoliomanagements vorgestellt. Der Ansatz basiert auf einem generischen Koordinationsmechanismus, der auf Grundlage der Fallstudienergebnisse ermittelt wurde. Der Ansatz wird durch Simulationsexperimente verdeutlicht. Dabei wird insbesondere der Einfluss unterschiedlicher Arten von Projektinterdependenzen auf das Ergebnis der Portfolioselektion in verschiedenen Entscheidungskonstellationen untersucht. Beispielsweise wird illustriert, in welchem Maße dezentrale Entscheidungsstrukturen zu geringer Synergieausnutzung, Redundanzen und Budgetüberschreitungen führen können.

Die Ergebnisse dieser Arbeit tragen zu einem besseren Verständnis der Bedeutung adäquater Governance-Strukturen für das IT Projektportfoliomanagement sowie der Faktoren, die die Ausgestaltung dieser Strukturen bedingen, bei. Gleichzeitig lassen sich durch den generischen mathematischen Ansatz, der in dieser Dissertation vorgestellt wird, unterschiedliche Entscheidungskonstellationen im Hinblick auf ihre Vorteilhaftigkeit untersuchen und Hypothesen für zukünftige Forschungsprojekte ableiten.

1 Introduction

1.1 Motivation

In recent years, information technology (IT) has become indispensable in most large companies, and for some industries, like the financial industry, IT is the main production factor today.[2] At the same time, many companies are heavily investing into new IT systems and capabilities.[3] In order to cope with technological and strategic changes but also to drive innovation, constantly new IT project proposals accrue within these organizations. In this context, there is a trend to manage more and more organizational activities as projects.[4]

While constant renewal and innovation are of high importance for the prospering of an organization, some project proposals are not of benefit to the company and, therefore, should be rejected. Moreover, IT projects typically underlie significant risks, wherefore even some of the project proposals promising high returns should not be approved. Most importantly, IT resources such as project managers or programmers are typically very scarce. Consequently, there are often more potential IT projects than can be staffed with the available resources.[5] As IT projects compete for the same scarce resources and are often subject to additional interdependencies, they should be assessed and managed in comparison and not in isolation. This situation briefly describes the background for IT project portfolio management, the main subject of the current dissertation. Simply speaking, in contrast to project management which is concerned with "doing projects right", project portfolio management is in particular concerned with "doing the right projects".[6]

In order to effectively evaluate, select, and manage IT projects as a portfolio, appropriate governance arrangements are required.[7] Establishing IT governance arrangements involves specifying decision rights and accountabilities by implementing structural, procedural, and relational mechanisms.[8] There is no IT governance arrangement that fits to all companies.[9] Consequently, when implementing new governance arrangements in a given organization, several contingency factors need to be taken into account and different groups of stakeholders

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[2] Cf. Verhoef, 2005, p. 316.
[3] Cf. Weill & Ross, 2004, p. 14f.
[4] Cf. Killen & Hunt, 2010, p. 159.
[5] Cf. Archer & Ghasemzadeh, 1999, p. 207.
[6] R. G. Cooper et al., 2000, p. 18. Also compare De Reyck et al., 2005, p. 524; Elonen & Artto, 2003, p. 395.
[7] Cf. Cao et al., 2005, p. 371.
[8] Cf. Peterson, 2004, p. 14; Weill & Ross, 2004, p. 2. The concept of IT governance will be introduced in detail in chapter 2.
[9] Cf. Cao et al., 2005, p. 368; Weill & Ross, 2004, p. 18.

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need to be considered.[10] This in particular applies to the IT project portfolio management context, where many different kinds of stakeholders are involved.[11]

Importantly, IT projects commonly are not only a matter of the IT department. As information systems are the backbone of many large companies, they affect stakeholders in various business units and departments. Consequently, requirements for changes to these systems or demands for new information systems are typically triggered by business stakeholders from different parts of the organization.[12] In this context, previous literature on IT project portfolio management has emphasized the need for obtaining a centralized view on the corporate-wide IT project portfolio.[13] However, this does not necessarily reflect the way IT project portfolio management arrangements are implemented in practice. In contrast, in many companies rather decentralized governance arrangements for IT project portfolio management are installed, where IT projects are not approved and managed at a corporate-wide level but at a divisional or departmental level. Moreover, federal arrangements can often be encountered, where different kinds of IT projects are handled at different hierarchy levels, depending on the project characteristics.[14]

While decentralized arrangements reduce complexity and leave a certain degree of autonomy to local units, these arrangements are susceptible to inefficiencies caused by redundancies and the negligence of synergy potentials.[15] Centralized arrangements, in contrast, may foster the exploitation of synergy potentials and the implementation of strategic initiatives, but are often incompatible with the organizational culture and other contingency factors.[16] Federal arrangements can provide a compromise but often lead to an even more fragmented view on the portfolio and are particularly prone to ineffectiveness.[17] Consequently, some fundamental tradeoffs need to be regarded when choosing a particular governance arrangement. This dissertation sets out to explore this tradeoff in detail in the context of IT project portfolio management. For this purpose, contingency factors fostering or inhibiting different governance arrangements are explored and consequences of the use of different arrangements are investigated.

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[10] Cf. Sambamurthy & Zmud, 1999.
[11] Cf. Crawford et al., 2008, p. 46; Jonas, 2010, p. 832.
[12] Cf. Chiang & Nunez, 2009, p. 104f.; Legner & Löhe, 2012, p. 3; Weill & Ross, 2004, p. 15. A definition of the term *IT project* as it is understood in this dissertation will be provided in section 3.2.1.1.
[13] Cf. De Reyck et al., 2005, p. 526; Jeffery & Leliveld, 2004, p. 43; Maizlish & Handler, 2005, p. 15.
[14] For example, large and costly projects are often handled at higher levels in the hierarchy than smaller, less expensive projects. Different governance arrangements encountered in practice will be described and discussed in more detail in chapter 4.
[15] Cf. C. V. Brown & Magill, 1994, p. 372; Peterson, 2004, p. 10f.
[16] Cf. C. V. Brown & Magill, 1994, p. 372; Peterson, 2004, p. 10f.
[17] Cf. Weill & Ross, 2004, pp. 130–132.

From a theoretical point of view, this dissertation contributes by transferring concepts from the domain of IT governance research to the IT project portfolio management context and by integrating existing theoretical foundations in the IT project portfolio management discipline. Major theoretical contributions resulting from this research are a contingency model and a formal model of decision-making in organizations.

This research is also of practical relevance as IT project portfolio management is particularly susceptible to political interventions and many companies struggle to install appropriate governance arrangements. In this context, IT governance experts and middle managers in charge of IT project portfolio management are often torn between conflicting requirements.[18] In order to support these experts and to prevent failures of costly change initiatives, a thorough assessment of antecedents and consequences of the use of alternative governance arrangements is of vital importance. For this purpose, an approach for assessing the impact of different governance arrangements for IT project portfolio management, dependent on the given organizational environment, is outlined in this dissertation.

1.2 Research objectives

The main objective of this thesis is to analyze the antecedents for and the impact of the use of different governance arrangements for IT project portfolio management. The following general research questions have motivated and guided the work presented in the subsequent chapters:

1. What is the current state of research in the domain of IT project portfolio management?
2. Which governance arrangements are employed for IT project portfolio management in practice?
3. Which contingency factors influence the design of governance arrangements for IT project portfolio management?
4. Which advantages and disadvantages apply to different governance arrangements for IT project portfolio management?
5. How can different governance arrangements be modeled and compared in the particular context of IT project portfolio selection?

The answering of the **first research question** provides the grounds for the following investigations. Project portfolio management in general and IT project portfolio management

[18] Pellegrinelli & Garagna as well as Unger, Gemünden, et al. emphasize that in particular employees in multi-project management offices often become victims of conflicts between centralized and decentralized stakeholders (cf. Pellegrinelli & Garagna, 2009, p. 652; Unger, Gemünden, et al., 2012, p. 609).

in particular is a relatively new field of research.[19] Still, significant progress has been made in recent years. Consequently, it is an important endeavor to identify and integrate the current literature, to demarcate the field of research, and to identify opportunities for future studies.

The **second research question** has been posed in order to gain deeper insights into the implementation of IT project portfolio management arrangements in practice. Although a significant body of literature on IT project portfolio management already exists, much of the previous work has been of conceptual nature. More recently, a growing number of empirical contributions have been published, but comprehensive insights into governance arrangements for IT project portfolio management are still considerably scarce.[20] Empirical research in this area has typically focused on specific aspects such as roles and responsibilities of middle managers or management control mechanisms.[21] Moreover, most existing empirical studies are concerned with project portfolios in general and not IT project portfolios in particular, wherefore the particularities of the specific governance context are not taken into account. Consequently, the second research question is intended to motivate a comprehensive study of governance arrangements in the specific context of IT project portfolio management.

The **third research question** takes account of the large impact of contingency factors in the IT governance context.[22] Typically, different variants of IT governance arrangements can be encountered in practice, dependent on a number of organizational and environmental factors.[23] In contrast to the second research question, which primarily motivates a description of the governance arrangements employed in practice, the third research question aims at an investigation of the impact of the environments in which these governance arrangements are embedded. This investigation is of high relevance as it helps to explain why different arrangements are used in practice and which arrangements are appropriate in a given context.

The **fourth research question** motivates an investigation of the consequences of the use of different governance arrangements in the IT project portfolio management context. While the appropriateness of a particular governance arrangement in a given context depends on different contingency factors, it is still of interest to investigate the general advantages and

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[19] Cf. Levine, 2005, p. 92.
[20] Cf. Unger, Gemünden, et al., 2012, p. 609.
[21] Cf. e.g. Blomquist & Müller, 2006; Canonico & Söderlund, 2010.
[22] Cf. A. E. Brown & Grant, 2005, pp. 703–706.
[23] Cf. Weill & Ross, 2004, p. 18.

disadvantages of different arrangements in order to anticipate outcomes on the IT project portfolio level.[24]

Finally, the **fifth research question** is inspired by previous research on decision-making in organizations.[25] By formally modeling and comparing different governance arrangements for IT project portfolio management, relationships and effects identified in previous research can be retraced and explained. Moreover, propositions for future empirical research can be derived. If adapted to the specific organizational context, such an approach also provides a means to support IT governance experts in evaluating the appropriateness of different potential governance designs.

1.3 Outline

In this section, the structure of this dissertation is briefly outlined and explained. Figure 1 gives an overview of the included chapters and their contents.

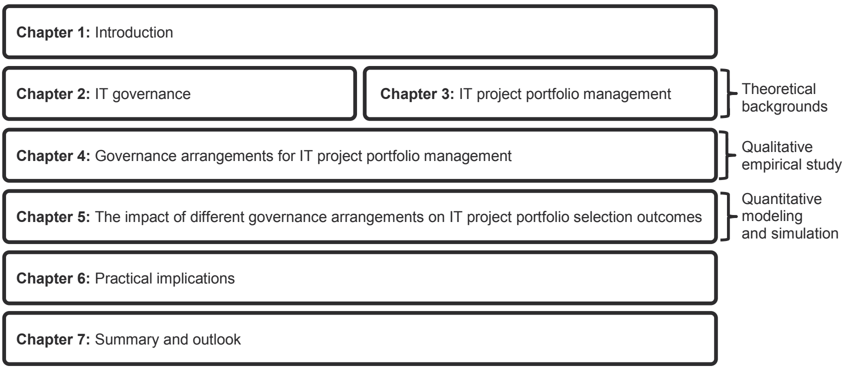

Figure 1: Outline of the dissertation

Following the current introduction, the two theoretical backgrounds of this dissertation are presented. First, concepts and constructs from IT governance research are introduced. The IT governance research discipline is well established and routed in theoretical backgrounds like

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[24] Motivated by a previous study of Tanriverdi (cf. Tanriverdi, 2006), in particular the impact of IT synergy potentials shall be investigated in this context.

[25] E.g. Sweeney et al., 1978; Winkofsky et al., 1981.

organizational theory and agency theory.[26] Consequently, the corresponding chapter – **chapter 2** – is limited to a relatively brief summary of existing conceptions.

The second theoretical foundation of this dissertation consists of conceptual and empirical backgrounds from the IT project portfolio management discipline. This discipline is relatively new. Therefore, in **chapter 3**, results of a structured literature review are presented in order to identify and analyze the state of the art in this field of research in a rigorous and comprehensive way. Chapter 3 in particular addresses the first research question. In the subsequent chapters, findings and concepts adapted from IT governance research will be applied to the IT project portfolio management discipline. Thereby, a stronger link between existing IT governance concepts and IT project portfolio management will be established.

In **chapter 4**, governance mechanisms employed for IT project portfolio management in practice are investigated based on a qualitative empirical study. In this context, different fields of activities, different contingency factors, and different outcome categories are identified and integrated into a comprehensive contingency model. Thereby, research questions 2 - 4 are addressed.

In **chapter 5**, the impact of using different decision-making arrangements for IT project portfolio selection is investigated based on a quantitative modeling approach. For this purpose, a new conception for modeling decision-making in organizations in the IT project portfolio management context is established and demonstrated. The underlying conception is grounded in the insights gained during the empirical study described in chapter 4. Based on a computational study, outcomes obtained in different governance arrangements are simulated and related to empirical findings. Moreover, a framework for visual comparisons based on efficient frontiers is presented in order to demonstrate alternative ways of employing the general approach. Chapter 5 in particular addresses the fifth research question but also represents an alternative way to respond to the fourth research question.

Practical implications of the current research are briefly described in **chapter 6**. Finally, a summary and an outlook on future research are provided in **chapter 7**.

[26] Cf. C. V. Brown, 1999, p. 425; Olson & Chervany, 1980, p. 58; Simonsson et al., 2010, p. 11; Winkler et al., 2011, p. 3.

2 IT governance – Structures, processes, and relationships in IT decision-making

Business processes in contemporary companies often heavily rely on the supporting information systems. Moreover, today, many innovations are to a considerable extent based on new IT capabilities. In order to warrant the continuous support of existing information systems as well as the development of new IT-based solutions, organizational units are required that provide the corresponding skills and resources. In the following, the term information systems function (shortly IS function) will be employed in order to refer to the entity of these organizational units within a firm.[27] The dispersion of IT competencies throughout the organization and the structuring of the IS function have been widely discussed in the information management literature. However, due to the rapid development of information technology, the role and structuring of IS functions has been subject to constant changes over the past decades.

In this chapter, major developments concerning the structuring and organization of the IS function will be discussed and the existing body of IT governance research will be presented in brief. As IT project portfolio management is embedded into a wider organizational context, it is vital to consider IT governance from a broad perspective when investigating organizational requirements for IT project portfolio management.

Section 2.1 contains a brief discussion of historical developments in corporate IS functions. Following, in section 2.2, the key terms *centralization* and *decentralization* are introduced in the context of the organizational integration of the IS function. The common perception that different fields of activities of the IS function require different decision-making arrangements has led to the notion of the term *IT governance*. The corresponding transition in literature towards contemporary IT governance conceptions is described in section 2.3. Findings from the IT governance literature are discussed in section 2.4. Finally, in section 2.5, the requirement for alignment between the IS function and different business units is discussed in order to provide the theoretical foundation for a later discussion of coordination mechanisms in the context of IT project portfolio management.

2.1 Historical developments in corporate IS functions

Studies on the structuring and the organizational integration of the IS function have a long history in information systems research. Historically, the role and the internal organization of

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[27] This is in accordance with the predominant use of the term in the relevant literature.

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corporate IS functions has been largely influenced by rapid developments in information technologies and the growing pervasiveness and heterogeneity of IT.[28]

The early days of IT were characterized by large mainframe systems providing computational resources for the entire company. Accordingly, corporate IS functions offered central services and, therefore, were usually centralized to a large degree.[29] When, at the beginning of the 1980s, minicomputers became available and, later, personal computers were introduced, computational resources became more and more dispersed to decentralized units in many companies.[30] This in parallel led to a stronger decentralization of IS functions as local units required local IT support for their information systems.[31]

Since the mid-1980s, rapidly falling prices for computer equipment and growing computational performance lead to a fast adoption of information technology, but at the same time resulted in rather chaotic system landscapes. In turn, many companies began to recentralize their IS function.[32] However, at this time, new forms of centralization emerged that differed significantly from the kind of centralization in IS functions observable during the initial phase.[33] As IT became more pervasive in most companies the role of IS functions changed. While in the 1960s and 1970s decisions about IT resources were made at the locations where these resources resided, this was not necessarily the case anymore in the 1990s. Consequently, new governance arrangements for IT emerged. These were characterized by centralized control over decentralized resources and coordination through standardization.[34]

Due to technical and organizational innovations, the IS functions over time became responsible for new fields of activities. In many companies, decentralized decision-making had led to complex system landscapes causing huge operational costs. In order to simplify these system landscapes and to provide for flexibility at the same time, IS architecture management became an important task of the IS function.[35]

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[28] Although the developments in corporate IS functions certainly differ from company to company, there have been a number of common trends in the historic development of IS functions. These general developments are discussed here.

[29] Cf. Ahituv et al., 1989, p. 389; Zmud, 1984, p. 80. Definitions of the terms *centralization*, *decentralization* and *federal arrangements* are provided in section 2.2.1.

[30] Cf. Kahai et al., 2003, p. 52; Tavakolian, 1989, p. 309; Zmud et al., 1986, p. 17f.

[31] Cf. Kahai et al., 2002, p. 44.

[32] Cf. Kahai et al., 2002, p. 44; von Simson, 1990, p. 158.

[33] Cf. Kahai et al., 2002, p. 45.

[34] Cf. Kahai et al., 2002, p. 45.

[35] Cf. Allen & Boynton, 1991, p. 435.

In addition, as more and more processes were supported by IT systems and interconnection within and between companies increased, the business impact of information technology became stronger and the strategic value of IT moved into focus.[36] As IT-enabled business processes require cooperation between the IS function and different business units, business/IT alignment became a growing challenge.[37] IT architectures should support the business strategy and, at the same time, business strategies often depend on underlying IT capabilities.[38] Therefore, in many companies, the spectrum of tasks of the internal IS function has broadened in recent years and shifted towards supporting the business strategy.[39] Over the time, the traditional perception of the IS function as a single homogeneous entity became obsolete.[40] Nowadays, the spectrum of tasks may range from infrastructure and application management activities over software development and project management tasks to relationship management and consulting activities.

Triggered by new corporate governance requirements (e.g. the Sarbanes-Oxley Act), increasing IT controlling activities, and a growing need to justify IT expenses, recent years have also seen a stronger structuring and professionalization of the IS function.[41] In this context, IT-internal processes and fields of activities like IT service management, IT demand management, and IT portfolio management are subjected to a stronger formalization and standardization. Maturity models and IT governance frameworks have emerged.[42]

Today, de-facto standards (also referred to as "best practice reference models") like Val IT, COBIT, and ITIL provide frameworks of reference for the structuring of IT-related tasks.[43] These standards support distinct IT governance and IT management subjects at different levels of abstraction and detail.[44] However, despite the growing availability of reference frameworks, IT governance arrangements still have to be adjusted to the given organizational context and contingency factors need to be taken into account.[45] Furthermore, organizational

[36] Cf. Chan & Reich, 2007b, p. 303; Sambamurthy & Zmud, 2000, p. 106; Venkatraman, 1997, p. 51. It should be noted that the business impact of IT is subject to controversial debates. For example, a vivid discourse has been started by Nicholas Carr who critically discussed the future role of information technology and hinted at the potential commodity character of hardware and software (cf. Carr, 2004).
[37] Cf. C. V. Brown & Magill, 1994, p. 371.
[38] Cf. Ross, 2003, p. 31.
[39] Cf. Kearns & Sabherwal, 2007, p. 131.
[40] Cf. Peterson, 2004, p. 9.
[41] Cf. Looso & Goeken, 2010, p. 5f.
[42] Cf. Simonsson et al., 2010, p. 11.
[43] Cf. Looso & Goeken, 2010, p. 2f.
[44] Cf. Simonsson et al., 2010, p. 11.
[45] Cf. C. V. Brown & Magill, 1994.

structures and strategies are subject to frequent changes.[46] Therefore, IT governance arrangements also have to be redesigned from time to time in order to cope with new external or internal situations.[47]

Over the last decades, there has in particular been a trend towards outsourcing certain IT activities in many companies.[48] Especially IT infrastructure management and application development are nowadays often provided by external service providers and offshoring partners.[49] Moreover, new forms of IT provisioning like Cloud Computing and Software as a Service (SaaS) have led to changes in the tasks and governance arrangements of internal IS functions.[50] In consequence, some tasks – like the provisioning and operation of hardware – have moved out of focus in a number of companies. However, the ability to effectively and efficiently manage the existing IT resources – whether internally or externally – has remained a fundamental requirement for contemporary IS functions.[51] In order to effectively manage IT spending and adequately address strategic objectives, IT projects have gained growing importance in recent years.[52] Consequently, the governance of IT investments via IT project portfolio management has become a key challenge.[53]

Governance arrangements for IT project portfolio management are the key topic in this dissertation, but before governance arrangements are investigated in the particular context of IT project portfolio management, it is important to review the existing body of IT governance research first. Thereby, a theoretical and conceptual foundation for the following chapters is provided.

2.2 Centralization and decentralization

Historically, a huge part of information systems research has been concerned with the positioning and structuring of the IS function. In this context, the concept of centralization and decentralization, borrowed from organizational theory, has been widely used.[54] In the current section, the terms *centralization* and *decentralization* will be defined and general advantages and disadvantages of both extremes will be discussed. In the following sections,

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[46] Cf. Nickerson & Zenger, 2002.
[47] Cf. Sabherwal et al., 2001.
[48] Cf. Bossert et al., 2010, p. 94.
[49] Cf. Beulen et al., 2005, p. 133f.; Buxmann et al., 2013, pp. 123–131.
[50] Cf. Winkler & Benlian, 2012; Winkler et al., 2011.
[51] Cf. Chan & Reich, 2007b, p. 336; Dutta, 1996, p. 257; Maizlish & Handler, 2005, p. 1.
[52] Cf. Canonico & Söderlund, 2010, p. 796.
[53] Cf. Jeffery & Leliveld, 2004, p. 41.
[54] E.g. Ahituv et al., 1989; C. V. Brown & Magill, 1998; Burlingame, 1961; Ein-Dor & Segev, 1982; Kahai et al., 2003, 2002; Olson & Chervany, 1980.

the terms will be subjected to a critical discussion and the evolution of contemporary concepts of IT governance research will be outlined.

2.2.1 Definitions

As the terms *centralization* and *decentralization* are fundamental for the following chapters, both terms will be defined and discussed in detail in section 2.2.1.1 in order to ensure a concise understanding. The term *federal arrangement*, which is also commonly used in IT governance research, will be defined in section 2.2.1.2.

2.2.1.1 Centralization and decentralization

Although the terms *centralization* and *decentralization* are omnipresent in IS management literature, the search for a general definition is compounded by the fact that the terms have been used in different contexts. In the following, a number of definitions extracted from the existing literature will be presented. Based on these definitions, commonalities and differences in the perception of the two terms will be discussed. The definitions will be presented chronologically in order to demonstrate evolutions in the IS management literature.

One of the first descriptions of the concept of decentralization in IS research has been provided by Burlingame. Burlingame uses this concept in order to characterize the impact of advances in information technology on the future role of middle managers. Therefore, the description applies to the company as a whole and not specifically to the IS function.[55]

> "For the purposes of our discussion, the concept of decentralization can be simply stated. Decision-making responsibility is assigned at the lowest point in the organization where the needed skills and competence, on the one hand, and the needed information, on the other hand, can reasonably be brought together."[56]

Olson & Chervany name "Centralization of Authority" as one of six characteristics of the overall organization. They examine the influence of these characteristics on the positioning of the IS function.[57] In this context, Olson & Chervany define "Centralization of Authority" as follows:

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[55] Burlingame, 1961, p. 121.
[56] Burlingame, 1961, p. 121f.
[57] Olson & Chervany, 1980, p. 60.

> "In a highly centralized company, most decisions are made at the top of the management hierarchy. In a decentralized company, many decisions are delegated to lower management levels."[58]

Tavakolian investigates the impact of the strategic orientation of the firm on the degree of centralization of IT activities.[59] In this definition, a connection between the "degree of centralization of IT activities" and "user's responsibilities" is outlined:

> "[…] the degree of centralization of IT activities refers to the locus of responsibilities for the IT activities. The higher the degree of centralization, the lower the users' responsibilities."[60]

Kahai et al. examine the congruence between the location of resources in the IS function and the location of decision-making rights for these resources. They perceive centralization and decentralization as two extreme ends of a continuum. Similar to Tavakolian, they hint at the different roles of a centralized IS function and users of IT products and services. Moreover, Kahai et al. highlight the aspect of geographical dispersion:

> "At one extreme of the continuum, i.e., in a centralized environment […], resources are located, operated, and managed exclusively by an IS group in a central location. Any interaction of the organization's employees with the IS function is in the form of products and services that they receive, *regardless of their geographical location*. At the other extreme of the continuum, i.e., in a decentralized environment […] IS resources are located near and operated and managed exclusively by users who are dispersed throughout the organization. Employees make decisions about the resources without consultation with, or input from, a central IS function […]."[61]

Brown & Magill present a definition of the term "centralization/decentralization (C/D) solution" in the context of the distribution of responsibility between a corporate IS unit and business units with own IT personnel. They claim that this is the most common definition:[62]

[58] Olson & Chervany, 1980, p. 60
[59] Cf. Tavakolian, 1989, p. 311.
[60] Tavakolian, 1989, p. 311.
[61] Kahai et al., 2002, p. 45.
[62] Cf. C. V. Brown & Magill, 1994, p. 373.

> "In a centralized solution, the IS responsibility is held totally within a centralized or corporate IS unit. In a decentralized solution, the IS responsibility is held totally within business units, resulting in multiple units with IS personnel dispersed throughout a firm." [63]

Peterson defines the term "centralized IT governance mode". He emphasizes that the term should not be applied to IT and IT governance in general but to "the main elements in the portfolio of IT".[64]

> "In a centralized IT governance model, corporate and senior-level executives have decision-making authority for IT investments […]"[65]

Analogously Peterson also provides a detailed definition of a "decentralized IT governance model":

> "When all IT decision-making authority is allocated to different lines of business (LoB), separate (global) business divisions (GBD), or strategic business units (SBU), the structure is described as a completely decentralized IT governance model."[66]

From the former definitions it becomes obvious that the terms *centralization* and *decentralization* are used to refer to the overall organizational context in which the IS function is embedded, as well as to the role and structuring of the IS function itself. In this regard, the degree of centralization of the overall organization can be understood as a potential contingency factor for the degree of centralization of the IS function.

We also learn from the former definitions that the terms *centralization* and *decentralization* are typically applied to the distribution of decision-making rights and responsibilities. However, they can also relate to the distribution of resources like, for example, hardware, or IT personnel. Kahai et al. name these two aspects of centralization/decentralization the "decision aspect" and the "location aspect".[67] In the particular context of IT project portfolio management governance, the main focus lies on the assignment of decision-making rights and responsibilities concerning the available resources (like funds and IT project staff). Therefore, when the terms *centralization* and *decentralization* are employed in this dissertation they usually relate to the decision aspect. However, as the impact of the structuring of the overall

[63] C. V. Brown & Magill, 1994, p. 373.
[64] Cf. Peterson, 2004, p. 10.
[65] Peterson, 2004, p. 10.
[66] Peterson, 2004, p. 10.
[67] Kahai et al., 2002, p. 44.

organization on the governance arrangements employed for IT project portfolio management is also investigated in the following, the location of resources will also be of interest.

From the definitions presented above, it becomes apparent that the degree of centralization of the IS function does not only affect the IS function itself but also IT users from outside the IS function, i.e., the different business units in the overall organization. Particularly in more recent contributions, centralization is attributed to a strong involvement of a centralized IS function, while decentralization is understood as a strong involvement of different business units.[68] In contemporary organizations, the IS function is often organized as a corporate-wide center. Consequently, assigning decision-making rights to the IS function usually corresponds to centralizing decision-making competencies.

In this context, it is important to highlight the close relationship between IT governance research and the concept of business/IT alignment.[69] Particularly in the IT project portfolio management context, the interplay between the IS function and different business units is of high relevance. The demand for new IT projects usually originates from various stakeholders in different business units.[70] Therefore, the degree of centralization of governance arrangements for IT project portfolio management does not only affect the IS function but also the business units.

2.2.1.2 Federal arrangements

Centralization and decentralization have been widely used as basic concepts in IS research. However, already at a relatively early stage of IT governance research it has been recognized, that these two concepts are rather extreme cases of the continuum of potential governance arrangements. In practice, decision-making rights are often distributed to different decision makers or decisions are jointly taken in a committee. These alternative forms of governance have been labeled as *federal arrangements* or *hybrid structures*.

In general, federal arrangements represent a compromise between centralized and decentralized arrangements. They involve representatives from a central authority as well as local authorities. Originally, the term “federal” refers to a “[…] system of government in which several states form a unity but remain independent in internal affairs”.[71] Similarly, in

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[68] Also compare Winkler et al., 2011, p. 4.
[69] The concept of business/IT alignment in general will be discussed in more detail in section 2.5.
[70] Cf. Chiang & Nunez, 2009, p. 104f.; Legner & Löhe, 2012, p. 3. A definition of the term *IT project* as it applies to this dissertation will be introduced in section 3.2.1.1.
[71] Oxford Dictionaries, 2012.

federal IT governance arrangements local units may exercise some decision-making rights independently from the corporate center.

Already in 1986 Zmud et al. envisaged a federal government role of the IS function. In this context, he noted the following:

> "In carrying out a similar federal government role [like the federal government] within the enterprise's information economy, the information systems department cannot dictate how business units are to handle their information processing activities. Still, they can and must influence the actions of these business units through policies, regulations and standards."[72]

Based on this description, the conflict between local and corporate IT requirements becomes apparent. The IS function by its very nature is in a key position for bridging the gap between the need for local autonomy and the need for coordination. The IS function should support the local requirements of the business units but at the same time has to protect and facilitate the efficiency and integrity of the corporate-wide IT landscape. Zmud et al. relate this requirement to a federal government role of the IS function:

> "In short, this federal government role for the information systems function stresses both the desirability of entrepreneurial information-related behaviors by business units, as well as the need to insure that these behaviors are not detrimental to the enterprise's information technology posture in either the short or long run."[73]

Brown & Magill also employ the term "federal governance role" to describe the relationship between the IS organization and the business units:

> "Within the information economy of a firm, a 'federal government role' is prescribed for the central IS organization that is responsible for the 'transportation architecture' (processors, databases, and networks), while the business units provide information products and services (i.e., plan, build, and run their own application systems)."[74]

Like Zmud et al., Brown & Magill comprehend the IS function as a central instance responsible for unit-overarching activities. Nevertheless, the role of the IS function described by Brown & Magill significantly differs from the role described by Zmud et al.. While Zmud et al. see the IS function as a coordinator employing policies, regulations and standards in

[72] Zmud et al., 1986, p. 18.
[73] Zmud et al., 1986, p. 18.
[74] C. V. Brown & Magill, 1994, p. 372.

order to influence and align the actions of the different units, Brown & Magill see the responsibility of the IS function in managing a central architecture, while the business units independently manage their own application systems. In this concept, the IS function and the business units are responsible for separate IT-related decisions. Consequently, the two definitions presented above demonstrate that there are different perceptions of the configuration of federal arrangements.

In general, the emergence of the concept of federal arrangements in IT governance research historically led to a broadening of the continuum of governance arrangements and to more differentiated conceptualizations of IT governance arrangements in different contexts. As pointed out by Brown & Magill, IT governance arrangements have often been described as a "tri-partite" centralization/decentralization choice with a federal or hybrid structure between the two extremes but also as a continuum of centralization/decentralization choices.[75] Research in recent years, however, has taken a much deeper look into the complete spectrum of formal and informal structures, processes, and relational mechanisms that can be used in order to govern IT decisions.[76]

In practice, there are nearly unlimited options to shape IT governance arrangements. Structures, processes, and relational mechanisms as well as rights and responsibilities of the units involved can differ in various degrees and dimensions.[77] However, in order to be able to compare different IT governance arrangements in a research context, it is common to abstract from the specifics and to distinguish between a limited number of prototypical arrangements.

Weill & Ross, for example, distinguish between six different general governance archetypes, one of them being the federal archetype.[78] In this context, Weill & Ross provide the following quite general definition of the federal archetype:

> "Combination of the corporate center and the business units with or without IT people involved"[79]

As this definition demonstrates, a characteristic feature of federal arrangements is the interplay between a centralized unit and different decentralized units. Moreover, the relationship between the IS function and different stakeholders from the business-side is of

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[75] Cf. C. V. Brown & Magill, 1994, p. 373f.
[76] Cf. De Haes & Van Grembergen, 2009, p. 130f.
[77] Cf. De Haes & Van Grembergen, 2009, p. 123; Sambamurthy & Zmud, 2000, p. 107; Weill & Ross, 2004, pp. 85–116.
[78] Cf. Weill & Ross, 2004, p. 12.
[79] Weill & Ross, 2004, p. 12.

particular interest in this context. This aspect is intensively addressed in IS theory in the literature concerned with business/IT alignment.[80] In the typology of governance arrangements introduced by Weill & Ross both aspects – the degree of centralization and the relationship between business and IT – play an important role. The latter aspect is in particular covered by a governance arrangement similar but still different from the federal arrangement - the "IT duopoly".[81]

In contemporary IT governance arrangements one can often witness combined decision-making of a number of decentralized business units and a centralized IS function. However, it is important to note that centralization does not necessarily mean that all decision-making rights are assigned to the IS function. Centralization can also imply that a number of top managers centrally decide in a "business monarchy".[82] Moreover, the IS function itself might also not be completely centralized but organized in a federal way.

2.2.2 Comparison of centralized, decentralized, and federal arrangements

As mentioned above, various coordination mechanisms can be employed in order to link local and central authorities as well as the business and the IT side. In this subsection, it will be abstracted from these mechanisms in order to compare the general advantages and disadvantages of centralized, decentralized, and federal arrangements. Although centralized and decentralized IT governance arrangements are idealized concepts, this notion can be perfectly employed in order to illustrate some general tradeoffs in the design of organizational structures – in particular the tradeoff between autonomy and control. Brown & Magill, for example, summarize the general tradeoff between centralization and decentralization as follows:

> "Within the literature there also appears to be general agreement about the primary organizational tradeoffs: centralization affords greater efficiencies (economies of scale) and standardized controls as well as organizational integration, while decentralization provides local control and ownership of resources as well as greater responsiveness to business unit needs"[83]

[80] Cf. section 2.5.
[81] Cf. Weill & Ross, 2004, p. 12.
[82] Cf. Weill & Ross, 2004, p. 12.
[83] C. V. Brown & Magill, 1994, p. 372.

Consequently, in order to install an appropriate governance arrangement it is important to evaluate factors like the required degree of efficiency and responsiveness to business unit needs in a first step. This goes along with defining a corporate strategy and an IT strategy.[84]

Assigning decision-making rights to centralized or decentralized units can lead to a number of positive as well as negative consequences that should be anticipated by IT governance experts. Consequently, it is important to know the general advantages and disadvantages of centralized, decentralized, and federal governance arrangements. These have been widely discussed in the existing literature.

Peterson summarizes the advantages and disadvantages of centralization and decentralization as depicted in Table 1.[85] In the table, plus signs indicate advantages while minus signs symbolize disadvantages. The plus signs in the federal IT governance column indicate that federal arrangements have the potential to combine the advantages of centralization and decentralization and, thus, meet the "[...] dual demands for flexibility and speed on the one hand, and efficiency and standardization on the other."[86] However, it should be noted that Table 1 should not be interpreted in such a way that federal IT governance models are preferable in every constellation. Peterson highlights that contingency factors have to be taken into account so that there is no "best way" to govern IT.[87] Moreover, as discussed below, federal IT governance arrangements often also involve significant disadvantages.

[84] The relationships between strategy and structure will be discussed in more detail in section 2.5 in the context of business/IT alignment.

[85] In this context, it should be noted that Peterson's understanding of a federal model is that IT infrastructure decisions are centralized and IT application decisions are decentralized (cf. Peterson, 2004, p. 11). Peterson also distinguishes between an IT-centric and a business-centric federal model depending on the involvement of business executives in IT decision-making (cf. Peterson, 2004, p. 11).

[86] Cf. Peterson, 2004, p. 11.

[87] Cf. Peterson, 2004, p. 21.

Table 1: Advantages and disadvantages of centralized, decentralized, and federal IT governance arrangements[88]

	Centralized IT Governance	Decentralized IT Governance	Federal IT Governance
IT synergy	+	–	+
IT standardization	+	–	+
IT specialization	+	–	+
Business responsiveness	–	+	+
Business ownership	–	+	+
Business flexibility	–	+	+

Source: Brown and Magill, 1998; Rockart et al., 1996.

Already in 1996, Hodgkinson provided a comparison of advantages and disadvantages of centralized and decentralized IT organizations with a particular emphasis on the advantages of federal arrangements (cf. Figure 2). In this context, Hodgkinson also states that "The federal IT organization attempts to capture the benefits of both centralized and decentralized IT."[89]

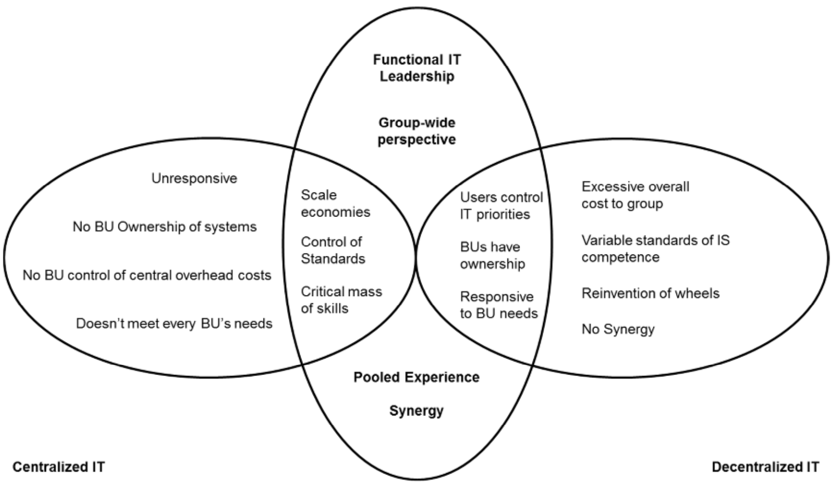

Figure 2: Potential advantages of federal IT organizations[90]

[88] Reprinted from Peterson, 2004, p. 11 with permission from Taylor & Francis.
[89] Hodgkinson, 1996, p. 249.
[90] Reprinted from Hodgkinson, 1996, p. 249 by permission of Oxford University Press.

While the advantages and disadvantages of centralization identified by Hodgkinson are quite similar to those described by Peterson, there is a difference in their concepts of a federal arrangement. In Peterson's concept, the business functions as well as the IS function are involved in a federal arrangement. Hodgkinson, in contrast, focuses on the internal structuring of the IS function. In his concept, a federal IT organization comprises a corporate IS function that provides group-wide services and several decentralized IS departments that support the business units. The central IS function coordinates the activities of the decentralized IS departments to a certain degree.[91] These two different concepts reflect the general evolution of the field of IT governance from an internal focus on the IS function towards a broader focus on the relationship between business and IT.[92]

The evaluation of federal models in Table 1 and Figure 2 may lead to the impression that federal decision-making arrangements in general are the preferred form of IT governance. However, this does not hold true in practice. Although federal arrangements indeed possess the potential to combine some advantages of centralized and decentralized arrangements, care must be taken when establishing a federal arrangement. Finding the right balance between centralized and decentralized decision-making is a demanding task. Therefore, federal arrangements need to be implemented with significant caution.[93] As federal arrangements can become a very ineffective way of governing IT, they are in fact very often inferior to other arrangements. Weill & Ross, for example, find – based on empirical data – that federal decision-making arrangements underperform for most IT decisions – including IT investment decisions.[94] The disadvantages of federal arrangements are due to the involvement of a large number of participants at different organizational levels, often leading to very complex and nontransparent structures. Thereby, decision-making is slowed down and bad compromises are accepted.[95]

Returning to the advantages and disadvantages of centralized and decentralized IT governance, it should be noted that the information requirements imposed by the given decision-making environment and the respective communication costs have a strong impact on the required degree of centralization.[96] In general, an important advantage of centralized arrangements is that information from different parts of the organization can be integrated by

[91] Hodgkinson, 1996, p. 248f.
[92] The concept of business/IT alignment will be discussed in detail in section 2.5.
[93] Cf. Peterson et al., 2000, p. 445.
[94] Cf. Weill & Ross, 2004, pp. 130–132.
[95] Cf. Weill & Ross, 2004, p. 130.
[96] Cf. Malone, 1997; Wyner & Malone, 1996.

centralized decision makers. This enables decisions that are more informed.[97] Thereby, centralized arrangements provide the opportunity to keep track of the activities of different parts of the organization and to coordinate these activities. For example, discounts can be negotiated by coordinating investment decisions of different units.[98] However, the integration of local information by a central authority is not an easy task. Even if local units are willing to provide the relevant information, it might not be possible to integrate and appropriately consider local information at a corporate level. This problem is described in more detail by Wong et al.:

> "An additional concern with centralized decision making is that as information moves up an organizational hierarchy, it may be subject to more distortion. Specifically, in centralized firms various levels of management must exchange and interpret information from lower organizational levels. Thus, the meaning of the information may be altered before it reaches the upper echelons of the organization."[99]

Although there might be a strong tendency towards centralizing or decentralizing IT decisions in some organizations, the terms *centralized*, *decentralized* or *federal* usually do not conveniently characterize the organizational design of the IS function as a whole. In some fields of IT activities, there is a strong tendency to centralize decision-making. For example, establishing a centralized corporate-wide service infrastructure promises cost-effectiveness, synergies, and scalability.[100] In other fields, differing local requirements necessitate decentralized decision-making. Consequently, in contemporary IT governance conceptions, different kinds of governance arrangements may apply to different fields of activities. Such conceptions will be discussed in more detail in section 2.4.

2.3 From centralization and decentralization to IT governance

The historical developments of corporate IS functions described in section 2.1 were accompanied by complementary developments in IT governance research. An important progress in IT governance research has been triggered by the notion of contingencies.[101] The growing diversity and complexity of decision-making arrangements in practice led to the insight, that the appropriateness of a particular governance arrangement is contingent upon the given context. Consequently, there is no single best governance arrangement that is suitable

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[97] Cf. Malone, 1997; Wong et al., 2011, p. 1210.
[98] Cf. Shapiro & Varian, 1998, p. 140f.
[99] Wong et al., 2011, p. 1211.
[100] Cf. Peterson, 2004, p. 12.
[101] Contingency theory in the general has emerged in the context of organizational theory. It has been largely shaped by authors like Lawrence & Lorsch, 1967, T. Burns & Stalker, 1961, and Woodward, 1965 (cf. Weill & Olson, 1989b, p. 60).

for every company. Factors like industry, firm size, organizational characteristics, and strategic directions can have a strong influence on IT governance requirements.[102] As pointed out by Sambamurthy & Zmud and others, these contingencies are often conflicting and interacting.[103] Therefore, it is important not to look at contingency factors in isolation but to consider the entire organizational environment when assessing the appropriateness of a particular IT governance arrangement.

Since the 1980s, a large number of contingency theories have been proposed in IT governance research.[104] In this context, the impact of different contingency factors – individually and combined – on the design of governance arrangements has been investigated in several empirical studies.[105] Brown & Magill, for example, have conducted an empirical study in order to analyze the combined effect of a large number of potential contingency factors on different degrees of centralization in different fields of activities.[106] Sambamurthy & Zmud have researched the effects of conflicting, reinforcing, and dominating contingencies based on a case study in eight firms.[107] They have categorized contingency factors into three categories: "corporate governance", "economies of scope", and "absorptive capacity".[108] However, although a large number of contingency factors on different levels of aggregation have been identified, there is no final agreement on the most relevant factors as some results diverge and the interactions between the different factors need to be considered.[109]

In addition to the emergence of contingency theory, a further important development in IT governance research should be highlighted. This second development consists in the recognition that the concepts of centralization and decentralization cannot be applied to the IS function and IT governance as a whole.[110] Olson & Chervany were among the first to recognize that different fields of activities of the IS function require different governance arrangements:

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[102] Brown & Grant provide a comprehensive list of contingency factors and authors contributing to the identification and analysis of such factors (cf. A. E. Brown & Grant, 2005, p. 704).
[103] Cf. A. E. Brown & Grant, 2005, p. 705; Sambamurthy & Zmud, 1999, p. 264.
[104] Cf. Weill & Olson, 1989b, pp. 66–76.
[105] An overview of respective contributions is presented in A. E. Brown & Grant, 2005, p. 701.
[106] Cf. C. V. Brown & Magill, 1994, p. 378.
[107] Cf. Sambamurthy & Zmud, 1999.
[108] Cf. Sambamurthy & Zmud, 1999, pp. 264–268.
[109] Cf. A. E. Brown & Grant, 2005, p. 704f.
[110] Cf. Peterson, 2004, p. 10.

> "A single continuum between complete centralization and decentralization of the information services function does not exist. As has been noted, there are several dimensions to the issue, each of which may be centralized or decentralized."[111]

Consequently, different types of IT-related decisions can be governed in different ways.[112] Brown & Magill use the term "split solutions" in order to indicate that a combination of centralized, decentralized, and "shared" arrangements can be implemented in the same firm.[113] The finding that companies tend to use different decision-making arrangements for different business units and different tasks has led to more differentiated IT governance concepts then the basic concepts of centralization, decentralization, and federal arrangements.[114]

Brown & Grant provide an extensive review of IT governance research until 2004. They argue that early contributions on IT governance were separated into two different streams of research (cf. Figure 3).

The first stream of research was primarily concerned with different IT governance structures observable in practice.[115] Initially, "basic structures" were considered based on the concept of centralization and decentralization.[116] Later, expanded structures emerged that included federal arrangements (vertical expansion) and the use of different designs for different decisions (horizontal expansion).[117]

The second stream of research was concerned with understanding the relationship between contingency factors and IT governance structures.[118] Again, Brown & Grant distinguish between basic and expanded research designs. At the beginning, contingency factors were analyzed separately from each other. Later research, in contrast, was concerned with the analysis of multiple contingencies, taking into account the interactions between different contingency factors.[119] As the first research stream shifted towards expanded structures, contingency factors were also mapped to more advanced IT governance designs.[120]

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[111] Olson & Chervany, 1980, p. 58.
[112] Cf. C. V. Brown & Magill, 1994, p. 381; Peterson, 2004, p. 10; Weill & Ross, 2004, p. 11; Xue et al., 2008, p. 70.
[113] Cf. C. V. Brown & Magill, 1994, p. 388.
[114] Cf. C. V. Brown & Magill, 1998, pp. 178–189.
[115] Cf. A. E. Brown & Grant, 2005, p. 699.
[116] Cf. A. E. Brown & Grant, 2005, p. 699f.
[117] Cf. A. E. Brown & Grant, 2005, pp. 701–703.
[118] Cf. A. E. Brown & Grant, 2005, p. 703.
[119] Cf. A. E. Brown & Grant, 2005, pp. 703–705.
[120] Cf. A. E. Brown & Grant, 2005, p. 705f.

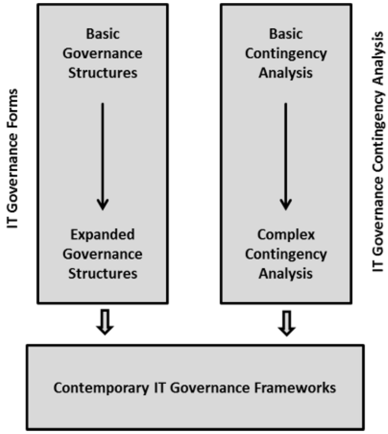

Figure 3: Developments in IT governance research[121]

Brown & Grant argue that in particular the IT governance framework proposed by Weill & Ross "[…] represents the beginning of a convergence and aggregation of two previously divided research paths."[122] In this framework, Weill & Ross distinguish between five different fields of decision-making that should be covered by appropriate IT governance archetypes.[123] One of six different archetypes can be employed for each field of decision-making.[124] The appropriateness of a certain archetype for a particular decision depends on different contingency factors – most importantly strategic and structural drivers.[125]

In the following section, the contemporary notion of IT governance will be explained in more detail. In this context, the framework of Weill & Ross and the categorization of structural, procedural and relational IT governance mechanisms will be discussed.

2.4 IT governance

In contrast to the terms *centralization* and *decentralization*, the term *IT governance* does not refer to the organizational positioning of the IS function in the first place. The term is also not limited to the internal structuring and the efficiency of the IS function. Instead, IT governance is understood as a matter of defining accountabilities and implementing rules and processes in

[121] Reprinted from A. E. Brown & Grant, 2005, p. 700 (© 2005 by the Association for Information Systems).
[122] A. E. Brown & Grant, 2005, p. 707.
[123] Cf. Weill & Ross, 2004, pp. 10–14.
[124] Cf. Weill & Ross, 2004, p. 12.
[125] Cf. A. E. Brown & Grant, 2005, p. 707f.; Weill & Ross, 2004, p. 158.

such a way that a purposeful collaboration of the staff members within the IS function as well as a good collaboration between the IS function and other business functions (business/IT alignment) is promoted.[126]

2.4.1 Emergence of the IT governance concept

The evolution of the concept of IT governance is closely linked to the realization of the importance of business/IT alignment. As historically more and more business processes became supported by information systems, a need for stronger collaboration between the business units and the IS function emerged. In this context, the relationships between business and IT had to be reorganized in many organizations. This often also went along with a reorganization of the internal structures and processes of the IS function. Therefore, IT governance can be seen as a (relatively) new concept triggered inter alia by the requirement for stronger business/IT alignment.[127]

2.4.2 Definitions

Similar to the term *organization*, the term *IT governance* has a dual character. On the one hand, *IT governance* refers to the **act** of structuring the IT organization.[128] On the other hand, the term also refers to the resulting **structure** itself (as well as the specified processes and the relationships between the different stakeholders).[129] From the former perspective, IT governance can be defined as:

> "*[...] specifying the decision rights and accountability framework to encourage desirable behavior in the use of IT.*"[130]

This often cited definition by Weill & Ross is of a very general nature. However, it highlights the importance of considering the impact of IT governance. Specifying a governance arrangement is not an end in itself. Rather, this activity shall lead to an improvement in the way IT is managed and used.

Peterson provides a definition that addresses both aforementioned perspectives on IT governance:

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[126] Cf. Simonsson et al., 2010, p. 11.
[127] Cf. Simonsson et al., 2010, p. 11.
[128] This perspective is taken up, for example, in the definition of Weill & Ross, 2004, p. 8.
[129] This perspective becomes apparent for example in the definition of Simonsson et al., 2010, p. 10.
[130] Weill & Ross, 2004, p. 2.

> "[…] IT governance is defined as: the distribution of IT decision-making rights and responsibilities among enterprise stakeholders, and the procedures and mechanisms for making and monitoring strategic decisions regarding IT."[131]

This definition hints at the distinction between structural, procedural, and relational IT governance mechanisms. This distinction between the three different kinds of mechanisms constitutes an important concept in IT governance research that will be discussed in more detail at the end of this section.

Van Grembergen & De Haes particularly highlight the importance of business involvement in IT decision-making. Therefore, they introduce the term "Enterprise Governance of IT" instead of IT governance. Van Grembergen & De Haes provide the following description of the concept:

> "Enterprise Governance of IT is an integral part of corporate governance and addresses the definition and implementation of processes, structures and relational mechanisms in the organization that enable both business and IT people to execute their responsibilities in support of business/IT alignment and the creation of business value from IT-enabled business investments."[132]

This definition is quite exhaustive. First, the rooting of IT governance in corporate governance is highlighted.[133] In fact, the strong interest in IT governance at the beginning of the 21st century has largely been triggered by new governance requirements in reaction to corporate scandals like the Enron scandal in 2002.[134] As IT governance is often perceived as one part of corporate governance, IT governance mechanisms have to be linked with other governance mechanisms – as for example financial governance mechanisms.[135] Second, in the above definition it is clearly highlighted that structural mechanisms, procedural mechanisms as well as relational mechanisms can be employed in combination in order to implement an IT governance arrangement. Finally, the strong connection between IT governance and business/IT alignment is emphasized. The definition of Van Grembergen & De Haes reflects a large portion of the contemporary foci in IT governance research. However, IT governance is a complex concept and consequently multiple perspectives exist.

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131 Peterson, 2004, p. 8.
132 Van Grembergen & De Haes, 2009, p. 3.
133 Cf. Weill & Ross, 2004, pp. 4–7.
134 Cf. Weill & Ross, 2004, p. 4.
135 Cf. Weill & Ross, 2004, p. 5.

2.4.3 The IT governance framework of Weill and Ross

As mentioned in the preceding section, the IT governance framework introduced by Weill & Ross in 2004 had a large influence on later IT governance research. Therefore, this framework will be discussed in more detail in the following. Based on a large-scaled survey of 256 enterprises, Weill & Ross have identified six different governance archetypes (cf. Figure 4).[136] These archetypes can primarily be differentiated by the two properties of the degree of centralization and business/IT relatedness.[137] Accordingly, the level of hierarchy where a decision is made and the degree of participation of business and IT representatives are considered in this conception.

	C-level executives	Corporate IT and/or business unit IT	Business unit leaders or key business process owners
Business monarchy	✓		
IT monarchy		✓	
Feudal			✓
Federal	✓	✓	✓
	✓		✓
IT duopoly	✓	✓	
		✓	✓
Anarchy			

Figure 4: IT governance arrangements according to Weill & Ross[138]

As discussed in the section 2.3, it would not be advisable to characterize the entire governance model of a company by one of the archetypes listed above. Instead, different governance arrangements might apply to different decision-making domains. Consequently Weill & Ross

[136] Note that Weill & Ross distinguish between two different variants of federal archetypes and IT duopolies. These variants differ according to the involvement of different groups of stakeholders. An anarchy is a special archetype where different stakeholders or groups decide independently of each other (cf. Weill & Ross, 2004, p. 12). Anarchies are a seldom form of governance and are rarely formally sanctioned (cf. Weill & Ross, 2004, p. 63).

[137] Different concepts for a categorization of decision-making arrangements have been proposed in IT governance literature. These categorizations are based on dimensions like the degree of centralization, the degree of involvement and participation of local decision makers, the degree of formalization, standardization and control, the degree of business and/or IT involvement, the relationships between decision makers, the role of the CIO etc.

[138] Reprinted from Weill & Ross, 2004, p. 60 with permission (© 2003 MIT Sloan School Center for Information Systems Research).

distinguish between five interrelated domains that can be governed in different ways.[139] The different governance archetypes and decision-making domains are combined into a framework called the "IT governance arrangement matrix" (cf. Figure 5).

This framework provides a good example for a contemporary IT governance conception. On the one hand, different decision-making domains are distinguished, and on the other hand, different governance archetypes are considered. The archetypes reflect the hierarchical level where a decision is made as well as the involvement of IT and business stakeholders. Weill & Ross use this framework in order to describe empirically which governance arrangements are employed in practice, but also to measure performance effects.[140] The data contained in Figure 5 illustrates which arrangements are used for decision-input and decision-making in the 256 enterprises surveyed by Weill & Ross.

Decision / Archetype	IT Principles		IT Architecture		IT Infrastructure Strategies		Business Application Needs		IT Investment	
	Input	Decision	Input	Decision	Input	Decision	Input	Decision	Input	Decision
Business Monarchy	0	27	0	6	0	7	1	12	1	30
IT Monarchy	1	18	20	73	10	59	0	8	0	9
Feudal	0	3	0	0	1	2	1	18	0	3
Federal	83	14	46	4	59	6	81	30	93	27
Duopoly	15	36	34	15	30	23	17	27	6	30
Anarchy	0	0	0	1	0	1	0	3	0	1
No Data or Don't Know	1	2	0	1	0	2	0	2	0	0

Most common input patterns for all enterprises — Most common decision patterns for all enterprises.

The numbers in each cell are percentages of the 256 enterprises studied in twenty-three countries. The columns add to 100 percent.

Figure 5: IT governance arrangement matrix[141]

The framework of Weill & Ross provides a suitable tool to examine IT governance at a firm-wide level. However, in order to retrace the effects of the use of a particular archetype for a particular field of decision-making a closer look is required. Consequently, throughout their

[139] Cf. Weill & Ross, 2004, p. 10f.
[140] Cf. Weill & Ross, 2004, pp. 117–146.
[141] Reprinted from Weill & Ross, 2004, p. 64 with permission (© 2003 MIT Sloan School Center for Information Systems Research).

book Weill & Ross also present case studies in order to illustrate how IT governance arrangements are implemented in practice. Furthermore, Weill & Ross also discuss and analyze the effects of different contingency factors – in particular the effects of strategic and structural drivers.[142] Although Weill & Ross have a great share in advancing IT governance research, their conception of IT governance is rather broad and general. Other researchers have analyzed IT governance arrangements in specific contexts and have thereby added further detail. The qualitative empirical study described in chapter 4 of this dissertation also contributes to this endeavor.

2.4.4 Structural, procedural, and relational mechanisms

As highlighted in section 2.4.2, an important recognition in the field of IT governance is that in addition to structural mechanisms (in particular covering formal roles and positions) also procedural and relational mechanisms can be employed in order to shape comprehensive IT governance arrangements.[143] Similarly, Weill & Ross describe "decision-making structures", "alignment processes", and "communication approaches" as governance mechanisms that can be used to implement an IT governance arrangement.[144] Examples for structural, procedural, and relational mechanisms are listed in Table 2.

Table 2: Structural, procedural, and relational mechanisms[145]

Structural Capability	**Process Capability**	**Relational Capability**
Key mechanisms: Formal positions and roles Committees and councils Examples: CIO and DIO IT program managers IT relationship managers IT account managers IT project office IT executive councils IT steering committee IT project committees E-commerce advisory board E-CRM task force Centers of competence and excellence	Key mechanisms: Strategic IT decision making Strategic IT monitoring Examples: Balanced scorecard analysis Critical success factors analysis Scenario analysis Cost/benefit/risk analysis SWOT analysis Service-level agreements IT chargeback system IT delivery management IT benefits management IT performance tracking Shared IT performance database	Key mechanisms: Business–IT partnerships Shared learning Examples: Active participation by key stakeholders Partnership rewards and incentives Shared understanding of business/IT objectives Active conflict resolution (nonavoidance) Cross-functional business/IT training and job rotation Business/IT colocation Business/IT "virtual connection" and "communities of practice"

142 Cf. Weill & Ross, 2004, pp. 158–170.
143 Cf. Peterson et al., 2000, p. 437; Peterson, 2004, p. 14.
144 Weill & Ross, 2004, p. 85f.
145 Reprinted from Peterson, 2004, p. 14 with permission from Taylor & Francis.

While the given structure in terms of the departments, formal roles, and work descriptions forms the “blueprint” for the corporate IT governance design, procedural mechanisms are installed in order to formalize decision-making and to implement policies.[146] Relational mechanisms, in contrast, cover rather informal ways of achieving collaboration and mutual understanding between different stakeholders involved in IT decision-making.[147] Weill & Ross particularly emphasize communication approaches as a means to “[...] disseminate IT governance principles and policies and outcomes of IT decision-making processes.”[148] Especially in large enterprises, effective IT governance requires the combined use of different structural, procedural, and relational mechanisms.[149] Of course, the chosen mechanisms also have to fit to each other and need to be set up appropriately.[150] Governance mechanisms that do not fit to the organizational requirements or turn out to be ineffective should be abandoned in order to avoid conflicts and disruptions.[151]

2.4.5 The difference between governance and management

After having discussed what IT governance is about and which mechanisms can be employed in order to implement IT governance arrangements, it is important to highlight the difference between governance and management. While IT governance is concerned with the design and implementation of structural, procedural, and relational mechanisms in order to enable appropriate IT decision-making, it is not concerned with making decisions on an ongoing basis. The latter is the responsibility of IT management. Weill & Ross describe the difference between governance and management as follows:

> “Governance determines who makes the decisions. Management is the process of making and implementing the decisions.”[152]

For example, in the particular context of IT project portfolio selection, the role of IT governance is to specify the general process of how IT projects shall be evaluated and selected and who participates in decision-making. In contrast, the decision to accept a particular project is a management decision that should be taken by the responsible persons in accordance with the defined roles and processes.

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[146] Cf. Van Grembergen & De Haes, 2009, p. 22f.; Weill & Ross, 2004, p. 85f.
[147] Cf. Peterson, 2004, p. 15f.; Van Grembergen & De Haes, 2009, p. 22.
[148] Weill & Ross, 2004, p. 86.
[149] Cf. Peterson, 2004, p. 16; Van Grembergen & De Haes, 2009, p. 21; Weill & Ross, 2004, p. 108.
[150] Cf. Weill & Ross, 2004, p. 108.
[151] Cf. Weill & Ross, 2004, p. 108.
[152] Weill & Ross, 2004, p. 8.

IT-related decisions do not only affect the IS function but also many other stakeholders in different business functions. In order to ensure that the requirements of the business side as well as the requirements of the IS side are considered, alignment between the both parties is required. The concept of business/IT alignment has received significant attention in IS literature in recent years. As the interplay between stakeholders from the IS function and different business units is of high interest in the IT project portfolio management context, the concept of business/IT alignment is explicitly discussed in the following section.

2.5 Business/IT alignment

In this section, the extensive literature in the field of business IT/alignment will be briefly covered with a specific focus on the relationship between IT governance and business/IT alignment.[153] The existing literature in this domain has strongly focused on aspects like the shaping of the IT strategy as well as the design of IT services and IT capabilities in order to support the corporate strategy. Although this is also of interest here, the primary focus is on the strong requirement for communication and cooperation between business and IT stakeholders. This aspect is particularly important concerning the appropriate design of governance arrangements for IT project portfolio management.

Several definitions for the term *alignment* have been provided in IS literature.[154] Most of these relate to the alignment between the business and the IT strategy, which is not the primary focus here. However, Chan & Reich also cite a focus group participant from a study conducted by Campbell[155] with the following quite general definition of alignment:

> " 'Alignment is the business and IT working together to reach a common goal.' "[156]

This definition describes the basic understanding of business/IT alignment in the context of this dissertation. Although this definition lacks precision,[157] it possesses the advantage that it does not prescribe how alignment has to be achieved. In particular, the definition is not limited to the strategic level. It also covers alignment occurring at the tactical level. Furthermore, the social and cultural dimension of alignment is not omitted by this definition. Therefore, it is compliant with the requirements for alignment for effective IT project portfolio management. In this context, not only the IT strategy and the strategies of the

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153 An extensive review of the literature on business/IT alignment until 2006 is provided by Chan & Reich, 2007a.

154 Several definitions of the term *alignment* are, for example, discussed by Chan & Reich, 2007b, p. 300.

155 Cf. Campbell, 2005.

156 Chan & Reich, 2007b, p. 300.

157 Cf. Chan & Reich, 2007b, p. 300.

different business units involved have to be taken into account, but also the communication and collaboration between business and IT leaders.[158]

Historically, business/IT alignment research has been influenced to a large extent by the strategic alignment model of Henderson & Venkatraman (cf. Figure 6).[159]

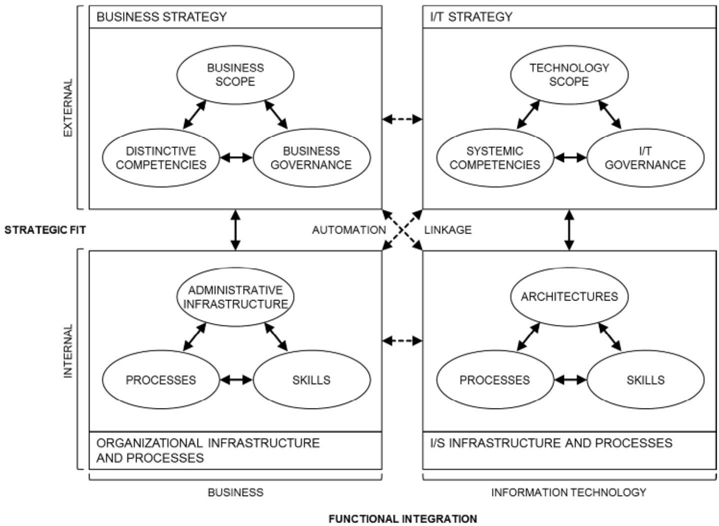

Figure 6: Strategic alignment model[160]

In general, the strategic alignment model provides a high-level perspective on structuring and strategy making. However, it also demonstrates that IT governance and business/IT alignment are connected.

While the strategic aspect of business/IT alignment has been intensively discussed in the existing IS literature, there has been relatively little research on the relationships between IT governance and business/IT alignment.[161] This relationship is quite important in the particular context of IT project portfolio management.[162] On the one hand, strategic project proposals

158 Cf. Chan & Reich, 2007b, p. 301.
159 Cf. Chan & Reich, 2007b, p. 303.
160 Reprinted from Henderson & Venkatraman, 1993, p. 476 with permission from IBM Systems Journal.
161 Cf. De Haes & Van Grembergen, 2009, p. 125.
162 Cf. Cho & Shaw, 2009b, p. 2; Oh et al., 2007, p. 1270; Raghunathan & Raghunathan, 1992, p. 120.

usually originate from the business side and shall support business objectives. On the other hand the implementation of IT projects requires resources that are usually controlled and managed by the IS function. Consequently, cooperation between business and IT is required and governance arrangements have to be designed in such a way that business and IT are aligned.

The relationship between IT governance and business/IT alignment is two-sided. Organizations with mature IT governance arrangements tend to score high on business/IT alignment and vice versa.[163] Van Grembergen & De Haes conducted a series of critical case studies in ten Belgian companies in the financial sector in order to identify which IT governance practices are "crucial enablers for business/IT alignment".[164] Based on this research, they identified the following seven practices as "key minimum baseline practices" for IT governance:[165]

- IT steering committee
- IT project steering committee
- Portfolio management
- IT budget control and reporting
- CIO reporting to the CEO/COO
- IT leadership
- Project governance / management methodologies

Most of these practices directly or indirectly relate to the governance of IT project portfolios and IT projects. In general, practices like appropriate IT investment prioritization, IT resource allocation, and IT project portfolio management have been identified as important enablers of business/IT alignment.[166] Relationship-based factors like mutual understanding between business and IT representatives and the participation of business representatives in IT planning (and vice versa) are also important antecedents of business/IT alignment[167] as well as a high degree of communication between the IS function and the business units involved.[168]

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[163] Cf. De Haes & Van Grembergen, 2009, p. 135; Van Grembergen & De Haes, 2009, p. 89.
[164] Van Grembergen & De Haes, 2009, p. 108.
[165] De Haes & Van Grembergen, 2009, p. 135; Van Grembergen & De Haes, 2009, p. 94.
[166] Cf. Broadbent & Kitzis, 2005, p. 4f.; Broadbent & Weill, 1993, p. 177; Cumps et al., 2006, p. 9; Luftman & Brier, 1999; Luftman et al., 1999, p. 20; Luftman, 2000.
[167] Cf. Chan & Reich, 2007b, p. 305
[168] Cf. Campbell, 2005, pp. 663–665; Chan & Reich, 2007b, p. 306; Reich & Benbasat, 2000, p. 106.

In contemporary literature, IT project portfolios are described as a means for strategy implementation.[169] Therefore, mapping the IT project portfolio to the business and IT strategy is also an important aspect of IT project portfolio management. Consequently, there is a close link between IT project portfolio management and business/IT strategic alignment. Business/IT strategic alignment also constitutes a moderating effect between IT investment and firm performance.[170] The relationship between the IS function and the business units in the context of IT project portfolio management is one of the key themes in this dissertation. In particular, the requirement for alignment between different stakeholders is an aspect that distinguishes IT project portfolio management from a number of other project portfolio management disciplines.[171]

[169] Cf. De Reyck et al., 2005; Dietrich & Lehtonen, 2005; Elonen & Artto, 2003; Meskendahl, 2010; Ross & Beath, 2002.
[170] Cf. Byrd et al., 2006, p. 316.
[171] Key characteristics of IT projects in comparison to other projects will be discussed in more detail in section 3.2.3.

3 IT project portfolio management – Evaluating, selecting, and staffing IT projects

In this chapter, the current state of research on IT project portfolio management is characterized and discussed. In contrast to the introduction into the foundations of IT governance in the previous chapter, the following overview is based on a structured literature search process instead of an unstructured review.[172] The different approaches are due to the different nature of the two disciplines. While IT governance research is well-established in the IS literature and has already been surveyed in a number of structured literature reviews, the field of IT project portfolio management is relatively new and more specialized and, thus, has not been analyzed to the same extent as the IT governance domain.

Consequently, in order to ensure a comprehensive coverage of the literature, which is spread through quite different publication outlets, a structured literature search has been conducted. The approach employed to investigate, order, and analyze the existing contributions will be described in section 3.1. Following, the results of the literature analysis are presented in section 3.2. Implications for further research are discussed in section 3.3.

3.1 Research approach

The preferred way to investigate the state-of-the-art in a specific field of research is to conduct a structured literature review based on a documented and reproducible search process. Webster & Watson explain the advantages of such an approach:

> "A review of prior, relevant literature is an essential feature of any academic project. An effective review creates a firm foundation for advancing knowledge. It facilitates theory development, closes areas where a plethora of research exists, and uncovers areas where research is needed."[173]

An effective and rigorous review requires that the entire search process is made transparent in such a way that the reader is able to comprehend and reconstruct the search.[174] In order to provide this level of transparency, the approach employed for identifying and analyzing the existing body of literature on IT project portfolio management will be explained in this

[172] Parts of the structured literature review described in this chapter have previously been published in the proceedings of the 20th European Conference on Information Systems (cf. Frey & Buxmann, 2012).
[173] Webster & Watson, 2002, p. xiii.
[174] Cf. Vom Brocke et al., 2009, p. 2.

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section. The structured literature review has been conducted in order to provide a foundation for the following work. Moreover, three general objectives were addressed this way.

Objectives:

- Provide an overview of the scattered body of knowledge concerning IT project portfolio management
- Integrate the existing findings in the field of research
- Identify pathways for future research

Guidelines on how to conduct a structured literature review have been presented in a number of articles. A brief overview of respective contributions and their focus is presented in Table 3.[175] Wherever possible, these guidelines have been considered for the following review.

Table 3: Guidelines for conducting a structured literature review

Author	**Content / guidelines**
H. M. Cooper, 1988	Cooper inter alia presents an often-cited taxonomy of literature reviews.
Webster & Watson, 2002	Webster & Watson encourage authors to conduct more conceptual structuring in IS reviews.
Levy & Ellis, 2006	Levy & Ellis provide detailed instructions on how to conduct a literature review. Arguments in favor of the high value of an effective literature review in the field of IS research are presented.
Vom Brocke et al., 2009	Vom Brocke et al. encourage authors to provide a comprehensive description of their literature search process. They highlight the importance of traceability.
Bandara et al., 2011	Bandara et al. propose a tool-supported method to extract, analyze, and report literature. They also introduce a general pre-codification scheme.

[175] The list is certainly not complete. However, this literature has been employed in order to structure and guide this literature review on IT project portfolio management.

In general, the steps described in the process model proposed by Vom Brocke et al. (cf. Figure 7) have been followed. These steps will be described in the following in the particular context of the conducted literature review.

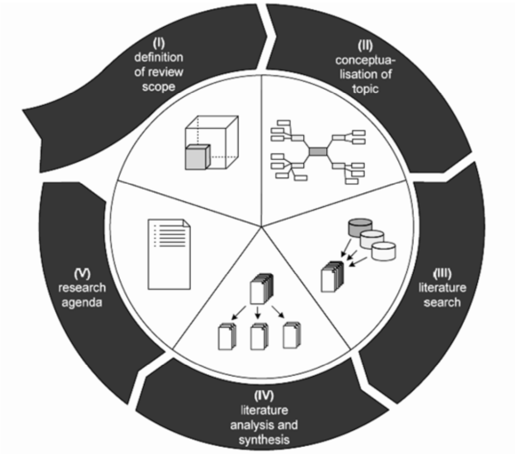

Figure 7: Literature review process[176]

3.1.1 Definition of the review scope

At the outset of a structured literature review, it is important to specify the scope of the analysis. The motivations to conduct a review can be quite distinct and different reviews possess dissimilar characteristics.[177] As it is usually not possible to cover all aspects in a single review, it is important to shape the focus and to classify the review before conceptualizing and conducting the literature search. A comprehensive taxonomy of literature reviews has been developed by Cooper.[178] Cooper distinguishes between six different characteristics (focus, goal, perspective, coverage, organization, and audience) and provides a list of main categories for each characteristic.[179] As demonstrated by Vom Brocke et al., this taxonomy can be used in order to specify the scope of a literature review.[180]

[176] Reprinted with permission from vom Brocke et al., 2009, p. 8.
[177] Cf. Vom Brocke et al., 2009, p. 8.
[178] Cf. H. M. Cooper, 1988, pp. 107–112.
[179] Cf. H. M. Cooper, 1988, p. 109.
[180] Vom Brocke et al., 2009, p. 8

Figure 8 illustrates the scope of the current study. Note that the categories are not exclusive except for the categories referring to the perspective and the coverage.[181] Consequently, a literature review may cover more than one category concerning a particular characteristic. The categories highlighted in dark grey in Figure 8 display the major direction of the present review. Categories in light grey were also covered but were not in the focal point of the study.

Characteristics		Categories			
(1)	focus	research outcomes	research methods	theories	applications
(2)	goal	integration	criticism	central issues	
(3)	organisation	historical	conceptual	methodological	
(4)	perspective	neutral representation	espousal of position		
(5)	audience	specialised scholars	general scholars	practitioners/ politicians	general public
(6)	coverage	exhaustive	exhaustive and selective	representative	central/pivotal

Figure 8: Classification of the literature review approach[182]

The focus of a literature review describes the main aspects that are of interest for the researchers involved. Concerning the present literature review, research outcomes addressing governance requirements for IT project portfolio management were of major interest. The review has been conducted in particular in order to be able to consider existing findings and recommendations and to derive a deeper understanding of existing research streams. Due to the diverse spectrum of methodologies and the still relatively sparse application of theories to project management and project portfolio management research,[183] research methods and theories also were of interest in the wider focus of the review.

The main goal of the structured review was to integrate contributions from diverse research streams in order to provide a consistent and comprehensive foundation for future research. Although criticism was not the main objective of the study, the lack of integration in the field of research and further shortcomings are recognized and critically noted in the following.

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[181] Cf. Vom Brocke et al., 2009, p. 8.

[182] According to the taxonomy of H. M. Cooper, 1988, p. 109; schema adapted from Vom Brocke et al., 2009, p. 8. Also compare Frey & Buxmann, 2012, p. 3.

[183] Cf. Killen et al., 2012, p. 1f.

The organization of the review is primarily conceptual. However, as will be explained in more detail in section 3.1.2, the concepts were not presupposed in advance to the structured search, but were derived from the contributions under investigation.

The results of the study are presented in a neutral way. Still, the IT governance background of the researchers might have influenced the categorization of the identified contributions to a certain degree.[184]

Due to the formal and documented search process, the review can be retraced by other researchers. Care has been taken to conduct the study in accordance with existing guidelines in order to provide a resilient foundation for subsequent research. Consequently, specialized scholars are the primary audience of the following review. However, also practitioners might benefit from this review as they can gain a condensed overview of the current state-of-the-art.

Finally, concerning the coverage of the relevant literature it was aimed at identifying all relevant contributions. However, in order to keep the review dense, it was necessary to limit the analysis to the most relevant contributions. As only a sample of the identified contributions is described, the degree of coverage is exhaustive but selective.[185]

3.1.2 Conceptualization

The second step in the literature review process proposed by Vom Brocke et al. consists in the conceptualization of the field of research.[186] This is an important undertaking, as the identification of the search terms for the next step (automated literature search) requires an accurate overview of the key terms and concepts that were used in earlier contributions.

In order to identify such key terms and concepts it is advisable to consult sources that provide a broad overview of the subject.[187] In this context, Vom Brocke et al. name seminal textbooks, encyclopedias, or handbooks as suitable sources.[188] Consequently, in addition to a limited

[184] Great care has been taken to include contributions from different outlets and to consider all potential contributions matching the search terms. However, the selection of the final set of contributions based on the full content is by its very nature susceptible to subjective factors.
[185] Cf. H. M. Cooper, 1988, p. 111.
[186] Cf. Vom Brocke et al., 2009, p. 9.
[187] Cf. Vom Brocke et al., 2009, p. 9.
[188] Cf. Vom Brocke et al., 2009, p. 9.

number of academic contributions, the following seminal textbooks were used in order to identify major research streams in the existing literature.[189]

- Artto et al., 2001
- Bonham, 2005
- Dye & Pennypacker, 1999
- Kendall & Rollins, 2003
- Maizlish & Handler, 2005
- Meredith & Mantel, 2006
- Reiss, 1996

In general, a main objective in conducting a structured literature review should consist in identifying dominant theoretical concepts and relating the identified literature to these concepts.[190] This is in particular advisable in mature fields of research. In emerging fields of research, an alternative approach consists in developing a new conceptual model.[191]

It is advisable to get familiar with main concepts in the field of investigation already in advance to the search process, in order to gain a basic understanding of the existing body of knowledge.[192] One can also use dominant theoretical concepts as key words for the literature search process. However, in the context of the current study this was not practicable, since a large part of the relevant literature on IT project portfolio management does not rely on theoretical concepts and a number of new concepts are currently emerging. Therefore, the construction of a search term based on theoretical concepts would have resulted in the omission of a huge part of the existing literature and a too narrow focus. Consequently, instead of composing the search term based on theoretical concepts, major research topics and dominant terms were identified.

Based on the review of the above-mentioned textbooks and a preliminary set of journal contributions, the following main topics were discovered:

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[189] Note that most of the listed books are not specialized on IT project portfolio management. They are not limited to the IT context and also cover topics in the wider context of project portfolio management or project management in general. Nevertheless, these books provide a good starting point for identifying relevant terms and concepts.

[190] Cf. Levy & Ellis, 2006, p. 184; vom Brocke et al., 2009, p. 10; Webster & Watson, 2002, p. xvi.

[191] Cf. Webster & Watson, 2002, p. xiv.

[192] Cf. Vom Brocke et al., 2009, p. 9

- Budgeting
- Prioritization / Evaluation
- Project (portfolio) selection
- Program management
- Resource management / Resource allocation
- Governance

Based on these main topics, several different search terms were tested and altered iteratively in order to foster a high degree of coverage and to make sure that the identified contributions appropriately fit to the topic. For this purpose, it was also tested if all contributions in a pre-selected sample were covered when querying different databases with the respective search terms. A condensed version of the final search term is depicted in Table 4:[193]

Table 4: Search term

"project portfolio management" OR (project AND (portfolio OR program* OR multi*) AND (budget* OR select* OR prioriti* OR evaluat* OR "resource management" OR "resource allocation" OR governance))

For the query, synonyms and plural forms were considered as well as different spellings.[194] The final search term supports a direct search for the term *project portfolio management* as well as a query for a composite term. During the conceptualization phase, it became apparent that some general findings from general project portfolio management literature are conferrable to the specific field of IT project portfolio management. Therefore, the query was initially not limited to contributions explicitly referring to information technology or information systems. Consequently, the term *project portfolio management* was used without limitation to the IT/IS context.

The composite term consists of three parts. First, in order to exclude literature focusing on asset portfolios, the term *project* was included. The purpose of the second part of the term is to exclude literature that exclusively deals with the management of single projects. As it became apparent during the initial survey of seminal textbooks that a number of authors distinguish between *multi project management*, *management of multiple projects*, and *project portfolio management*, potential variants of the term *multi* were also considered. Finally, by

[193] The syntax of the search term had to be slightly altered for different scientific databases, but the general structure was the same for all databases.

[194] The stars in the search term represent so called *wildcard characters*. These allow for the consideration of all possible endings of the respective terms.

including the third part of the composed term, the search was limited to the main topics identified during the conceptualization phase.

3.1.3 Literature search

The composition of a concise search term during the conceptualization phase is an important prerequisite for the next step – the literature search. For the search process, again, a number of decisions regarding the scope of the review have to be taken.

First, it has to be decided which databases and journals shall be queried. The following databases were employed in order to identify relevant journal articles:

- EBSCOhost (Business Source Premier and EconLit databases)
- Thomson Reuters Web of Knowledge[195] (Web of Science database)
- Science Direct
- JSTOR

These databases were chosen because they cover a wide range of journals from different domains. Articles about IT project portfolio management have been published in the information systems literature, but also in operations research journals and specialized project management journals. It was tested that all three domains of literature are sufficiently covered by the aforementioned databases. Taken together these four databases cover more than 3,000 journals in the information systems domain, including the top 25 MIS journals listed by the AIS.[196]

As recommended by Webster & Watson, conference proceedings were also taken into account.[197] For this purpose, the AIS Electronic Library (AISeL) was employed. The proceedings of the following conferences were queried:

- Australasian Conference on Information Systems (ACIS)
- Americas Conference on Information Systems (AMCIS)
- European Conference on Information Systems (ECIS)
- Hawaii International Conference on Systems Science (HICSS)
- International Conference on Information Systems (ICIS)
- Pacific Asia Conference on Information Systems (PACIS)

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[195] Formerly known as the ISI Web of Knowledge.
[196] Cf. Ackermann et al., 2011, p. 3.
[197] Cf. Webster & Watson, 2002, p. xvi.

In order to promote a high level of quality of the articles that are identified during the automated search, and to reduce the number of papers to be examined, it is common to limit the search to a small number of top-ranked journals.[198] However, for the literature review described in this chapter, this did not seem to be advisable. Many publications on IT project portfolio management have been published in specialized project management journals. Some of these journals do not appear in the top-journal listings but still contain often-cited publications that are particularly relevant for the field of research. Consequently, the databases were queried without a restriction to a preselected set of journals.

Instead of excluding certain journals ex ante, the articles resulting from the query were filtered incrementally in order to exclude contributions not meeting quality criteria or not fitting into the scope of the review. Contributions had to be peer-reviewed and had to provide a list of references in order to be selected. Work-in-progress was excluded as well as contributions that promoted certain products. Only publications written in English were considered. In order to fit into the scope of the review, selected contributions had to be directly concerned with IT project portfolios or had to be of general nature without taking a limited focus on portfolios not comparable with IT project portfolios. As the activities of IS functions have broadened over time and as the characteristics of IT projects have strongly changed in the last two decades, only contributions published since 1990 were considered.[199]

A brief overview of the phases and the timeframe of the search process is given in Table 5. In the first step, the titles and abstracts of contributions in the selected databases and conference proceedings were queried for the search term described above. Search filters were applied in order to account for the aforementioned quality criteria. Based on this initial search, 1.609 journal contributions and 189 conference papers were identified. In the next step, the titles and abstracts of all identified contributions were screened manually. In this step, contributions obviously not related to IT project portfolio management were removed. In the third step, the full contents of the remaining 204 journal articles and 42 conference papers were read. Publications not conferrable to the field of research were removed in this step, leaving a set of 67 journal articles and 17 conference papers. This set of contributions was then filtered for redundant articles written by the same author or group of authors. In case of strong redundancies only the more recent and elaborate versions were retained. After this step, a set of 40 journal articles and 11 conference papers with high relevance to the field of research remained.

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[198] Cf. Vom Brocke et al., 2009, p. 9.
[199] Compare section 2.1 for a description of historical developments in corporate IS functions.

Table 5: Literature search process[200]

Phase:	Number of journal contributions remaining:	Number of conference papers remaining:	Begin:	End:
Initial search (keywords)	1.619	189	2011-06-20	2011-06-29
Initial Screening (title & abstract)	206	42	2011-06-29	2011-07-14
Intensive screening (full text)	67	17	2011-07-15	2011-10-04
Refinements	40	11	2011-10-04	2011-10-24
Forward and backward search	48	12	2011-10-25	2011-11-09

It has frequently been proposed to conduct a forward and backward search subsequent to the automated key word search.[201] In this context, Levy & Ellis recommend to "[…] look for and circle any terms or expressions that might serve as keywords that would facilitate the forward or backward searching […]".[202] During the review process, it became apparent that a variety of terms is used in order to refer to the project portfolio management context. Therefore, a forward and a backward search were conducted in order to ensure that related articles not identified during the automated search were also considered. During the backward search, the publications contained in the reference lists of the contributions identified so far were extracted and reviewed according to the same criteria as applied during the initial search. A forward search includes the retrieval of publications citing the identified articles. For this purpose, tools like Google scholar and the Web of Science can be used.[203] Both were employed in order to identify the respective articles. Again, the resulting contributions were reviewed according to the same criteria as applied during the initial search. Based on the forward and backward search, eight additional articles and one additional conference paper were identified. The search finally yielded 60 contributions – 48 journal articles and 12 conference papers. A complete list of these publications is provided in Appendix A. The following literature analysis and synthesis is based on these sources.[204]

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[200] Frey & Buxmann, 2012, p. 4.
[201] Cf. Bandara et al., 2011, p. 7; Levy & Ellis, 2006, p. 190; Webster & Watson, 2002, p. xvi.
[202] Levy & Ellis, 2006, p. 206.
[203] Cf. Bandara et al., 2011, p. 7.
[204] During and after the execution of the study, automated database alerts were employed in order to identify newly published contributions. Contributions published after the end of the study were not included into the analysis, as this would have resulted in a rather unstructured process. Nevertheless, contributions published outside the timeframe of the study are taken into account and discussed in the following chapters, in particular in chapter 4.

3.2 Literature analysis and synthesis

A brief overview of the main characteristics of the literature sample is provided in Figure 9. It becomes apparent that the articles surveyed have been published in journals and conferences belonging to three major disciplines: Information systems research, project management research, and operations research. While 24 of the 60 contributions were published in IS journals or proceedings, 18 have appeared in project management journals and 16 were printed in operations research journals.[205] The figures illustrate that the relevant research in the IT project portfolio management domain has different origins. As research in these three disciplines has evolved independently of each other to some extent, comparing and integrating these contributions is a promising endeavor.

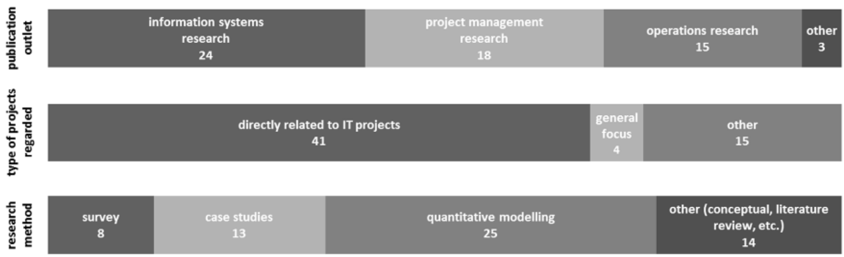

Figure 9: Sample characteristics[206]

As displayed in Figure 9, most of the contributions in the sample directly relate to IT projects and, thus, address particularities of IT projects and IT project portfolio management. Four contributions have a general focus on project portfolio management. The remaining 15 articles relate to other kinds of projects – like research and development (R&D) projects – but are conveyable to the IT project portfolio management context.[207] Key characteristics of IT projects in comparison to other project types will be discussed in more detail in section 3.2.3.

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[205] The classification of the publication outlets has been independently conducted by two researchers. The classifications of both researchers were congruent. Three contributions were published in outlets apparently not belonging to any of the three major disciplines and were therefore classified as *other*.

[206] Adapted from Frey & Buxmann, 2012, p. 5.

[207] In order to identify the project types considered in the respective contributions, the documents were automatically queried for respective search terms. In addition, all documents were also manually searched for the considered project types.

The project sample was also analyzed with regard to the applied research methods.[208] As depicted in Figure 9, a large number of contributions methodically rely on quantitative modeling, often combined with a single case study or a numerical example. Quantitative modeling approaches are not limited to contributions published in operations research outlets. A number of authors publishing in IS journals and project management journals have also introduced formal mathematical models. Twenty-one publications in the sample are of empirical nature. These contributions are typically concerned with governance aspects in the IT project portfolio management context. In particular, many recent contributions are based on case studies or surveys. The remaining contributions mostly rely on literature reviews or are of argumentative nature.

In the following subsections, the identified contributions will be analyzed with respect to different objects of investigation like their theoretical foundations or the definitions contained therein. In addition, general developments in the research discipline will be discussed.

3.2.1 Definitions

In order to reflect the current understanding of key terms in the contemporary literature on IT project portfolio management, definitions contained in the identified contributions were extracted. These definitions will be discussed and compared in the following.

A broad overview of the relationships between different terms in the project portfolio management context is provided by Patanakul & Milosevic (cf. Figure 10). In general, a project portfolio is composed of different projects and/or programs. Programs are established in order to manage strongly goal-related projects.[209] Patanakul & Milosevic also introduce the term "Management of a group of multiple projects" in order to point out that a single project manager can also be responsible for multiple smaller projects that are not necessarily goal-related.[210]

[208] In some contributions, different research methods were employed. In this case, the contribution was classified according to the method predominantly described and applied. Contributions that could not be clearly related to a particular research method were classified as *other*.
[209] Cf. Pellegrinelli, 1997, p. 142.
[210] Cf. Patanakul & Milosevic, 2009, p. 217.

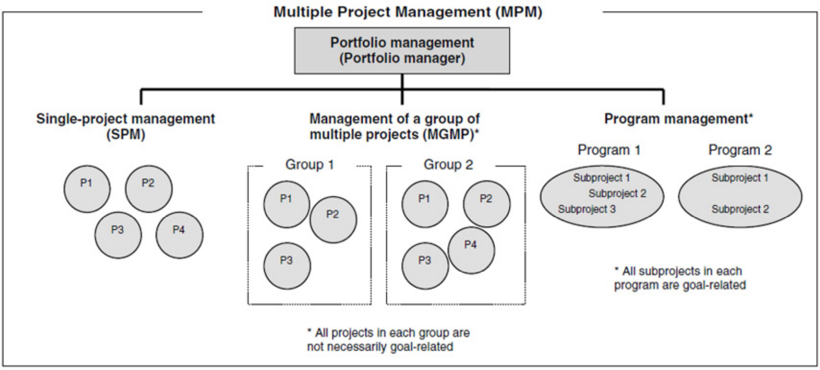

Figure 10: Overview of relevant terms in the context of multi project management[211]

The focus in Figure 10 lies on management aspects. However, before discussing the management of IT project portfolios in more detail, it is important to provide a definition of the terms *IT project* and *project portfolio* first. The term *IT project* will be discussed in section 3.2.1.1. In section 3.2.1.2, definitions of the term *project portfolio* will be compared. Then, the term *project portfolio management* will be defined in section 3.2.1.3. A particular important aspect in the context of project portfolio management relates to the process of selecting the projects that, in combination, constitute the portfolio. For this reason, the term *project portfolio selection* will be discussed separately in section 3.2.1.4.

3.2.1.1 IT project

As IT projects are the primary subject of IT project portfolio management, it is important to have a clear definition of the term *IT project*. Unfortunately, none of the surveyed contributions contained a concise definition of this term.

With regard to the terms *project*, *program* and *portfolio* as well as *project management*, *program management* and *portfolio management*, a number of contributions refer to the definitions contained in the PMBOK guide.[212] The PMBOK guide is a de-facto standard for

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[211] Reprinted from Patanakul & Milosevic, 2009, p. 217 with permission from Elsevier.
[212] E.g. Ajjan, 2009; Blomquist & Müller, 2006; Müller et al., 2008; Patanakul & Milosevic, 2009.

the project management profession. It is issued by the Project Management Institute (PMI).[213] The PMBOK Guide contains the following definition of the term “project”:

> “A project is a temporary endeavor undertaken to create a unique product, service, or result.”[214]

In general, this definition also applies to IT projects. However, for a concise definition of the term *IT project* it is necessary to highlight some specifics. An interesting remark concerning IT projects is contained in a conference paper written by Prifling.[215] Based on a study in the financial services industry, Prifling notes the following:

> “What stands out is the finding that there are almost no IT projects anymore. All but only a few very small technical amendment projects are business driven projects that touch IT to a greater or lesser extent.”[216]

Prifling further states that this finding “[…] can be explained by the immanent nature of IT in the financial service industry.”[217] A view into other industries also shows that more and more IT-related projects are business-driven. However, the fact that a project is business-driven does not automatically imply that the project should not be classified as an IT project. Rather, the critical point for planning purposes is that IT resources are required in order to accomplish the project and that IT systems potentially have to be amended.

In the context of this dissertation, IT projects therefore are not conceived as purely technical projects conducted on behalf of the IS function. Instead, an IT project may be initiated by stakeholders from the IS function as well as from the business side. The critical point is that resources managed by the IS function are required.[218] In order to provide a concise understanding of the term *IT project*, the following working definition is proposed for the current dissertation:

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[213] Due to its nature as a practitioner-oriented compendium of “good practices”, the PMBOK guide is not included in the set of publications identified during the structured literature search. Nevertheless, this guide is of high relevance for the project management profession and a number of contributions refer to this standard. Therefore, the definitions contained in the PMBOK guide are also discussed in this section.

[214] PMI, 2008, p. 5.

[215] Cf. Prifling, 2010a.

[216] Prifling, 2010a, p. 4.

[217] Prifling, 2010a, p. 4.

[218] In this context, Thomas et al. use the term “IT-enabled projects” in order to highlight the fact that the projects are driven by the business units (cf. Thomas et al., 2007, p. 11). In the following, the term *IT project* includes such “IT-enabled projects”.

> *"An IT project is a nonrecurring temporary endeavor requiring a significant amount of IT resources and/or significant changes in the IT infrastructure or application landscape."*

This definition is well applicable to the IT project portfolio management context. As will be discussed in more detail in the following sections, the IT project portfolio management context is characterized by a limited amount of IT resources (funds, project managers, programmers, licenses, hardware, etc.). These resources have to be allocated to a limited number of project proposals. IT resources are usually managed by the internal IS function, but are often employed in order to implement projects proposed by internal customers/stakeholders from within different business units.[219] This requires coordination between the IS function, the business units and other corporate functions. Therefore, business/IT alignment plays a vital role in the context of IT project portfolio management.[220] This conception of an IT project is also in line with the growing strategic focus in IT project portfolio management research.[221]

3.2.1.2 Project portfolio

The term *project portfolio* is defined relatively consistently in the surveyed literature. Table 6 contains two definitions extracted from the identified publications as well as the definition of a *portfolio* provided by the PMI. As these definitions are often referenced by other authors, there seems to be a common understanding of the concept. In particular the definition of Archer & Ghasemzadeh has been widely cited.[222]

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219 Cf. Chiang & Nunez, 2009, p. 104.

220 Cf. section 2.5. Of course, there are also IT infrastructure projects that only affect the IS function. Additionally, depending on the industry, IT projects might also be conducted for external customers. Although these projects may also be managed in a portfolio, the focus in this dissertation lies on IT projects conducted for internal customers.

221 Cf. Bardhan et al., 2004; Burke & Shaw, 2008; De Reyck et al., 2005; Jeffery & Leliveld, 2004; Lanzinner et al., 2008; Martinsuo & Lehtonen, 2007; Meskendahl, 2010.

222 Blichfeldt & Eskerod, 2008; Jonas, 2010; Martinsuo & Lehtonen, 2007 and Müller et al., 2008 have inter alia cited this definition.

Table 6: Definitions of the term "project portfolio"

Publication	Definition
Archer & Ghasemzadeh, 1999, p. 208	"A project portfolio is a group of projects that are carried out under the sponsorship and/or management of a particular organization. These projects must compete for scarce resources (people, finances, time, etc.) available from the sponsor, since there are usually not enough resources to carry out every proposed project which meets the organization's minimum requirements on certain criteria such as potential profitability, etc."
Martinsuo & Lehtonen, 2007, p. 56	"Project portfolio is a group of projects that share and compete for the same resources and are carried out under the sponsorship or management of an organization […]."
PMI, 2008, p. 8	"A portfolio refers to a collection of projects or programs and other work that are grouped together to facilitate effective management of that work to meet strategic business objectives. The projects or programs of the portfolio may not necessarily be interdependent or directly related."

The PMI definition emphasizes the strategic orientation of project portfolio management. The portfolio as a whole can be seen as a means to reach a strategic objective. Moreover, the PMI definition also hints at the fact that a portfolio may not only contain projects but also programs. Furthermore, a significant difference between programs and portfolios is highlighted in this definition. While the projects in a program are goal-related, a project portfolio may contain projects and programs that are independent of each other concerning their content and goals.[223] Although these differences might be disputable, in the following project portfolios and programs are considered as distinct concepts in line with the widely acknowledged PMI definitions.[224]

Based on the above definitions, the following general characteristics of a project portfolio can be summarized:

- A project portfolio contains a group (set) of (active) projects and/or programs.
- Projects in a portfolio are selected from a larger set of candidate (proposed) projects.
- The projects in a portfolio are sponsored and/or managed by a particular organization.
- The projects compete for the same scarce resources.
- Apart from the competition for the same scarce resources, the projects and programs in the portfolio are not necessarily interrelated.

223 Cf. Blomquist & Müller, 2006, p. 52f.; Patanakul & Milosevic, 2009, p. 217f.; PMI, 2008, p. 9.

224 Different views on the relationship between programs and portfolios exist. Platje et al., for example, consider portfolios and programs as one and the same concept (Platje et al., 1994, p. 100). Apparently, the confusion between the terms *portfolio* and *program* is due to historical differences between European and American organizations. These differences have lately been resolved in favor of the American perspective expressed, for example, in the PMI definition (cf. Sanchez et al., 2009, p. 23).

3.2.1.3 Project portfolio management

The term *project portfolio management* is of course closely related to the term *project portfolio*. However, some specifics concerning the way projects are managed in a portfolio are noteworthy. Table 7 contains three definitions of the terms “project portfolio management” and “IT portfolio management” extracted from the identified publications as well as the definition of “portfolio management” provided by the PMI.

Table 7: Definitions of the term “project portfolio management”

Publication	Definition
Martinsuo & Lehtonen, 2007, p. 56	“Project portfolio management can be considered a dynamic decision process, where a list of active projects is constantly updated and revised […].”[225]
Peters & Verhoef, 2008, p. 17	”IT-portfolio management is concerned with the problem of managing the business value of the IT-investment portfolio.”
Meskendahl, 2010, p. 807	“Project portfolio management – defined as the simultaneous management of the whole collection of projects as one large entity […].”
PMI, 2008, p. 9	“Portfolio management refers to the centralized management of one or more portfolios, which includes identifying, prioritizing, authorizing, managing, and controlling projects, programs, and other related work, to achieve specific strategic business objectives. Portfolio management focuses on ensuring that projects and programs are reviewed to prioritize resource allocation, and that the management of the portfolio is consistent with and aligned to organizational strategies.”[226]

A number of other authors in particular refer to the definition of the PMI.[227] In this definition, the strategic aspect of IT project portfolio management is highlighted as already in the PMI definition of the term “project portfolio”. The PMI definition as well as the definition provided by Meskendahl illustrate the need for centralized overview and control in order to manage the portfolio as a single entity. An important aspect highlighted in the definition of Martinsuo & Lehtonen is that project portfolio management is a dynamic process. Although a portfolio may be initialized at a single moment in time, reprioritizations and other changes are usually inevitable, wherefore it is important to track these changes constantly. With regard to

[225] Note that this definition strongly resembles the definition provided by Cooper & Edgett in the new product portfolio management context (R. G. Cooper & Edgett, 1997, p. 16). The only difference is that Cooper & Edgett originally refer to “active new product (and R&D) projects” and not to active projects in general.

[226] Note that the general term *portfolio management* is used here. However, the definition in particular refers to the management of portfolios composed of projects and programs.

[227] E.g. Ajjan, 2009; Blomquist & Müller, 2006; Müller et al., 2008.

the initial composition of a project portfolio (i.e. the more static aspect), the term *project portfolio selection* is frequently used. This term will be discussed in the following section.

3.2.1.4 Project portfolio selection

While project portfolio management is concerned with the entire lifecycle of a project portfolio, the term *project portfolio selection* refers to the particular activity of accepting or rejecting project proposals in order to compose the project portfolio. Table 8 introduces two definitions characterizing this activity.

Table 8: Definitions of the terms "project selection" and "project portfolio selection"

Publication	Definition
Archer & Ghasemzadeh, 1999, p. 208	"Project portfolio selection is the periodic activity involved in selecting a portfolio, from available project proposals and projects currently underway, that meets the organization's stated objectives in a desirable manner without exceeding available resources or violating other constraints."
J. W. Lee & Kim, 2001, p. 111	"Information System (IS) Project selection means identifying some alternative projects in order to maximize the net benefit to the organization and allocating resources only among those alternatives, within the given constraints on resources […]."

Both definitions emphasize the importance of not exceeding the constrained resources. In most organizations, there are not enough resources to conduct every proposed project, even if it provides a positive net benefit.[228] The resource capacity may be restricted, for example, by limited funds or a limited availability of experts.[229] Furthermore, a certain level of risk should not be exceeded. Therefore, a systematic project portfolio selection approach is required. Archer & Ghasemzadeh describe project portfolio selection as a periodic activity. This implies that project proposals are collected during a certain period in order to be able to compare the available alternatives. Nevertheless, it is important to keep in mind that project portfolio management in general is of dynamic nature as the project environment itself is dynamic.

The definition provided by Archer & Ghasemzadeh is more generic than the definition of Lee & Kim as meeting "the organization's stated objectives" is a more general objective than maximizing the net benefit. The organization's objectives do not necessarily have to be of

[228] Cf. Ward, 1990, p. 222.

[229] The term *resource capacity* may refer to very different kinds of resources. Typically, the two broad categories of financial resources and human resources are distinguished. In addition, hardware and software are occasionally mentioned.

financial nature but can also be, for example, strategic or risk-related. As will be discussed in section 3.2.6, these different objectives also characterize different approaches for project portfolio prioritization and selection.

Archer & Ghasemzadeh have also introduced an often-cited project portfolio selection framework (cf. Figure 11). This framework inter alia describes the different steps a project typically passes during its lifecycle. The five accentuated phases in Figure 11 describe major steps of project portfolio selection.[230] The framework also highlights the importance of strategic guidelines and a methodical approach for project portfolio selection. In addition, the dynamics and uncertainty inherent in project portfolio management are accounted for by the inclusion of the portfolio adjustment step.[231]

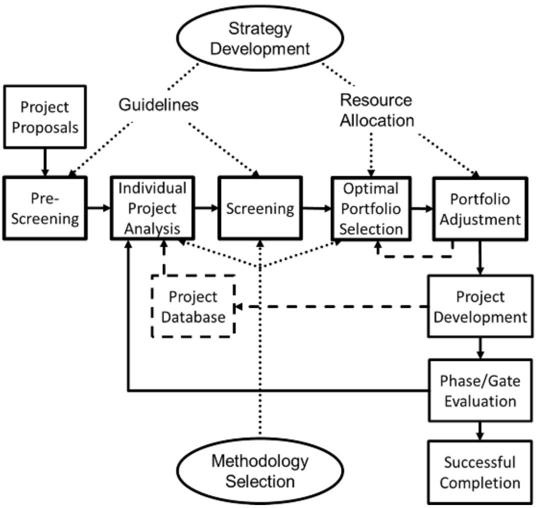

Figure 11: Framework for project portfolio selection[232]

[230] Cf. Archer & Ghasemzadeh, 1999, p. 211.
[231] At this point, the different phases will not be described in more detail. For a comprehensive description of the framework, refer to Archer & Ghasemzadeh, 1999, pp. 211–214.
[232] Reprinted from Archer & Ghasemzadeh, 1999, p. 211 with permission from Elsevier.

3.2.2 Modern portfolio theory

Portfolio research in general has been largely shaped by the work of Nobel Laureate Harry Max Markowitz on portfolio selection. Although Markowitz' modern portfolio theory has been developed with a focus on financial portfolios and is, therefore, not directly applicable to project portfolios, it has nevertheless influenced later work on project portfolio management. For this reason, Markowitz' work is briefly discussed in this section.

In 1952, Markowitz published a groundbreaking article in the Journal of Finance.[233] In this contribution, Markowitz emphasized the importance of diversified portfolios, where risk and return are balanced. Based on his observations about financial security portfolios, he concluded:

> "Diversification is both observed and sensible; a rule of behavior which does not imply the superiority of diversification must be rejected both as a hypothesis and as a maxim."[234]

In Markowitz' conception of portfolio management, the consideration of risk – measured in terms of variance – plays an essential role.[235] At the same time, Markowitz points out that it is insufficient to consider risk at the level of single securities. Risks have to be taken into account at the level of the entire portfolio.[236] Diversification is a measure to reduce risk at the portfolio level, but it is also vital to consider interrelations between different securities (expressed in terms of covariance):

> "Similarly in trying to make variance small it is not enough to invest in many securities. It is necessary to avoid investing in securities with high covariances among themselves."[237]

An important concept introduced by Markowitz is the notion of efficient frontiers. The basic idea behind the concept of efficient portfolios is to identify portfolios that maximize return for a given level of risk or minimize risk for a given level of return. Efficient frontiers contain all portfolios not dominated by other portfolios. Therefore, the portfolios on the efficient frontier are potential candidates for selection – depending on the risk/benefit preference of the decision maker.[238] An example of an efficient frontier is depicted in Figure 12. Several

[233] Cf. Markowitz, 1952.
[234] Markowitz, 1952, p. 77.
[235] Cf. Markowitz, 1952, p. 77.
[236] Cf. Markowitz, 1952, p. 77 and 89.
[237] Markowitz, 1952, p. 89.
[238] Cf. Markowitz, 1952, p. 82.

contributions identified during the structured search are based on the concepts of efficient frontiers and Pareto-efficient solutions.[239]

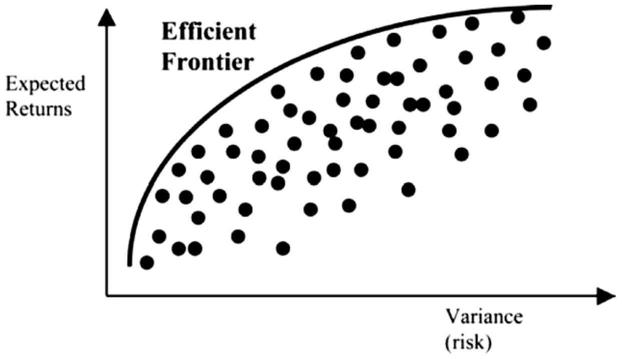

Figure 12: Mean-variance efficient frontier[240]

The applicability of modern portfolio theory to IT portfolios has been controversially discussed. Verhoef, for example, offers a number of arguments why "you cannot simply apply security portfolio management to IT portfolios."[241]

One distinctiveness noted by Verhoef is that, in contrast to securities, IT systems cannot easily be disinvested. Consequently, there is much less flexibility in replacing one IT investment by another than selling a security and buying another one.[242] In this context, Verhoef also highlights that usually business logic is incorporated into an IT system which often leads to a strong dependence on the system.[243] Therefore, selling and buying IT systems and IT projects like securities is not an option. Similarly, Verhoef argues that the principle of diversification as proposed by Markowitz for financial securities cannot be applied to IT projects – neither with regard to the technical aspect nor with regard to the business aspect.[244] Verhoef also argues that the available information about financial securities typically largely

[239] E.g. Cho & Shaw, 2009a; Eilat et al., 2006; Gutjahr & Reiter, 2010; Phillips & Bana e Costa, 2007; Stummer et al., 2009; Stummer & Vetschera, 2003; Urli & Terrien, 2010.
[240] Reprinted from Better & Glover, 2006, p. 85 with permission from Taylor & Francis.
[241] Verhoef, 2002, p. 5.
[242] Cf. Verhoef, 2002, p. 6.
[243] Cf. Verhoef, 2002, p. 6f.
[244] Cf. Verhoef, 2002, p. 7f.

differs from the available knowledge about IT projects. Historic information about securities is usually gathered in a systematic way whereas historic information about IT projects is often completely missing.[245]

Verhoef finally concludes that modern portfolio theory is not applicable to IT portfolio management at all, as "[…] the nature of software does not resemble the nature of a security."[246] Although there are indeed large differences between securities and IT projects, still a significant number of contributions are based on concepts from modern portfolio theory. This suggests that some general findings from modern portfolio theory are also relevant for IT project portfolio management. In particular, this holds true for the general tradeoff between risk and return and the application of efficient frontiers.[247]

3.2.3 Key characteristics of IT projects

IT project portfolio management is a relatively new concept. Although McFarlan had introduced the idea of applying portfolio management practices to IT projects already in 1981,[248] only in recent years the topic has gained growing attention in both theory and practice. However, project portfolio practices have long been applied to different kinds of projects like construction projects, R&D projects, and new product development projects. Therefore, the question arises if some findings from other project portfolio management disciplines are directly conferrable to the IT project portfolio management discipline. In order to be able to address this question, the literature search had not been limited to publications specialized on IT projects in the first place.[249] During the review process, contributions were searched for statements concerning the differences and similarities between portfolio practices for different project types. Based on this analysis, the following major characteristics of IT projects are discussed in the subsequent sections:

- Difficult evaluation and comparison of IT projects
- Strong interdependencies between IT projects
- Specific governance context
- Internal sponsorship of IT projects
- Need for unique skills and resources
- Specific risks and a high degree of uncertainty

[245] Cf. Verhoef, 2002, p. 8.
[246] Verhoef, 2002, p. 8. Maizlish & Handler also critically discuss the similarities and differences between financial portfolio management and IT portfolio management (cf. Maizlish & Handler, 2005, p. 27f.).
[247] Also compare the discussion of the theoretical backgrounds of the identified contributions in section 3.2.4.
[248] Cf. McFarlan, 1981.
[249] Cf. section 3.1.2.

3.2.3.1 Difficult evaluation and comparison of IT projects

IT investments compete with other investments for the funds available in an organization.[250] Consequently, it would be desirable to be able to compare IT projects with other projects. However, as stated by Ward: “There is no simple answer to the question – on what basis should IS/IT investments be evaluated against other investments?”[251] According to Ward, the evaluation of IT investments underlies a number of peculiarities. For example, it is difficult to evaluate the returns resulting from an IT investment. Frequently, not all benefits can be reasonably expressed in quantitative terms.[252]

Lanzinner et al. also point at the difficulties associated with assessing the benefits of IT projects. For example, they state, “IT benefits can arise in different business divisions, be indirect and may not be obvious at first glance.”[253] Similarly, Angelou & Economides and Irani et al. hint at the many intangible benefits of IT investments which make it difficult to compare IT investments with each other and with other more tangible investments.[254] Irani et al. also emphasize the “[…] complexity of inter-relationships amongst IT/IS decision-making variables […]”.[255] Chou et al. argue that criteria covering social and organizational implications should be considered during the evaluation process.[256] In this context, they also highlight that it is important to take account of the opinions of different levels of stakeholders and that qualitative as well as quantitative criteria should be applied in order to select IT projects.[257]

Bardhan et al. state that “[…] long payback periods, uncertainty, and changing business conditions” are challenging aspects concerning the evaluation of IT investments.[258] Kenneally & Lichtenstein examine IT projects of a multinational manufacturer and provide evidence “[…] that IS projects include considerable optional value.”[259] In general, real options as a means to evaluate IT projects are discussed by several authors.[260]

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[250] Cf. Ward, 1990, p. 222.
[251] Ward, 1990, p. 222.
[252] Cf. Ward, 1990, p. 222f.
[253] Lanzinner et al., 2008, p. 4.
[254] Cf. Angelou & Economides, 2008, p. 479; Irani et al., 2002, p. 201.
[255] Irani et al., 2002, p. 200.
[256] Cf. Chou et al., 2006, p. 1027f.
[257] Cf. Chou et al., 2006, p. 1028.
[258] Bardhan et al., 2004, p. 34.
[259] Kenneally & Lichtenstein, 2002, p. 248.
[260] E.g. Angelou & Economides, 2008; Bardhan et al., 2004, 2006; Benaroch et al., 2006; Burke & Shaw, 2008; Diepold et al., 2009; Kenneally & Lichtenstein, 2002.

In summary, the evaluation of IT projects is complicated by factors like intangible benefits, a high degree of uncertainty, interdependencies between the projects and a specific decision-making environment. This also complicates a comparison of IT investments with other kinds of investments.

3.2.3.2 Strong interdependencies between IT projects

The high degree of interdependence among IT applications and IT projects is often mentioned as a particular important characteristic to be considered in the IT project portfolio management context.[261] In this context, the complexity of interactions between IT projects has been described as a distinguishing attribute of IT projects in comparison to other project types like R&D projects.[262] Santhanam & Kyparisis, for example, have investigated a number of models for R&D project selection with respect to their applicability in the IT project portfolio selection context.[263] They come to the following finding:

> "We find that these models have limited application in the IS context because they make many restrictive assumptions about the extent and type of interdependencies among projects."[264]

Santhanam & Kyparisis conclude that, due to specific nature of interdependencies between IT projects, models designed for R&D project selection cannot be simply transferred to the IT project portfolio management context.[265]

Different kinds of interdependencies between IT projects have been described and many examples have been provided in existing contributions. In this context, the term *interaction* is often used synonymously to the term *interdependency*.[266] Other terms like *synergistic effects*, *interrelations* and *contingencies between projects* are also closely related.[267] In the following, the most frequently used term *interdependencies* will be employed. Project interdependencies have gained much attention in the IT project portfolio management literature.[268] A structured literature review focused on project interdependencies in the project portfolio selection

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[261] E.g. Cho & Shaw, 2009a, p. 3f.; Diepold et al., 2009, p. 2; Kundisch & Meier, 2011a, p. 477, 2011b, p. 2; J. W. Lee & Kim, 2000, p. 386, 2001, p. 112; Santhanam & Kyparisis, 1995, p. 807, 1996, p. 381.
[262] Cf. Kundisch & Meier, 2011b, p. 478.
[263] Cf. Santhanam & Kyparisis, 1996, p. 381.
[264] Santhanam & Kyparisis, 1996, p. 381.
[265] Cf. Kundisch & Meier, 2011a, p. 2.
[266] Cf. Kundisch & Meier, 2011a, p. 477.
[267] For an overview of the nomenclature used by different authors compare Kundisch & Meier, 2011a, p. 481.
[268] Cf. Cho & Shaw, 2009b, p. 2; De Reyck et al., 2005, p. 525; Meskendahl, 2010, p. 812.

context has been provided by Kundisch & Meier.[269] Project interdependencies will be discussed in more detail in section 5.2.2. Here, it shall be particularly highlighted that interdependencies between IT projects are a characteristic feature of IT project portfolios.

3.2.3.3 Specific governance context

Another important aspect about IT project portfolio management is the specific governance context. This context is specific due the involvement of different business and IT units. Although the phenomenon of competition for scarce resources among different business units is not limited to the IT project portfolio management context, the relationship between business and IT is of a special nature.

Ajjan, for example, finds that business and IT evaluate project risks and return differently.[270] Consequently, he highlights the importance of communication and business/IT alignment for the appropriate evaluation of IT projects.[271] Similarly, Hsu et al. point at the need for integrating users into the project screening process (user-IS integration).[272] They propose the "[…] compatibility of the operating philosophy and culture between user unit and IS department"[273] as one of three project evaluation criteria. Chou et al. argue that social, political, behavioral, and organizational aspects have to be taken into account during IT investment evaluation.[274]

Based on a qualitative study in 36 Australian companies, Thomas et al. identify a strong business/IT relationship as an important prerequisite for effective IT investment decisions.[275] They come to the following conclusion:

> "The conclusion is that the key to more effective IT project evaluation is not more formal and sophisticated methods, but rather, more effective governance structures and decision processes."[276]

Although appropriate governance arrangements are needed for all project portfolio management disciplines, the specific requirements differ depending on the decision-making object. Governance arrangements for IT project portfolio management particularly need to be

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[269] Cf. Kundisch & Meier, 2011b, p. 480.
[270] Cf. Ajjan, 2009, p. 5.
[271] Cf. Ajjan, 2009, p. 7.
[272] Cf. Hsu et al., 2011, p. 522.
[273] Hsu et al., 2011, p. 523.
[274] Cf. Chou et al., 2006, p. 1027f.
[275] Cf. Thomas et al., 2007, p. 10.
[276] Thomas et al., 2007, p. 1.

adapted to the specific IT decision-making context, which places high demands on business/IT alignment.

3.2.3.4 Internal sponsorship of IT projects

The specific governance requirements of IT project portfolios are also a consequence of the nature of IT projects as internally focused projects.[277] In this context, Meskendahl points out that the management of portfolios composed of internal projects – like R&D and IT projects – differs from the management of a portfolio of externally sponsored projects.[278] Elonen & Artto specifically investigate "[…] problems in managing internal development projects in multi-project environments".[279] Although not all identified problems solely apply to portfolios of internally sponsored projects, problems such as "Many bodies are entitled to set up a project"[280] or the pursuing of "'Own' objectives of a unit"[281] are particularly relevant in internally managed project environments.

3.2.3.5 Need for unique skills and resources

When comparing IT projects with other kinds of projects, it has also to be considered that the resources required to implement an IT project are often distinct from other kinds of resources. Schniederjans & Santhanam, for example, note that "IS departments have staff, machine, and financial limitations that should prohibit the selection of some IS projects."[282]

On the other hand, Cho & Shaw emphasize that great synergy potentials can be exploited by an appropriate use of IT resources:

> "IT resources can be distinguished from other forms of resources by their great potential of enhancing synergy between IT units."[283]

With reference to modern portfolio theory, they state:

> "Holding multiple financial products does not create additional return, whereas holding multiple IT resources may enable a firm to earn additional return from its IT investment."[284]

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[277] As defined in this dissertation (cf. section 3.2.1.1).
[278] Cf. Meskendahl, 2010, p. 808.
[279] Elonen & Artto, 2003, p. 395.
[280] Elonen & Artto, 2003, p. 400.
[281] Elonen & Artto, 2003, p. 400.
[282] Schniederjans & Santhanam, 1993, p. 245.
[283] Cho & Shaw, 2009a, p. 1.
[284] Cho & Shaw, 2009a, p. 2.

Cho & Shaw state that "IT resources can be used remotely […]" and that "[…] IT resources can be used by multiple users simultaneously".[285] Based on these two characteristics, Cho & Shaw infer that IT resources such as IT machines and IT human resources can be shared to a large extent across different business units.[286] With reference to Wernerfelt and the resource-based view, Cho & Shaw provide the following general definition of resources:

> "Resources of a firm can be anything that is thought of as a strength and weakness of the given firm (Wernerfelt, 1984)."[287]

In this context, Cho & Shaw in particular emphasize the notion of strategic IT resources.[288] They mention the following kinds of sharable resources: "Hardware, software, network systems, IT human resources, and other IT resources [...]".[289]

Similarly to Cho & Shaw, Santhanam & Kyparisis highlight the impact of the shareability of IT resources on the prevalence of project interdependencies and the obtainable synergy potentials:

> "Resource interdependencies arise because of sharing of hardware and software resources among various IS projects such that the implementation of two or more related projects will require fewer resources than if they were implemented separately."[290]

Stummer & Vetschera discuss consequences arising from the shareability of IT resources in the context of group decision-making.[291] They demonstrate how a fair compromise can be obtained in situations where "global resources" have to be shared between different units.[292]

The allocation and scheduling of IT resources is an extensive research topic in the operations research and IS literature. In this context, the assignment of human resources to IT projects is of particular relevance. Heimerl & Kolisch, for example, who are concerned with resource allocation in a multi-project context, describe IT resources as "external and internal resources with different skills and different unit costs […]".[293] According to Heimerl & Kolisch, human resources involved in IT projects are usually scarce, multi-skilled and may possess very

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[285] Cho & Shaw, 2009a, p. 4f.
[286] Cf. Cho & Shaw, 2009a, p. 5.
[287] Cho & Shaw, 2009a, p. 5. Also compare Wernerfelt, 1984, p. 172.
[288] Cf. Cho & Shaw, 2009a, p. 6.
[289] Cho & Shaw, 2009a, p. 7.
[290] Santhanam & Kyparisis, 1995, p. 808.
[291] Cf. Stummer & Vetschera, 2003, p. 253.
[292] Cf. Stummer & Vetschera, 2003, pp. 257–265.
[293] Heimerl & Kolisch, 2010, p. 344.

different degrees of efficiency, depending on the specific task.[294] Often, IT skills are not interchangeable and retraining IT personnel in order to acquire new skills may be associated with significant risks.[295] Another characteristic feature of the IT project portfolio management context is that a significant fraction of the required human IT resources is often provided by outsourcing partners.[296]

In summary, IT resources possess specific characteristics like a certain degree of shareability between different projects. These characteristics also partly explain the strong prevalence of interdependencies in IT project portfolios.

3.2.3.6 Specific risks and a high degree of uncertainty

In section 3.2.3.1, it has already been highlighted that uncertain information may complicate the evaluation and comparison of IT projects. In general, the information environment, in which IT project portfolio selection and IT project portfolio management take place, is characterized by a high level of uncertainty and risks.[297]

Prifling emphasizes the strong impact of organizational risks on IT projects. Based on a qualitative study in the financial industry, he theorizes that a consensus-oriented organizational culture leads to too many projects and, consequently, to a shortage of resources and project delays.[298] This risk is not directly linked to the characteristics of IT projects but a consequence of the environment in which IT project portfolio selection takes place.

In regard to risks directly associated with IT projects, Peters & Verhoef distinguish between business domain risks and IT risks.[299] While business domain risks primarily consist in the risk of falling short of the expected benefits, IT risks are related to project failure, budget overrun and time overrun.[300] Although these risks apply to virtually any project, they materialize in specific ways in IT projects. For example, requirements creep is a very common problem arising in software development projects.[301] Furthermore, the circumstance

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[294] Cf. Heimerl & Kolisch, 2010, p. 344. The scarcity of resources is, of course, a general characteristic of portfolio management environments and not limited to IT project portfolios. The causes and effects of resource scarcity are discussed in detail by Engwall & Jerbrant, 2003.
[295] Cf. Verhoef, 2002, p. 7.
[296] Cf. Heimerl & Kolisch, 2010, p. 344.
[297] Cf. Chen & Cheng, 2009, p. 390.
[298] Cf. Prifling, 2010a, p. 1.
[299] Cf. Peters & Verhoef, 2008, p. 18.
[300] Cf. Peters & Verhoef, 2008, p. 18.
[301] Cf. Peters & Verhoef, 2008, p. 28.

that IT systems often comprise business logic makes it difficult to abandon an IT project, even if it does not deliver the expected benefits.[302]

Diepold et al. highlight that it is not sufficient to consider exogenous risks (also referred to as systematic or market risks) during IT project portfolio selection.[303] Instead, project-specific risks have a major impact on the overall risk of the project portfolio and, thus, need to be taken into account in addition. Diepold et al. also provide examples for IT-specific risks:

> "[…] private risks or project-specific risks, like for instance deficient software quality, incorrect interpreted specifications, or problems with new technologies or frameworks, account for the major source of all risks concerning IT investments."[304]

Drake & Byrd provide a comprehensive review of risks in IT project portfolios.[305] In particular, they highlight that it is important to consider IT risks at the level of the single projects as well as risks arising from the interrelatedness of projects and risks at the IT project portfolio level.[306] Drake & Byrd also provide a typology of risk factors concerning IT project portfolio management.[307] In this context, they distinguish between the following five types of risks:[308]

- Strategic alignment risks
- Organization & management risks
- Cultural & climate risks
- Project relationship risks
- Financial risks

While the first three risk types[309] affect the portfolio as a whole, project relationship risks refer to risks arising from the interdependencies between the projects.[310] Relationship risks may only affect a fraction of the projects in the portfolio.[311] Finally, financial risks may apply to all three levels – single projects, a fraction of the portfolio and the portfolio as a whole.[312]

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302 Cf. Verhoef, 2002, p. 6.
303 Cf. Diepold et al., 2009, p. 4.
304 Diepold et al., 2009, p. 4.
305 Cf. Drake & Byrd, 2006.
306 Cf. Drake & Byrd, 2006, p. 3.
307 Cf. Drake & Byrd, 2006, pp. 4–8.
308 Drake & Byrd, 2006, p. 8.
309 These three risk types are based on the findings of McFarlan, 1981.
310 Cf. Drake & Byrd, 2006, p. 4.
311 Cf. Drake & Byrd, 2006, p. 4.
312 Cf. Drake & Byrd, 2006, p. 4.

The importance of considering risk at the portfolio level has been widely acknowledged in the project portfolio management literature. This aspect has already been highlighted in the initial work of Markowitz on financial portfolio management.[313] Drake & Byrd also explicitly discuss the relationships between financial portfolio management, new product portfolio management, and IT project portfolio management.[314] They argue: "[…] product portfolios share many more similarities with IT portfolios than financial portfolios."[315] Drake & Byrd also state: "Many of the risk factors that are true with product portfolios are also true of IT portfolios."[316]

This leads us back to the question to what extent IT project portfolio management and other (project) portfolio management disciplines are related. The fact that IT projects have certain specific characteristics does not automatically imply that findings and models from other (project) portfolio management disciplines cannot be converted to IT project portfolio management. Consequently, some general findings also apply to the IT project portfolio management discipline[317] and some general approaches can be employed in the IT context as well as in other contexts.[318] However, the specifics of IT projects often require specific governance arrangements. Therefore, it is reasonable to regard IT project portfolio management as a specific discipline.

3.2.4 Theoretical backgrounds of IT project portfolio management research

In order to understand the emergence of different research strands, it is important to know the theoretical backgrounds on which the field of research is based. Therefore, the theoretical foundations of the identified contributions were analyzed in the course of the literature review. It became apparent that these contributions relate to very different theoretical backgrounds.

As highlighted in section 3.2.2, Markowitz's modern portfolio theory provides a basic theoretical foundation for portfolio management research. Consequently, a number of authors refer to modern portfolio theory as a theoretical background.[319] As the applicability of modern

[313] Cf. Markowitz, 1952.
[314] Cf. Drake & Byrd, 2006, p. 3.
[315] Drake & Byrd, 2006, p. 3.
[316] Drake & Byrd, 2006, p. 4.
[317] For example, many risks listed in the typology of Drake & Byrd (cf. Drake & Byrd, 2006) apply to IT project portfolios as well as new product portfolios.
[318] For example, Klapka & Pinos develop a multi-criteria decision support system designed for R&D as well as IT project portfolio selection (cf. Klapka & Pinos, 2002). This implies that Klapka & Pinos consider their approach to be applicable to both project types.
[319] E.g. Cho & Shaw, 2009a; Drake & Byrd, 2006; Meskendahl, 2010.

portfolio theory to the IT project portfolio management context is contested,[320] the contributions building on modern portfolio theory typically adapt the general concepts – like the principle of diversification and the concept of efficient frontiers – to the specific context.[321]

Naturally, the theoretical backgrounds of the investigated contributions differ depending on the focus and the general approach employed. In particular, contributions dealing with mathematical approaches have different theoretical backgrounds than contributions concerned with the governance context of IT project portfolio management.

Authors proposing mathematical approaches for portfolio selection and resource allocation often make use of fuzzy theory[322] and real options theory[323]. As mentioned above, some of these contributions also expand on modern portfolio theory. In contrast, the theoretical backgrounds of the investigated empirical studies are more diverse. For example, Thomas et al. motivate their qualitative study with reference to the IT governance discipline.[324] Ajjan, Hsu et al. and Burke & Shaw make use of business/IT alignment and strategic alignment concepts.[325] Stummer et al. employ game theory, Blomquist & Müller relate their findings to transaction costs economics and Prifling uses structuration theory as theoretical perspective.[326] Of course, a number of authors also build new theoretical foundations, for example by employing a grounded theory approach[327] or by developing and empirically measuring concepts such as portfolio management efficiency and portfolio success.[328]

The diversity of the theoretical foundations of the surveyed contributions might also be a consequence of the breadth and complexity of the subject matter. This also indicates that the field of research is still emerging. Nevertheless, a number of common topics and concepts like diversification, uncertainty and risk, strategic alignment, synergy exploitation, etc. have already emerged from existing research.

Potential theoretical foundations of project management and project portfolio management disciplines have also been discussed from a more general perspective. For example, Killen et

[320] Cf. Cho & Shaw, 2009a, p. 2f.; Drake & Byrd, 2006, p. 3; Verhoef, 2002, p. 8.
[321] Cf. Cho & Shaw, 2009a; Eilat et al., 2006; Gutjahr & Reiter, 2010; Meskendahl, 2010; Phillips & Bana e Costa, 2007; Stummer et al., 2009; Stummer & Vetschera, 2003; Urli & Terrien, 2010.
[322] E.g. Chen & Cheng, 2009; Chou et al., 2006; Irani et al., 2002.
[323] E.g. Angelou & Economides, 2008; Bardhan et al., 2004, 2006; Benaroch et al., 2006; Diepold et al., 2009; Kenneally & Lichtenstein, 2002.
[324] Cf. Thomas et al., 2007.
[325] Cf. Ajjan, 2009; Burke & Shaw, 2008; Hsu et al., 2011.
[326] Cf. Blomquist & Müller, 2006; Prifling, 2010b; Stummer et al., 2009.
[327] E.g. Prifling, 2010a.
[328] E.g. Martinsuo & Lehtonen, 2007; Müller et al., 2008.

al. have recently identified the resource-based view, the dynamic capabilities concept and the absorptive capacity concept as suitable strategic management theories applicable to the project management and project portfolio management context.[329] Two contributions contained in the literature sample make use of the resource-based view.[330] Cho & Shaw refer to the economic theory of complementarities and the resource-based view in order to explain how diversification creates IT synergies[331] and Burke & Shaw employ the resource-based view in order to highlight that unique resources may explain why some projects fitting well into one organization may not fit into another one.[332] As the importance of strategy and the impact of scarce resources have frequently been highlighted in the context of IT project portfolio management, an adapted viewpoint of the resource-based view has the potential to provide a common ground for further work on IT project portfolio management research.[333] However, as will be illustrated in more detail in the following, the relevant literature is currently subdivided into different research streams with quite different foci. Therefore, although it is likely that the theoretical foundations of the field of research will gain stronger attention in future, it is also likely that future research will be based on a plurality of theoretical concepts.

3.2.5 Classification of the identified contributions

Already after the initial screening of the contributions obtained during the structured search, it became apparent that two different streams of research have emerged in the IT project portfolio management literature.[334] These two different streams of research as well as the fundamental developments in the research discipline are illustrated in the classification depicted in Figure 13.

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[329] Cf. Killen et al., 2012.
[330] Cf. Burke & Shaw, 2008; Cho & Shaw, 2009a.
[331] Cf. Cho & Shaw, 2009a, p. 4.
[332] Cf. Burke & Shaw, 2008, p. 2.
[333] Cf. Blichfeldt & Eskerod, 2008; Engwall & Jerbrant, 2003.
[334] Also compare Ajjan et al., 2008, p. 3.

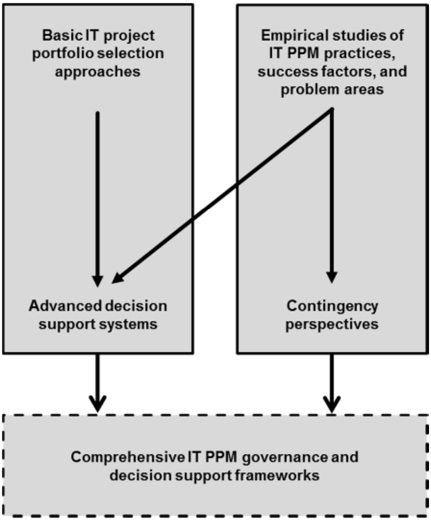

Figure 13: Classification of the identified contributions[335]

The first stream of research has been concerned with the development of mathematical models and approaches in order to support different IT project portfolio management tasks – most often IT project portfolio selection. While initial contributions typically were normative and prescriptive, later approaches incorporated practical and empirical findings obtained from observations of how IT project portfolio management is implemented in practice. Thereby, advanced decision support systems emerged. These systems are typically based on a holistic conception of IT project portfolio management and are designed in order to address a range of different related tasks like project portfolio selection and resource allocation. Instead of identifying an "optimal" solution based on an optimization problem, these systems usually propose different alternative solutions to the decision maker(s).

The second stream of research, in contrast, is primarily of empirical nature. The respective contributions have been concerned with the way IT project portfolio management is conducted in practice. In this research stream, success factors for effective IT project portfolio management as well as problem areas have been identified and maturity models have been

[335] Note that the structure of Figure 13 resembles the structure of the categorization derived by Brown & Grant for the IT governance literature (cf. Figure 3).

developed. However, it has also been recognized that the success of the implementation of IT project portfolio management practices depends on a number of contingency factors.

The two streams of research are more and more emerging. Increasingly, empirical findings are considered in the design of decision support systems and, on the other hand, the benefits obtainable from structured and system-supported IT project portfolio management practices are surveyed. As it has been recognized that the success of IT project portfolio management practices is contingent upon factors such as the political or organizational environment, a logical progression is the development of comprehensive frameworks linking contingency factors, IT project portfolio management practices and the supporting systems.[336]

In section 3.2.6, IT project portfolio selection approaches and decision support systems introduced in the surveyed publications will be analyzed. Following, in section 3.2.7, findings from conceptual and empirical contributions will be presented. Finally, in section 3.2.8, the convergence of the two streams of literature will be briefly discussed.

3.2.6 Mathematical approaches and decision support systems

In 23 of the 60 identified contributions, mathematical approaches or decision support systems for project portfolio selection and related tasks are introduced.[337] Many of these contributions (13 of 23) have been published in the operations research literature, but several have also appeared in the information systems literature and in project management journals. This indicates that research on mathematical models and decision support systems is not limited to a particular discipline.

Most of the analyzed approaches (20 out of 23) support (IT) project portfolio selection.[338] Cho & Shaw and Stummer & Vetschera, in contrast, are in particular concerned with the distribution of resources between different decision-making units (budgeting).[339] Heimerl & Kolisch present an approach for human resource allocation and project scheduling in the multi-project context.[340] Some contributions also address project selection, project scheduling,

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[336] A project portfolio selection framework that is empirically grounded and takes note of different preferences of different decision makers has been presented early on by Ghasemzadeh & Archer (cf. Ghasemzadeh & Archer, 2000). A decision-making approach designed for a specific organizational context (project selection in a decentralized constellation, where different departments try to obtain a fair compromise) has been presented, for example, by Stummer & Vetschera (cf. Stummer & Vetschera, 2003).

[337] Not all of these approaches are specifically designed for the IT context, but all are capable of taking account of the characteristics that are in particular relevant for IT projects.

[338] Of the five accentuated stages in Figure 11, in particular the "Individual Project Analysis" and the "Optimal Portfolio Selection" stages are supported by the surveyed approaches.

[339] Cf. Cho & Shaw, 2009a; Stummer & Vetschera, 2003.

[340] Cf. Heimerl & Kolisch, 2010.

and resource allocation simultaneously. For example, Gutjahr & Reiter, Gutjahr et al. and Stummer et al. introduce such integrated approaches.[341]

Though the project portfolio selection phase is most frequently supported in the investigated contributions, the nature of the proposed approaches is quite distinct.[342] A number of main themes are addressed in the motivations of the identified contributions. Based on these themes, the following major requirements for effective support of IT project portfolio selection can be derived:[343]

- Consideration of multiple objectives
- Consideration of non-financial resource constraints
- Consideration of risk at the portfolio level
- Consideration of strategic directions
- Consideration of intratemporal interdependencies
- Consideration of intertemporal interdependencies
- Consideration of mandatory projects
- Support of group decision-making
- Support of interactive decision-making
- Visual representations in order to inform the decision maker
- Consideration of dynamic changes

The degree to which the above-mentioned requirements are covered by the identified contributions can be retraced in detail in the concept matrix[344] contained in Appendix B. In the following, an aggregated overview is provided. Figure 14 depicts how many contributions cover the respective requirement. In the following, the requirements and their coverage in the existing literature will be briefly discussed.

[341] Cf. Gutjahr et al., 2010; Gutjahr & Reiter, 2010; Stummer et al., 2009.
[342] The fact that there is an overemphasis on the project selection phase in capital budgeting literature in general is also strongly highlighted by R. M. Burns & Walker, 2009.
[343] Note that these requirements are direct consequences of the characteristics of IT projects discussed in section 3.2.3.
[344] For a description of the term “concept matrix” refer to Webster & Watson, 2002, p. xvii.

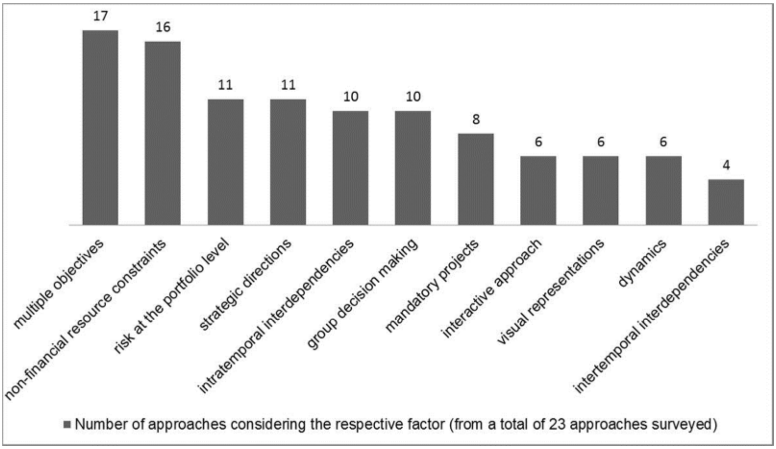

Figure 14: Fulfillment of requirements by the investigated approaches[345]

The importance of considering different kinds of benefit criteria (tangible and intangible, qualitative and quantitative) when evaluating IT investments has frequently been highlighted.[346] This is due to the specific requirements for the evaluation of IT investments.[347] Consequently, many authors have been concerned with the development of project portfolio selection approaches that are capable of considering and integrating multiple objectives. The respective approaches can be classified in two broad categories (cf. Figure 15).[348] The approaches in the first category aggregate the evaluations for all existing criteria into a single score. This way, a scalar is calculated for each project based on the decision maker's preferences, and an optimization approach can be employed in order to select a final portfolio based on these project scores.[349] The approaches in the second category first identify efficient portfolios and present these to the decision maker.[350] Therefore, in contrast to the first kind of approaches, the decision maker's preferences do not have to be explicated in advance of the selection step.[351]

345 Frey & Buxmann, 2012, p. 8.
346 Cf. Chou et al., 2006, for example.
347 Cf. section 3.2.3.1.
348 Cf. Urli & Terrien, 2010, p. 812.
349 Cf. Urli & Terrien, 2010, p. 812f.
350 This corresponds to the concept of efficient frontiers introduced by Markowitz.
351 Cf. Urli & Terrien, 2010, p. 813.

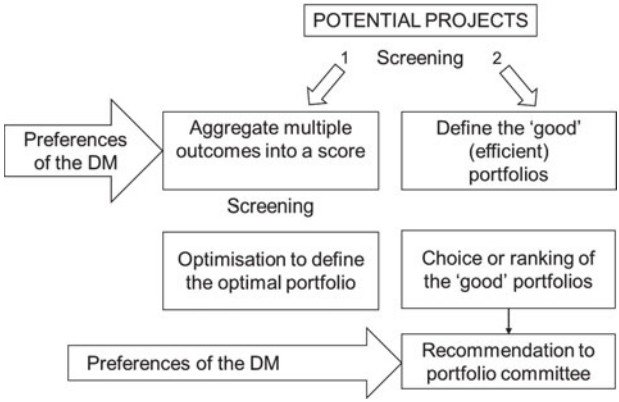

Figure 15: Two different kinds of approaches for project portfolio selection[352]

The second requirement relates to the consideration of resource constraints by the different approaches. In many mathematical models, resource constraints are treated rather abstractly. However, a number of authors highlight the particular impact of considering the specific skills of the human resources involved in projects.[353] Consequently, taking account of non-financial resource constraints has been emphasized as a requirement for approaches supporting project portfolio selection and resource allocation.[354]

As discussed in section 3.2.3, IT projects, as well as the information environment in which IT project portfolio selection takes place, underlie a high level of uncertainty and risks. Consequently, risk and uncertainty are taken into account by most of the investigated approaches. However, risk should not only be considered at the single project level but also at the level of the entire portfolio.[355] In contrast to risk in general, risk at the portfolio level is only addressed by 11 of the 23 identified approaches.

Strategic considerations play an important role in the IT project portfolio management discipline.[356] Therefore, it has been emphasized that the corporate strategy and the IT strategy should be taken into account during project portfolio selection.[357] In general, most multi-

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[352] Reprinted from Urli & Terrien, 2010, p. 812 with permission from John Wiley and Sons.
[353] Cf. section 3.2.3.5.
[354] Cf. Gutjahr & Reiter, 2010; Stummer et al., 2009; Stummer & Vetschera, 2003.
[355] Cf. Drake & Byrd, 2006.
[356] Cf. Burke & Shaw, 2008, p. 2f.; Meskendahl, 2010, p. 813f.
[357] Cf. Angelou & Economides, 2008, p. 485; Eilat et al., 2006, p. 1019f.

objective approaches are capable of incorporating strategic criteria. However, only in 11 of the investigated contributions strategic criteria are explicitly addressed (in six of them only briefly). In IT project portfolio management literature, a trend towards more strategic IT projects has been highlighted.[358] Consequently, it is likely that strategic criteria will be addressed more intensively in future project portfolio selection approaches. The internal sponsorship of IT projects and the specific governance context explain the relevance of strategic considerations.

IT projects are often mandated by legislative authorities for legal purposes or by upper management for strategic or prestige purposes.[359] Such mandatory projects are also frequently mentioned in the IT project portfolio management literature. Mandatory projects may consume a significant fraction of the available budget and, therefore, have to be taken into account during project portfolio selection. In eight of the 23 contributions, mandatory projects are explicitly considered.[360]

As discussed in section 3.2.3, a high degree of interdependence between different projects is a key characteristic of IT project portfolios. This is also reflected in many of the surveyed approaches. However, here a distinction has to be made between approaches considering intratemporal and approaches considering intertemporal interdependencies. While intratemporal interdependencies relate to the dependencies among projects in the current portfolio, intertemporal interdependencies in particular relate to the dependencies between current projects and follow-up projects.[361] Approaches concerned with intratemporal interdependencies typically cover exactly one planning period while the consideration of intratemporal interdependencies requires approaches that account for multiple planning periods.[362] Ten of the identified approaches consider intratemporal interdependencies but only four approaches take account of intertemporal interdependencies. The latter approaches typically build on real options theory.[363] In this context, the evaluation and consideration of project-specific risks, in combination with interdependencies between the projects, is a

[358] Cf. Stewart, 2008.
[359] Cf. Schniederjans & Santhanam, 1993, p. 248.
[360] Cf. Ghasemzadeh & Archer, 2000, p. 77; Klapka & Pinos, 2002, p. 436; Kundisch & Meier, 2011b, p. 8; J. W. Lee & Kim, 2000, p. 378, 2001, p. 114; Santhanam & Kyparisis, 1995, p. 808, 1996, p. 383; Schniederjans & Santhanam, 1993, p. 248.
[361] Cf. Kundisch & Meier, 2011a, p. 480.
[362] Some authors, like for example Bardhan et al., describe such multi-period models as dynamic optimization models (Bardhan et al., 2004, p. 60). However, it has to be noted that the term *dynamics* has a different meaning in this dissertation. Here, the term *dynamics* relates to the changes occurring during a decision-making cycle.
[363] Cf. Angelou & Economides, 2008; Bardhan et al., 2004, 2006.

particular challenge.[364] None of the investigated approaches is fully capable to consider project-specific risks as well as intratemporal and intertemporal interdependencies.[365]

Due to the specific governance context of IT project portfolio management, typically several stakeholders are involved in the decision-making processes. According to Chen & Cheng "[...] decision making by multiple decision makers is commonplace in most IS project selections."[366] Consequently, approaches are required that support group decision-making. This holds true for ten of the 23 considered approaches.

The high level of uncertainty and the specific evaluation requirements for IT projects make interactive approaches preferable. It has been criticized that many approaches are too rigid and confront the user with a final solution without allowing for adjustments and alternatives.[367] Interactive approaches, in contrast, support decision makers with information about alternative solutions and enable a detailed exploration of different options. Six of the investigated approaches explicitly or implicitly allow for user interaction. Five of these six interactive approaches provide visual representations of potential project portfolios.[368] At least three of these contributions introduce systems with graphical representations that allow the user to explore the solution space directly and to change preferences via the graphical interface.[369]

Due to the high level of uncertainty, dynamic changes play an important role in IT project portfolio management.[370] Planning parameters may change during a budgeting cycle for example due to the arrival of new projects or the necessity to re-assess projects and to re-allocate resources in order to account for strategic shifts.[371] Therefore, it is beneficial if project portfolio planning is robust to changes to a certain degree. However, only six of the investigated approaches are at least partly capable of considering dynamics. The consideration of dynamic changes requires a broad perspective on IT project portfolio management. Feedback loops between different stages have to be taken into account.[372] As the surveyed contributions are more or less focused on one or a few stages, these feedback loops are typically not taken into account. Furthermore, the combination of interdependencies and

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[364] Cf. Diepold et al., 2009.
[365] Project interdependencies will be discussed in more detail in section 5.2.2.
[366] Chen & Cheng, 2009, p. 390.
[367] Cf. Ghasemzadeh & Archer, 2000, p. 74.
[368] Cf. Ghasemzadeh & Archer, 2000, p. 75; Klapka & Pinos, 2002, pp. 442–445; Stummer et al., 2009, pp. 387–397; Urli & Terrien, 2010, p. 820; Zheng & Vaishnavi, 2011, pp. 91–94.
[369] Cf. Ghasemzadeh & Archer, 2000; Stummer et al., 2009; Zheng & Vaishnavi, 2011.
[370] Cf. Meskendahl, 2010, p. 814.
[371] Cf. Blichfeldt & Eskerod, 2008; Blomquist & Müller, 2006; Urli & Terrien, 2010.
[372] Cf. Figure 11 on page 56.

dynamic changes seems to be difficult to incorporate into a single approach. This leaves research opportunities for future contributions.

As indicated in the previous section, the stream of research concerned with approaches for IT project portfolio selection has emerged from basic mathematical models to more advanced decision support systems. Shortcomings of basic mathematical models have been summarized by Archer & Ghasemzadeh as follows:

> "Many of these techniques are not widely used because they are too complex and require too much input data, they provide an inadequate treatment of risk and uncertainty, they fail to recognize interrelationships and interrelated criteria, they may just be too difficult to understand and use, or they may not be used in the form of an organized process."[373]

Based on this critique, Archer & Ghasemzadeh have recommended that comprehensive decision support systems should be developed in order to address these issues. In a subsequent contribution, Archer & Ghasemzadeh have also introduced a decision support system that provides assistance for the different steps contained in their project portfolio selection framework (cf. Figure 11).[374] A major difference between early, rather rigid mathematical models and the decision support systems that have been introduced in recent years is that these decision support systems give the decision maker more flexibility. Instead of prescribing a single solution, multiple options are presented to the decision maker. The system does not make the decision but supports the decision maker. Beyond that, approaches that support user interaction also provide the opportunity to explore different solutions and to analyze the potential consequences of a decision immediately.[375]

The stream of research has made significant progress in recent years. In particular, empirical findings have furthered the adaption of the approaches to practical requirements. However, still all too often the governance context for which the respective approaches are intended is not sufficiently exposed. It is unlikely that a single decision support system fits into all kinds of organizations and governance contexts. A decision support system that could be employed

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[373] Archer & Ghasemzadeh, 1999, p. 207.
[374] Cf. Ghasemzadeh & Archer, 2000.
[375] Cf. Ghasemzadeh & Archer, 2000, pp. 77–79; Klapka & Pinos, 2002, p. 439; Stummer et al., 2009, pp. 384–389; Stummer & Vetschera, 2003, p. 256; Zheng & Vaishnavi, 2009, p. 89f.

in any organization would be too generic to be of practical use.[376] Therefore, a logical future direction consists in the development of models for specific governance contexts.[377] This development has already started. For example, Heimerl & Kolisch have compared the impacts of centralized and decentralized planning in the multi-project staffing and scheduling context, and Stummer & Vetschera have proposed a framework for resource allocation and project selection in decentralized constellations.[378] Thereby, these authors avoid the implicit assumption that projects are selected centrally.

Nevertheless, stronger integration of empirical and prescriptive mathematical contributions is required. Especially, it is important to identify relevant contingency factors in order to classify decision support frameworks according to the particular governance context they support.[379] Moreover, the underlying design principles should be reflected more intensively.

3.2.7 Empirical findings and concepts

In recent years, an increasing number of empirical contributions concerned with IT project portfolio management have been published. Researchers have started to investigate project portfolio management as a real-world phenomenon.[380] The respective contributions particularly cover success factors, problem areas, and contingency factors associated with the implementation and governance of IT project portfolio management practices.[381]

The increasing number of empirical contributions may also be due to the previous overweight of contributions concerned with mathematical models and decision support tools. Many of the initially proposed models were rather theoretical and did not consider practical requirements. It has been recognized that these models were not widely adopted in practice.[382] Therefore, a number of researchers set out to explore requirements and success factors for IT project portfolio management as well as the governance mechanisms employed in practice. In this

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[376] Note that there are commercial project management information systems covering the entire life cycle of a project and providing a wide range of approaches for disciplines like project management, program management and project portfolio management (cf. Ahlemann, 2009, p. 19). These solutions can be customized and are therefore applicable to a large range of organizations. Nevertheless, the choice of the right solution and the right approach for IT project portfolio management depends on the given governance context.

[377] This corresponds to the emergent stream of research outlined in the lower part of Figure 13.

[378] Cf. Heimerl & Kolisch, 2010; Stummer & Vetschera, 2003.

[379] Success factors and contingency factors identified in empirical research will be addressed in the next section.

[380] Cf. Blichfeldt & Eskerod, 2008, p. 358.

[381] Not all publications addressed in the following are specifically concerned with IT project portfolio management. Some cover the project portfolio management discipline in general. However, these contributions have been critically assessed regarding their compatibility with the IT project portfolio management context.

[382] Cf. Archer & Ghasemzadeh, 1999, p. 207.

context, the roles and responsibilities of the different stakeholders involved also moved into focus.[383]

The importance of effective governance structures has inter alia been highlighted by Thomas et al., who state the following:

> "The conclusion is that the key to more effective IT project evaluation is not more formal and sophisticated methods, but rather, more effective governance structures and decision processes."[384]

Different success factors for effective IT project portfolio management have been identified in former research. Table 9 presents an overview of success factors extracted from the contributions in the literature sample.[385] Detailed descriptions of these success factors are provided in Appendix C. The identified success factors were discussed in contributions explicitly concerned with IT project portfolio management.[386] Most of these success factors cover procedural aspects (e.g. risk analysis, financial analysis, measurement of costs and benefits, consideration of multiple constraints, etc.) while others are of organizational nature (e.g. centralized view on all projects, accountability for results, etc.). Relational aspects (e.g. top management commitment) have also been addressed in the existing literature. Throughout this dissertation, two factors and their relationship will be of particular interest: project interdependencies, and a centralized view on the available project proposals.

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383 Cf., e.g., Blomquist & Müller, 2006; Farbey et al., 1999.

384 Thomas et al., 2007, p. 2.

385 A cross in Table 9 indicates that the success factor listed in the respective column has been covered in the contribution contained in the respective row. Crosses in brackets mark success factors only partly covered by the respective publication.

386 Note that this list is not exhaustive. Not all success factors mentioned in the relevant literature have been listed. Only contributions containing sufficient information regarding the respective success factor were considered.

Table 9: Success factors identified in previous empirical and conceptual studies[387]

	Strategic fit / Strategic alignment	Consideration of project interdependencies	Centralized view	Financial analysis	Top management commitment	Accountability for results	Portfolio segmented by asset classes	Risk analysis / portfolio balance	Measurement of costs and benefits	Consideration of multiple constraints
Jiang & Klein, 1999a	X		(X)							
Elonen & Artto, 2003	X				(X)				(X)	(X)
Jeffery & Leliveld, 2004	X		X	X			X	X	(X)	
De Reyck et al., 2005	X	X	X	X	X	X	X	X	X	X
Thomas et al., 2007	X				X	X			X	
Müller et al., 2008	X									
Jonas, 2010					X					
Meskendahl, 2010	X	X					X	X		

It has been recognized that fundamental requirements for effective IT project portfolio management are covered to very different degrees in practice.[388] In order to be able to classify organizations according to their IT portfolio management practices, authors like Jeffery & Leliveld and De Reyck et al. have put forward the concept of maturity stages.[389] Based on empirical data, Jeffery & Leliveld were the first to draw a conception of typical maturity stages for IT portfolio management practices.[390] Jeffery & Leliveld describe three different stages (defined, managed, and synchronized).[391] Analogously, De Reyck et al. also distinguish between three stages (portfolio inventory, portfolio administration and portfolio optimization).[392]

[387] Adapted from Frey & Buxmann, 2012, p. 7.
[388] Cf. Jeffery & Leliveld, 2004, p. 41.
[389] Cf. De Reyck et al., 2005; Jeffery & Leliveld, 2004.
[390] Note that Jeffery & Leliveld as well as De Reyck et al. refer to IT portfolio management in general. However, a particular focus is put on projects.
[391] Cf. Jeffery & Leliveld, 2004, p. 43f.
[392] Cf. De Reyck et al., 2005, p. 532f.

The concept of maturity stages may lead to the wrong impression that reaching a high maturity stage is a desirable objective for all firms.[393] This would imply a quite narrow focus on the governance context of IT project portfolio management. The organizational environment in which IT project portfolio management is embedded and other factors have a large impact on the appropriateness of a particular governance arrangement.[394] Consequently, contingency factors have to be taken into account when choosing a governance arrangement for IT project portfolio management.[395] A number of contingency factors have been discussed in the identified empirical and conceptual contributions. However, it should be highlighted that the dependent variables addressed in these contributions differ widely (cf. Table 10).

Table 10: Contingency factors identified in empirical and conceptual studies[396]

Contribution	Contingency factors	Dependent variable
Jiang & Klein, 1999a	IS strategic relevance	Importance of internal, external and project metrics
Blomquist & Müller, 2006	Project type Environmental complexity	Program and portfolio management (roles, responsibilities, practices)
Martinsuo & Lehtonen, 2007	Single-project management factors	Portfolio management efficiency
Müller et al., 2008	Project type Internal dynamics Governance type Geographical location	Portfolio control practices
Canonico & Söderlund, 2010	Exploitation of mutual interdependencies Openness of projects to the external business environment	Management control mechanisms
Prifling, 2010a	Organizational culture	Project portfolio management and risk management in IT projects

Jiang & Klein have conducted a survey with 88 IS professionals in order to investigate how the strategic impact of current and future information systems influences the decision criteria used for IT project selection.[397] They distinguish between three different kinds of metrics for project evaluation: “[...] internal goals set by the organization, factors dictated by the external

[393] Cf. Maizlish & Handler, 2005, p. 46.
[394] Cf. Blomquist & Müller, 2006, p. 43.
[395] This evolution from the identification of general success factors towards a contingency perspective is illustrated in the classification depicted in Figure 13.
[396] Adapted in modified form from Frey & Buxmann, 2012, p. 7.
[397] Cf. Jiang & Klein, 1999a.

environment, and project metrics related to technical aspects, project risk, and project management."[398] They find that organizations in which current information systems have little strategic importance tend to rely on internal efficiency metrics.[399] Moreover, they find that "[...] organizations with a strategic emphasis on future systems consider external and internal factors more important than technical and risk considerations."[400] In general, Jiang & Klein highlight the importance of appropriately weighting selection criteria in order to "[...] align project selection and strategic goals of the organization [...]".[401]

Blomquist & Müller have conducted research on the involvement of middle managers in program and project portfolio management.[402] Based on a large-scaled survey with 242 participants, they have in particular surveyed the impact of project type and organizational complexity on the roles, responsibilities, and practices of middle managers in program and project portfolio management.[403] Blomquist & Müller inter alia conclude: "Organizations should adapt their governance structure to the needs of their environment and project types."[404] In this context, they provide detailed recommendations concerning good practices of middle managers in the program and portfolio management context.[405]

In a later contribution, Müller et al. have used data from the same survey in order to empirically measure the impact of portfolio control on portfolio success.[406] In this context, the moderating effects of the governance type and four other contingency factors (industry, geography, dynamics, and project type) have been measured.[407] Müller et al. come to the conclusion that "[...] organizations with different governance styles differ in their use of different portfolio control practices, whereas other contextual factors did not appear as significant."[408] However, Müller et al. conceptualize governance in terms of different ways of grouping projects (isolated, by joint objectives, by resources, hybrid).[409] This understanding of governance deviates from the conception of IT governance used in this dissertation.[410] It

[398] Jiang & Klein, 1999a, p. 175.
[399] Cf. Jiang & Klein, 1999a, p. 175.
[400] Jiang & Klein, 1999a, p. 175.
[401] Jiang & Klein, 1999a, p. 175.
[402] Cf. Blomquist & Müller, 2006.
[403] Cf. Blomquist & Müller, 2006, pp. 58–64.
[404] Blomquist & Müller, 2006, p. 63.
[405] Cf. Blomquist & Müller, 2006, p. 64.
[406] Cf. Müller et al., 2008.
[407] Cf. Müller et al., 2008, p. 37.
[408] Müller et al., 2008, p. 38.
[409] Cf. Müller et al., 2008, p. 32f.
[410] Cf. section 2.4.

should also be noted that the study of Müller et al. is concerned with program and project portfolio management in general and not specifically with IT project portfolio management.

Based on a large-scaled empirical study with 279 participating companies, Martinsuo & Lehtonen have investigated the impact of single project management on portfolio management efficiency.[411] They find that single project management factors partly explain the variance in project portfolio efficiency in terms of "[...] organizational members' estimate of the degree to which the projects together, as a portfolio, succeed in fulfilling the portfolio objectives, the objectives being strategic alignment, portfolio balance and value maximization."[412] In particular, the factors "Information availability" and "Project management efficiency" exert a significant impact on the dependent variable.[413] Martinsuo & Lehtonen have also investigated the impact of mediating factors, particularly company size. In this context, they find support for the "[...] presumption that portfolio management practices increase in relevance in larger companies."[414] While the link between single project management factors and portfolio management efficiency proved to be significant in this study, Martinsuo & Lehtonen also note that these factors only partly explain the variance in the dependent variable.[415] Therefore, they recommend further empirical studies with a particular focus on portfolio management practices.[416]

Canonico & Söderlund take a contingent view on management control mechanisms in multi-project organizations.[417] Motivated by the framework of management control mechanisms of Simons,[418] Canonico & Söderlund describe and discuss the belief systems, boundary systems, diagnostic systems and interactive systems employed by top management in multi-project organizations. Based on a comparative case study in two firms, they investigate contingency factors that exert an influence on the favorability of different management control mechanism. Canonico & Söderlund are primarily concerned with incentives for stakeholders at the project execution level in multi-project organizations. However, Canonico & Söderlund inter alia emphasize "[...] the importance of the 'exploitation of mutual interdependencies' among projects [...]"[419] and thereby address an aspect of high relevance to the IT project portfolio management context. In the concluding section of their contribution, Canonico & Söderlund

411 Cf. Martinsuo & Lehtonen, 2007.
412 Martinsuo & Lehtonen, 2007, p. 59.
413 Cf. Martinsuo & Lehtonen, 2007, p. 61.
414 Martinsuo & Lehtonen, 2007, p. 62.
415 Cf. Martinsuo & Lehtonen, 2007, p. 62.
416 Cf. Martinsuo & Lehtonen, 2007, p. 62.
417 Cf. Canonico & Söderlund, 2010, p. 799.
418 Cf. Simons, 1994.
419 Canonico & Söderlund, 2010, p. 803.

demand for additional case study research on contingency factors concerning control mechanisms and organizational structures.[420]

Prifling has in particular examined organizational aspects of IT project portfolio management.[421] He employed a grounded theory approach in order to "[…] investigate the influence of the organizational culture on risks in IT projects".[422] In this contribution, it is theorized that IT project portfolio management and risk management in IT projects are contingent upon the organizational culture.[423] In particular, Prifling explains how a consensus oriented organizational culture can lead to too many projects and in effect to a shortage of resources and to project delays.[424] This contribution highlights an important and relevant aspect regarding the governance of multi-project environments. However, the study relies on a case in a single organization and the governance arrangements in the organization are not described in detail. Consequently, further research on this aspect is required.

In summary, the existing body of literature has uncovered and analyzed many contextual, procedural, and relational aspects in the context of IT project portfolio management.[425] However, comprehensive insights into governance arrangements for IT project portfolio management encountered in practice are rare. In particular, structural mechanisms are still underexplored. Structural mechanisms have been mentioned and described in existing empirical contributions. In this context, it has frequently been noted that typically multiple decision makers and committees are involved in IT project portfolio management.[426] However, it has not sufficiently been examined why and how these structural mechanisms are employed and which consequences result from the use of different governance arrangements. These aspects will be addressed in detail in chapter 4 of this dissertation.

3.2.8 Convergence of empirical and mathematical contributions

As indicated in section 3.2.5, there are two predominant streams of research in the IT project portfolio management discipline. On the one hand, there is a stream of research concerned with the design of mathematical models and decision support systems. On the other hand, there is a stream of research addressing success factors, maturity stages, and contingency

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[420] Cf. Canonico & Söderlund, 2010, p. 804.
[421] Cf. Prifling, 2010a.
[422] Prifling, 2010a, p. 1.
[423] Cf. Prifling, 2010a, p. 7.
[424] Cf. Prifling, 2010a, p. 7.
[425] For a classification of structural, procedural and relational capabilities compare Table 2 in section 2.4.4.
[426] Cf. Jiang & Klein, 1999a, p. 175; Jonas, 2010, pp. 823–825; L. S. Lee & Anderson, 2009, p. 113; Santhanam & Kyparisis, 1996, p. 382.

factors with regard to the governance of IT project portfolio management. These two streams are more and more beginning to converge.

When looking at the development in these two streams of research, it can be recognized that findings from empirical and conceptual studies more and more inform and motivate new mathematical models and decision support systems.[427] In previous contributions concerned with mathematical approaches computational experiments[428], numerical examples,[429] and single case studies[430] were typically presented at the end of the paper in order to demonstrate the application of the respective approach. However, many of these approaches do not meet practical requirements.[431] They have often been designed with a strong focus on mathematical concepts, but not taking into account the governance context and the requirements of potential users. Therefore, it is advisable to thoroughly investigate the requirements posed by different users and contexts based on empirical methods, before new normative approaches are constructed. Moreover, mathematical approaches should be tested in practice and should be adjusted according to the feedback of practitioners. Consequently, the design science paradigm[432] is gaining more and more attention.[433]

On the other hand, research concerned with new approaches and decision support systems also influences empirical research. Decision support systems are used in a significant number of organizations in the form of project portfolio management software. The investigation of the organizational impact of these systems provides a further opportunity for empirical research.[434]

Finally, it should be noted that both streams of research still have potential to evolve. In particular, comprehensive models taking account of contingency factors and addressing the links between contingency factors and suitable portfolio management practices would be of high value for information systems theory as well as for practitioners.

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[427] For example, the framework derived by Archer & Ghasemzadeh, 1999 has informed future studies like Urli & Terrien, 2010.
[428] E.g. Heimerl & Kolisch, 2010; Stummer & Vetschera, 2003.
[429] E.g. Chen & Cheng, 2009; Klapka & Pinos, 2002; Santhanam & Kyparisis, 1995; Schniederjans & Santhanam, 1993; Urli & Terrien, 2010.
[430] E.g. Angelou & Economides, 2008; Chou et al., 2006; Stummer et al., 2009.
[431] Cf. Archer & Ghasemzadeh, 1999, p. 207; Urli & Terrien, 2010, p. 812.
[432] Cf. Baskerville & Pries-Heje, 2010; Hevner et al., 2004; Markus et al., 2002.
[433] For example, Ahlemann, 2009; Stewart, 2008 and Zheng & Vaishnavi, 2011 have applied design science approaches.
[434] Cf. De Reyck et al., 2005, p. 526; Jeffery & Leliveld, 2004, p. 43.

3.3 Research agenda and implications for future research

The main purpose of conducting a structured literature review is to provide the grounds for future research.[435] Therefore, the final step consists in identifying a research agenda.[436]

One possible way to identify likely paths for future research is to screen through the concluding sections of the contributions identified during the literature search and to note the gaps mentioned in these contributions.[437] Consequently, the sample at hand has been analyzed for research proposals. An overview of the identified proposals is provided in Appendix D. Based on these suggestions and an analysis of the major developments in the field of research,[438] several trends and requirements for future work have been derived. The major items on the resulting research agenda are summarized in Figure 16.

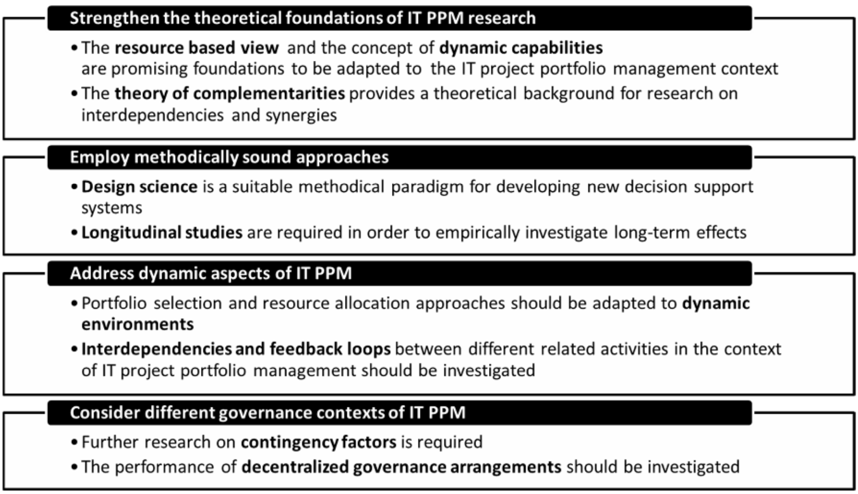

Figure 16: Research agenda

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[435] The research opportunities identified during a structured literature review may inform own research projects but should in particular motivate other researchers to close research gaps (cf. Webster & Watson, 2002, p. xix).

[436] Cf. Vom Brocke et al., 2009, p. 10; Webster & Watson, 2002, p. xix.

[437] Cf. Bandara et al., 2011, p. 8.

[438] Cf. section 3.2.5.

Firstly, during the literature analysis it became apparent that the theoretical foundations of the surveyed contributions are rather diverse.[439] Consequently, the provision of a common theoretical ground for the research discipline is an important endeavor. Promising strategic management theories that are applicable to a wide range of contributions in the field of research are the resource-based view and the concept of dynamic capabilities.[440] Furthermore, the theory of complementarities[441] provides an important background for contributions concerned with interdependencies and synergy potentials.[442]

Secondly, it should be highlighted that, in the past, research on IT project portfolio management has often lacked methodical rigor. With regard to the development of future decision support systems, the design science paradigm provides a promising methodical foundation.[443] In the empirical research stream, longitudinal studies have been proposed as a suitable approach for examining long-term effects and for considering the dynamics inherent in IT project portfolio management.[444]

Dynamic aspects in the context of IT project portfolio management need stronger consideration in future research. This in particular applies to project portfolio selection and resource allocation approaches that are usually static and should be extended in order to take account of dynamic changes in the environment.[445] Moreover, this also applies to the governance context of IT project portfolio management as a whole. Different fields of activities should not be regarded in isolation. Instead, the interdependencies and feedback loops between activities like budgeting, project portfolio selection, and resource allocation should be investigated in more detail.[446]

Finally, in several of the analyzed contributions, further research on contingency factors with regard to different governance styles as well as performance and efficiency effects has been recommended.[447] In this context, deeper insights into the governance styles and arrangements employed in practice are required.[448] In particular, often a strongly centralized governance context of IT project portfolio management with a single decision maker has been

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[439] Cf. section 3.2.4.
[440] Cf. Killen et al., 2012.
[441] Cf. Milgrom & Roberts, 1995; Tanriverdi & Venkatraman, 2005; Tanriverdi, 2006.
[442] Cf. Cho & Shaw, 2009a, p. 3f.
[443] Cf. Ahlemann, 2009; Stewart, 2008; Zheng & Vaishnavi, 2011.
[444] Cf. Jiang & Klein, 1999a, p. 176; Jonas, 2010, p. 828.
[445] Cf. Eilat et al., 2006, p. 1035; Gutjahr et al., 2010, p. 678; Gutjahr & Reiter, 2010, p. 439; Urli & Terrien, 2010, p. 821.
[446] Cf. Lanzinner et al., 2008, p. 9.
[447] Cf. Blomquist & Müller, 2006, p. 64; Martinsuo & Lehtonen, 2007, p. 63; Müller et al., 2008, p. 39.
[448] Cf. Engwall & Jerbrant, 2003, p. 408; Müller et al., 2008, p. 39; Prifling, 2010a, p. 4.

presupposed in mathematical models.[449] However, this does not completely reflect the situation in practice where often strongly decentralized and distributed decision-making structures can be encountered.[450] Consequently, more research on centralization and decentralization in the context of IT project portfolio management is required as well as approaches that account for decentralized and federal settings.[451]

Particularly the last item on the agenda (contingency factors and decentralized governance arrangements) will be addressed in the following. In this context, different fields of activities that can be governed in different ways will be surveyed as well as interdependencies and feedback loops between these activities.

A qualitative study has been conducted in order to identify contingency factors and gain detailed insights into different governance arrangements for IT project portfolio management. This study will be presented in chapter 4. Chapter 5 will specifically be concerned with a comparison of centralized and decentralized arrangements for IT project portfolio selection. In this context, project interdependencies and the exploitation of synergy potentials will be of particular interest. These aspects will be addressed via mathematical modeling and simulation.

[449] Cf. Stummer & Vetschera, 2003, p. 254.
[450] Cf. Oral et al., 2001, p. 333; Stummer & Vetschera, 2003, p. 254.
[451] Cf. Stummer & Vetschera, 2003, pp. 274–276.

4 Governance arrangements for IT project portfolio management – A case study in ten companies

In order to gain a clearer understanding of the antecedents and impacts of different organizational design choices, it is important to analyze governance arrangements that exist in practice and to take account of the organizational context in which the respective arrangements are embedded. While relational and procedural mechanisms employed for IT project portfolio management have recently received growing attention in the relevant literature, the investigation of structural governance mechanisms is apparently underrepresented in current research. The study described in the following sets out to close this gap by analyzing governance arrangements for IT project portfolio management from a holistic perspective.[452]

Methodically, the investigation is based on case study research. Case studies offer the opportunity to gain deep insights into the phenomenon at hand and to provide sufficient detail of the subject matter.[453] Conceptually, the study is based on theoretical concepts borrowed from IT governance research.[454] In particular, the concept of structural, procedural, and relational mechanisms and the concept of centralization and decentralization are employed in order to describe and categorize the governance arrangements encountered in practice. Moreover, findings from earlier contributions are integrated in order to establish a comprehensive contingency perspective on the design of governance arrangements in the context of IT project portfolio management.[455]

In the following section, the purpose of the investigation is briefly explained. In section 4.2, the research objectives and research questions are presented. The conceptual framework for the current study is described in section 4.3, and the research approach is explained in section 4.4. The study's findings are presented in section 4.5. These findings are integrated into a comprehensive model in section 4.6. Finally, in section 4.7, a brief summary is provided and limitations of the study are discussed.

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[452] Parts of the study described in this chapter have previously been published in the proceedings of the 20th European Conference on Information Systems (cf. Frey & Buxmann, 2011).
[453] Cf. Yin, 2009, p. 4.
[454] Cf. chapter 2.
[455] Cf. chapter 3.

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4.1 Purpose of the investigation

The main purpose of the investigation described in this chapter is to explore governance mechanisms employed for IT project portfolio management with a particular focus on structural aspects. In order to reach this objective, it is important to identify and analyze different related fields of activities that can be governed in different ways. In this context, the existing IT governance literature represents an important background for this investigation, as well as existing empirical findings in the research domain of IT project portfolio management.

A second purpose of the study consists in establishing a holistic perspective on the governance of IT project portfolio management. In this context, antecedents leading to different governance arrangements in different fields of activities shall be investigated. Significant work has already been conducted in order to identify such contingency factors in related areas.[456] However, former contributions have typically focused on singular aspects and relationships. Therefore, a major objective of this investigation is to integrate current and previous findings in order to shape a holistic, empirically grounded contingency model.

4.2 Research questions

Based on the considerations discussed in the preceding section, the following research questions can be stated:

- Which fields of activities can be distinguished in the IT project portfolio management context and how are these different fields of activities interrelated?
- Which contingency factors can be identified and how do these contingency factors affect the design of governance arrangements for IT project portfolio management?
- Which general advantages and disadvantages pertain to different IT governance arrangements in the context of IT project portfolio management?

The first question aims at identifying and understanding different fields of activities in the IT project management context as a prerequisite for answering the following questions. The latter two questions aim at understanding the relationships between different environmental conditions, the governance arrangements employed for IT project portfolio management and the consequences of the use of different governance arrangements.

[456] A discussion of related empirical contributions is contained in section 3.2.7.

4.3 Conceptual framework

The general conceptual framework for the study at hand is depicted in Figure 17. It has been established in order to operationalize the research questions stated in the section 4.2. This framework is based on three foundations discussed in the following.

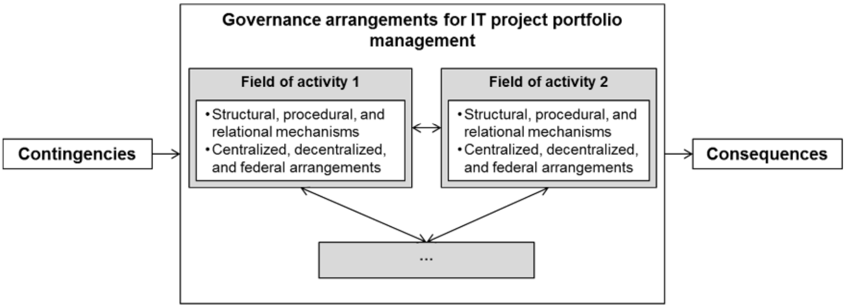

Figure 17: Conceptual framework

The identification of different fields of activities and the examination of different governance arrangements used for these fields of activities is motivated by the IT governance framework of Weill & Ross.[457] Weill & Ross distinguish between five main areas of decision-making pertaining to IT governance in general. The study at hand focuses in particular on IT investment decisions in the context of IT project portfolio management. Analogously to the approach taken by Weill & Ross, it is assumed that this decision-making domain can be further subdivided into different fields of activities that can be governed in different ways. In this context, it has to be considered that different decisions can be intertwined and, therefore, governance arrangements for different fields of activities need to be aligned.[458] Consequently, potential connections between different fields of activities have to be taken into account in the conceptual framework.

Peterson's distinction between structural, procedural, and relational governance mechanisms serves as a further foundation for the study at hand.[459] Due to the underrepresentation of research on structural mechanisms in the context of IT project portfolio management, structural mechanisms are of particular interest in the following. Nevertheless, also procedural

[457] Cf. Weill & Ross, 2004, p. 11.
[458] Cf. Blomquist & Müller, 2006, p. 64; Weill & Ross, 2004, p. 54.
[459] Cf. Peterson, 2004.

and relational mechanisms are investigated in order to obtain a comprehensive overview and to be able to conduct a theoretical integration with existing findings. Moreover, the classical distinction in IT governance research between centralized, decentralized, and federal arrangements also serves as a conceptual foundation.

As a third theoretical background, contingency theory informs the conceptual framework for the study at hand.[460] In order to explore why there are different governance arrangements for IT project portfolio management in practice, it is important to identify relevant contingency factors. It is assumed that contingency factors limit the spectrum of appropriate governance arrangements and thus indirectly have an impact on the outcomes of IT project portfolio management.

The study presented in the following is predominantly of explorative and descriptive nature. In order to support an emergent, inductive approach, the conceptual framework is designed in a nonrestrictive and flexible way.[461] The framework has been created in order to provide a general frame for the following research but makes no presumptions about specific items. Thereby, potential biases and preoccupations are reduced.

4.4 Research approach

Due to the nature of the research questions and the objective to gain deep insights into the way IT project portfolio management is implemented in practice, case study research was chosen as an appropriate research method for the current study. Case studies are in particular advantageous if the context of a phenomenon shall be investigated together with the phenomenon.[462] This characteristic fits well with the abovementioned research objectives as not only governance arrangements but also contingency factors that influence the design of these governance arrangements are of interest.[463]

4.4.1 Research design

In order to conduct case study research, it is important to develop a research design at the beginning.[464] Research questions are the first component of the research design.[465] Another

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[460] Cf. Sambamurthy & Zmud, 1999. Also compare section 2.3.
[461] Cf. M. B. Miles & Huberman, 1994, p. 17.
[462] Cf. Yin, 2009, p. 18.
[463] The research questions stated in section 4.2 include "how" questions. Case study research is in particular suitable for addressing "how" and "why" questions (cf. Benbasat et al., 1987, p. 370; Yin, 2009, pp. 8–10). Consequently, case study research is considered appropriate to answer these questions.
[464] Cf. Yin, 2009, p. 25.
[465] Cf. Yin, 2009, p. 27f.

important component is the unit of analysis.[466] For the case study design at hand, the primary units of analysis are governance arrangements for IT project portfolio management. The contextual unit of analysis is the general organizational and environmental context in which the respective governance arrangements are embedded.

Case study designs in general can be divided into single case and multiple case designs.[467] In order to address the research questions stated in section 4.2, a multiple case study design is required, as a single case would not provide the opportunity to observe different structures in different contexts. In addition, multiple cases have the additional benefit that usually more general research results can be obtained.[468] Multiple cases are an essential feature of the research design at hand, as a comparison between different governance arrangements is pursued.

Yin further distinguishes between holistic and embedded case study designs.[469] If more than one unit of analysis is regarded, the research design is called an embedded design. In contrast, if only one unit of analysis is regarded – as in the given case – the design is called a holistic case study design.[470] Accordingly, the design chosen for the study at hand is a holistic multiple case design.

The case companies for the current study were predominantly selected from two different industries – the financial services and the chemical and pharmaceutical industry. Thereby, similarities as well as differences between different companies and different industries were taken into account.[471] The financial services sector was chosen because this sector was among the first to use information technology. Consequently, it provides a good opportunity to study governance arrangements for IT project portfolio management in an advanced setting.[472] Due to the large number of projects in financial firms, IT project portfolio management practices are widely employed. It can also be assumed that IT projects are of particular importance in the financial services sector, since IT constitutes the backbone of financial services.

In addition to financial services firms, companies from the chemical and pharmaceutical industry were selected. While IT project portfolio management practices are also often applied by companies in this sector, the nature of the respective IT systems and projects is

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466 Cf. Yin, 2009, pp. 29–33.
467 Cf. Yin, 2009, p. 46.
468 Cf. Benbasat et al., 1987, p. 373.
469 Cf. Yin, 2009, pp. 50–52.
470 Cf. Yin, 2009, p. 50.
471 Cf. Orlikowski, 1993, p. 312.
472 Cf. Chiasson & Davidson, 2005, p. 592.

considerably different compared to those in the financial services sector. IT systems for chemical and pharmaceutical companies are usually more standardized and the share of IT staff in relation to the total number of employees is typically lower than in the financial services industry. The pharmaceutical industry is strongly regulated and a lot of documentation is required.[473] IS functions within chemical and pharmaceutical companies might also have a different standing and a different culture than IS functions within financial services companies. These differences might have an influence on the organizational structure, the relationship between business and IT, and the nature of the IT project portfolio management practices applied in the different sectors. Therefore, the chemical and pharmaceutical industry was considered suitable to witness differences in IT governance arrangements employed for IT project portfolio management and to allow for theoretical replication.[474] To allow for literal replication as well, companies were also chosen for their similarities concerning their organizational design.[475]

In order to be able to account for potential differences due to company size,[476] large as well as medium-sized companies were included.[477] Firms with small head counts were not taken into consideration since the number of IT projects in small firms might be quite low and, therefore, IT project portfolio management practices might not be required. Furthermore, in small firms it may be difficult to identify structural mechanisms due to informal relationships and a lack of documentation.[478]

4.4.2 Data collection

In order to address the research questions stated in section 4.2, a case study with ten different companies was conducted from January to December 2009. According to Eisenhardt four to ten cases usually work well in order to reach theoretical saturation.[479]

At the outset of the study, pilot cases were conducted in two companies. The two companies were particularly suited for a pilot case due to geographical proximity and very good access to the interview partners.[480] In contrast to the other investigated organizations, these companies did not belong to the financial services and chemicals/pharmaceuticals sector. Instead, they

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[473] Cf. Chiasson & Davidson, 2005, p. 598.
[474] Cf. Benbasat et al., 1987, p. 373; Yin, 2009, p. 54.
[475] Cf. Benbasat et al., 1987, p. 373; Yin, 2009, p. 54.
[476] Cf. Ein-Dor & Segev, 1982, pp. 62–64.
[477] The head counts of the investigated companies ranged between 3,000 and 96,000 employees.
[478] Similarly, Brown & Magill argue that a certain company size is required in order to be able to observe distinct governance roles and practices (cf. C. V. Brown & Magill, 1994, p. 374).
[479] Cf. Eisenhardt, 1989a, p. 545.
[480] Cf. Yin, 2009, p. 92.

offered industry specific services. Both cases provided a good opportunity to gain clarity on the scope of the study and the research design.[481] Findings from the pilot cases were considered and the case study's design was modified accordingly.[482]

Table 11 gives an overview of the ten cases. The two pilot cases are highlighted in grey. In order to protect the identities of the companies involved, identifiers are used instead of the company names when referring to the cases.[483] The table also lists the industry, relevant organizational characteristics, the roles of the interviewees in these companies, and the interview durations.[484]

Table 11: Case overview[485]

Company code	Industry	Organizational characteristics	Role of interviewee	Interview duration
C1	Industry specific services	Separated into relatively independent business segments	CIO	1 h 02 min
C2	Industry specific services	Organized into regions controlled by a central headquarter	Director for IT strategy and portfolio management	0 h 48 min
C3	Banking	Separated into business segments controlled by a central headquarter	Head of IT governance and architecture planning	0 h 43 min
C4	Banking	Separated into business segments controlled by a central headquarter	Head of IT governance; IT architect	1 h 06 min
C5	Banking	Separated into business segments controlled by a central headquarter	Head of IT governance	2 h 01 min
C6	Insurance	Separated into business segments controlled by a central headquarter	Head of IT planning and controlling	0 h 57 min
C7	Chemicals	Matrix structure (divisions and regions); IT is organized according to the regions	CIO EMEA	2 h 06 min
C8	Chemicals	Matrix structure (divisions and regions); IT is organized according to the regions	CIO EMEA	1h 28 min
C9	Chemicals / Pharmaceuticals	Separated into business segments controlled by a central headquarter	Head of the CIO office	1 h 02 min
C10	Pharmaceuticals	Matrix structure (divisions and regions); IT is organized according to the regions	CIO EMEA	0 h 48 min

Interview partners with a comprehensive overview of the IT governance arrangements and profound knowledge of the IT project portfolio management structures and processes were identified and contacted in the case companies. The key informants were especially CIOs, heads of IT governance departments, and heads of IT project portfolio management.

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481 Cf. Yin, 2009, p. 92.
482 This corresponds to a "flexible design" as described by Yin (cf. Yin, 2009, p. 62).
483 Human subjects protection is of vital importance in case study research (cf. Yin, 2009, p. 73).
484 Further company information like financial figures, the company-wide number of employees and the number of employees in the IS function have been collected but cannot be published due to privacy considerations.
485 Adapted from Frey & Buxmann, 2011, p. 4.

In case company C4, the head of IT governance and an IT architect were jointly interviewed. In each of the remaining case companies, only a single expert was interviewed. Conducting interviews with multiple respondents in each case company would have better corroborated the results since this would have opened up the opportunity to compare and contrast different perspectives on the unit of analysis. However, the inclusion of additional experts was hindered by the circumstance that in each company only very few subject matter experts had a complete overview of the governance arrangements for IT project portfolio management.

Open-ended, semi-structured interviews were conducted on site in direct dialog. As the interviewees had high demands on confidentiality, the on-site visits were in particular intended as a trust-building measure. As an additional advantage, the interviewees could visualize governance arrangements on white-boards. Moreover, documents could be directly discussed with the interviewees. The interview in company C9 was conducted in English. The other interviews were conducted in German language. All interviews were fully transcribed in order to ensure that all statements could later be retraced in detail.

In accordance with the explorative design of the study, it was opted for a relatively low degree of instrumentation.[486] An interview guideline was used, but it was handled in such a way that different building blocks were addressed in a flexible manner.[487] Moreover, the questions were adapted to the specific organizational context of the particular company.[488]

Different sources of evidence were gathered in order to pursue a corroboration strategy and to be able to triangulate the data.[489] Thereby, problems of construct validity were addressed.[490] For the qualitative study at hand, the following sources of evidence were collected and compared:

- Interviews
- Information obtained from the corporate websites – in particular organizational charts
- Press articles containing descriptions of IT governance and IT project portfolio management practices of the investigated firms, as well as reports describing recent organizational changes
- Internal documents containing organizational charts and process descriptions

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486 Cf. M. B. Miles & Huberman, 1994, p. 35.
487 An excerpt of the interview guidelines is provided in Appendix E.
488 This corresponds to Level 2 questions as described by Yin (cf. Yin, 2009, p. 87).
489 Cf. Yin, 2009, pp. 114–117.
490 Cf. Yin, 2009, p. 116.

A case study protocol and a case study database were established at the outset of the study and were constantly updated. The use of case study protocols and the development of a case study database are important tactics to safeguard a high reliability of case study research.[491] A case study database is also an important instrument for record keeping, in particular for multiple case designs.[492] The case study database for the current study was used to assemble all relevant data at a single place. Yin also recommends having key informants review a draft case study report as a tactic to increase construct validity.[493] Accordingly, a draft report was sent to the interview partners in order to make sure that the findings are consistent with the experts' perceptions.

4.4.3 Data analysis

In order to analyze the collected data, all transcripts, internal documents, press-articles, and web links were combined into a hermeneutic unit. During the data analysis process, the different sources were triangulated in order to address potential problems of construct validity.[494]

Coding techniques borrowed from the realm of grounded theory were used for data analysis.[495] First, open coding was conducted as described by Strauss & Corbin.[496] In this context, the transcripts were coded per paragraph, memos were assigned to selected text passages, and quotations were extracted. In order to connect different categories, axial coding techniques[497] were employed. The analysis was conducted with the qualitative data analysis software ATLAS.ti.[498]

Based on the identified categories, the cases were first analyzed independently (*within case analysis*). Following, a cross-case synthesis was undertaken.[499] During this process, different data displays were created.[500] The findings were constantly mapped to the conceptual framework and the existing literature in order to gain confidence in the findings and raise the internal validity and the generalizability of the results.[501]

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[491] Cf. Yin, 2009, p. 40f.
[492] Cf. Benbasat et al., 1987, p. 374.
[493] Cf. Yin, 2009, pp. 41, 182–184.
[494] Cf. Yin, 2009, pp. 114–117.
[495] Cf. Strauss & Corbin, 1990.
[496] Cf. Strauss & Corbin, 1990, p. 61.
[497] Strauss & Corbin, 1990, p. 96.
[498] Cf. http://www.atlasti.com.
[499] Cf. Yin, 2009, pp. 156–160.
[500] Cf. M. B. Miles & Huberman, 1994.
[501] Cf. Eisenhardt, 1989a, p. 544.

Before final publication, the case study results were summarized in several reports and were presented to and discussed with different groups of researchers. These discussions have helped to improve the structure and content of the resulting publication.[502]

4.5 Findings

In this section, the main findings that emerged from the case study analysis are presented. Due to the relatively large number of cases, the individual cases are not described separately here. Rather, the following subsections are devoted to the cross-case analysis.[503] A condensed overview of the individual cases is presented in Appendix F.

The structure of this section is aligned to the research questions stated in section 4.2. In section 4.5.1, four different fields of activities in the context of IT project portfolio management are briefly introduced. Following, in section 4.5.2 to 4.5.5, governance arrangements employed in these different fields of activities are presented in detail. In this context, interrelationships between the four fields of activities are also illustrated. Section 4.5.6 covers contingency factors influencing the design of governance arrangements for IT project portfolio management. Finally, in section 4.5.7 consequences of the use of different governance arrangements for IT project portfolio management are discussed.

4.5.1 Fields of activities

The multi-project environments encountered in the investigated companies were characterized by a huge number of activities and the involvement of many stakeholders. The decision-making structures were complex and many interdependencies and feedback-loops existed between different activities. In order to cope with this complexity, it is vital to identify potential boundaries and to distinguish between fields of activities that are governed in different ways. Based on the coding of the interview transcripts and a review of the provided documents, four related but distinct fields of activities were identified:

- IT budget allocation
- IT demand management
- IT project portfolio selection
- IT resource management

[502] As noted at the beginning of this chapter, parts of the study described herein have been published and presented at the European Conference on Information Systems in Helsinki (cf. Frey & Buxmann, 2011).

[503] According to Yin, this format corresponds to one of four different options for presenting case study research (cf. Yin, 2009, p. 172).

IT budget allocation is in particular concerned with the question, how much money to spend for IT investments in a given period and how to distribute the overall budget to different organizational units.[504] These decisions represent an important input for IT project portfolio management. The granted budget also indicates how many IT resources need to be provided.[505]

IT demand management represents an interface between the IS function and the business units. Project ideas collected in different business units are communicated to and discussed with IT demand managers. These demand managers support the business units in gathering the information required for project evaluation. They also uncover interdependencies between different project proposals.

IT project portfolio selection is concerned with the decision, which IT projects shall be funded and how to proceed if changes occur within the portfolio. In this context, the given budget and resource restrictions need to be taken into account.[506]

Finally, **IT resource management** is concerned with organizing and managing IT resources (in particular human resources) in such a way that the selected projects can be implemented with minimal delay.

It is important to note that these fields of activities have in particular been identified from an organizational and not from a procedural perspective. The notion *fields of activities* emphasizes that the activities falling into these four different domains are performed at an ongoing basis. Different organizational units, committees, and experts are responsible for these activities. Governance arrangements for the four fields of activities are analyzed in detail in the following four sections.

4.5.2 Governance arrangements for IT budget allocation

The following analysis focuses on the assignment of IT investment budgets to different decision-making units.[507] In all investigated companies, the scarcity of financial and human resources was highlighted as a major concern. Due to these resource limitations, even projects with a valid business case and a positive net present value were not approved automatically.

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[504] Note that in this thesis, the term *IT budget allocation* refers to the assignment of funds to organizational units and not to individual projects.
[505] Also compare Archer & Ghasemzadeh, 1999, p. 209.
[506] Also compare the definition of *project portfolio selection* in section 3.2.1.4.
[507] Budgets for operations and maintenance were also regarded during the study, but are out of scope here.

Instead, projects had to compete for scarce resources and so did the stakeholders and business units proposing these projects.[508]

IT budget allocation and IT project portfolio selection have been identified as separate fields of activities during the cross-case analysis, because in the investigated companies, different decision makers were involved in the two fields of activities and decisions were taken at different points in time. Still, IT budget allocation and IT project portfolio selection are strongly interlinked.[509] For example, an interviewee in case company C9 described the following connection:[510]

> *"Portfolio management becomes a little bit difficult because portfolio management also has to do with the money and the funding. Due to the fact that we are not one business – we are several businesses – during the budgeting process you need to allocate money to the businesses."* (Case C9)

In this context, several interviewees emphasized the tradeoff between the use of top-down and bottom-up approaches in the budgeting context.

4.5.2.1 Top-down and bottom-up planning

In a pure top-down budget planning approach, budgets are predetermined at the highest decision-making level, based on financial and strategic considerations.[511] Budgets are negotiated between corporate headquarters and the different business units before project portfolio selection can take place. A bottom-up planning approach, in contrast, is driven by operational requirements.[512] The size of the IT investment budget is not predetermined in advance. Instead, it accumulates from the costs caused by the selected projects. In this case, the total investment level is often controlled indirectly by setting hurdle rates that have to be met by the individual projects.[513] In practice, there are often different budgeting approaches for different kinds of projects. Large strategic projects are often initiated in a top-down manner at the highest decision-making level while smaller projects are initiated in a bottom-

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[508] This situation, where not all desirable projects can be implemented due to resource limitations, is also labeled *capital rationing* in the relevant literature (cf., e.g., Bierman & Smidt, 1984, p. 161; Herbst, 1982, p. 214).
[509] Cf. Olson & Chervany, 1980, p. 62.
[510] The interview quotes presented in this section were originally transcribed in German language and have later been translated to English.
[511] Cf. Weill & Olson, 1989a, p. 4.
[512] Cf. Weill & Olson, 1989a, p. 4.
[513] Cf. Baldenius et al., 2007, p. 838. For example, projects have to exceed a specified ROI in order to be approved.

up manner.[514] This often goes along with federal arrangements for IT project portfolio selection. Such arrangements are discussed in more detail in section 4.5.4.3.

In the investigated companies, IT budgets were usually negotiated between top management, the IS function, and different business units on a yearly basis. In this context, budget plans were typically derived based on previous year's values. Thereby, a certain degree of stability and balance was aspired. However, budgets were also adjusted to the current economic environment and to strategic considerations.

In general, budget-planning approaches were subject to frequent changes in the investigated companies. Transitions from bottom-up to top-down approaches and vice versa were reported by several interviewees, in particular in the chemical and pharmaceutical industry. These transitions were often due to recent organizational changes, typically triggered by mergers and acquisitions.[515] Many investigated companies were constantly occupied with readjusting procedural mechanisms for IT budget allocation. In some companies, the IS function was actively involved in the design of budgeting arrangements. In others, the IS function was not directly involved and had to react to these changes by providing resources accordingly.

According to the interviewees, a bottom-up approach for budget planning can have severe disadvantages. For example, it can lead to a flood of IT proposals from different business units. This may result in resource conflicts, which are difficult to resolve without a clear limit or hurdle rate. Moreover, a strict bottom-up approach in particular facilitates small, short-term, non-strategic projects.[516] An IT governance expert in a company from the chemicals and pharmaceuticals sector described his experience with a bottom-up approach as follows:

> *"Last year we had a real bottom-up process, and it was a complete total disaster. Because it became kind of a wish list and in the end we had to use brute force to take out things."* (Case C9)

A top-down approach, in contrast, is in principle well suited for limiting the number and scope of the projects in the portfolio. However, this requires a formalized arrangement for IT project portfolio selection and clear decision criteria. Moreover, it is also important that a stringent selection process is not only introduced but also enforced. This may depend on a clear mandate of the board, as described in the following quote:

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[514] Cf. Ferns, 1991, p. 151; Prifling, 2010b, p. 769.

[515] As noted by Cao et al., mergers and acquisitions can also cause severe problems concerning IT project portfolio management as the visibility of IT operations can be obstructed (cf. Cao et al., 2005, p. 369).

[516] Cf. Elonen & Artto, 2003, p. 397.

> *"There is a planning board, but only since this year. However, in my view, the IT planning board could only work well in terms of a decision-oriented reduction of projects if ultimately one had the mandate of the board of directors."* (Case C5)

When a top-down budgeting approach is supervised by a department or a committee without an adequate mandate, there is a risk that too many projects are scheduled or the allocation of funds is based on politics instead of strategic or financial criteria. Consequently, dependent on the organizational culture, it can become difficult to institutionalize a rigorous top-down approach.

A combination of top-down and bottom-up planning can be a compromise. An IT governance expert in case company C9 for example noted that the current budgeting process is top-down in principle, but that they "also look a little bit bottom-up." In the investigated companies, top-down and bottom-up planning approaches were often combined in an iterative manner in order to take account of general financial limitations as well as the current innovation potential. As noted by Phillips & Bana e Costa in the context of "decision conferencing" it "[…] is essential to ensure that bottom-up knowledge of what is realistically possible meets with top-down strategic direction of what is desired."[517] According to the interviewees, this aspect in particular becomes manifest in committee meetings and negotiations between the IS function and the business functions.

4.5.2.2 Volatility in the budgeting process

Several interviewees emphasized the inherently preliminary nature of budget planning. In companies performing an annual budgeting process, the planning process usually starts several months (in some cases more than a year) before the first projects are initiated. Consequently, the planning process is often initially characterized by a high level of uncertainty.

Uncertainties in the planning process occasionally lead to under-planning during the year, i.e. some projects need more resources than originally planned. Respective volume and change requests can impede projects that have not been started at the given point in time. In this case, funds are often withdrawn from projects that have not been initiated in order not to exceed the total budget.

On the other hand, the uncertainty inherent in the project portfolio can also lead to situations, where a certain share of the budget remains unallocated at the end of the budgeting cycle.

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[517] Phillips & Bana e Costa, 2007, p. 55.

Even in companies where the budget is specified top-down and monitored centrally, each business unit ultimately possesses a specific project portfolio. If approved projects are omitted or need fewer resources than originally planned, the question arises, how to deal with these resources. An interviewee in the financial industry described this situation as follows:

> *"Ultimately, each department has a specific project portfolio. This is approved ex post. And if there are changes, if someone needs less money, then he will consider himself as the owner of the budget. So, then he says, 'Now I need 200 days less in a project. So, I use these 200 days to sponsor either a project that was canceled or an ongoing project that requires more budget.' So, he sees himself as the owner of the budget."* (Case C5)

This may result in a deviation from the initial strategic focus. Therefore, it is not sufficient to specify budget targets and select projects on a yearly basis. It is also necessary to cope with changes and to encourage desirable behavior at an ongoing basis.

4.5.3 Governance arrangements for IT demand management

In order to support the systematic collection of IT project proposals and to manage the relationship between the IS function and the business units, most of the investigated organizations had recently established or revised governance arrangements for IT demand management. These arrangements were typically installed by the IS function in order to build an institutional interface to the internal customers and to provide a single point of contact. In all investigated companies, demand management was perceived as an important mechanism to coordinate between the IS function and the business units and to improve business/IT alignment.[518]

In the project portfolio management literature, descriptions of demand management practices are considerably scarce.[519] Cubeles & Miralles briefly mention demand management as a "[...] well-defined scheme for screening, categorizing and prioritizing projects".[520] In the investigated companies, IT demand management was predominantly concerned with screening requirements and preparing project proposals. Prioritization, in contrast, was not

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[518] In addition to the term *demand management*, the terms *requirements management* and *client management* were also commonly used. Although some interviewees preferred one or the other term, the differences between the underlying concepts were not clearly perceivable. Therefore, all three terms are subsumed under the same concept. In the following, the terms are used synonymously.

[519] According to Burns & Walker, the identification stage in general is largely neglected (cf. R. M. Burns & Walker, 2009, p. 80).

[520] Cubeles & Miralles, 2009, p. 99f.

described as a primary task of demand managers. In the conception presented herein, prioritization rather falls into the field of activity called “IT project portfolio selection”.[521]

With regard to demand management, Peterson provides the following description of liaison roles, including the role of IT client managers and IT relationship managers:

> “Liaison roles focus explicitly on managing the integration of decision-making processes across business and IT units. Numerous roles fulfill this function, including IT relationship managers (from a business perspective), IT account managers (from an IT perspective), IT client managers (from an IT perspective), and IT vendor managers (from an external IT perspective).”[522]

This description is compatible with the demand management arrangements encountered in the case companies. Demand management in particular affects the idea generation and proposal development stages, which are strongly underexplored in the existing literature.[523] In this section, demand management is addressed in detail by providing insights into the arrangements encountered in the investigated cases. In the following three subsections, structural, procedural, and relational mechanisms for IT demand management will be described. Following, the triggering function of demand management will be discussed in a separate subsection (section 4.5.3.4).

4.5.3.1 Structural mechanisms

The structural mechanisms for IT demand and relationship management encountered during the interviews strongly resemble the “bicycle wheel” introduced by Weill & Ross (cf. Figure 18). Within these structural arrangements, one or several demand managers have the dedicated task to discuss requirements with business unit representatives, to support the specification of IT project proposals, and to ensure that these proposals are specified according to the criteria required for the project evaluation process. In some organizations, demand managers also act as consultants and actively try to trigger new IT initiatives.[524]

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[521] Cf. section 4.5.4.
[522] Peterson, 2004, p. 14.
[523] Cf. R. M. Burns & Walker, 2009, p. 82.
[524] See section 4.5.3.4.

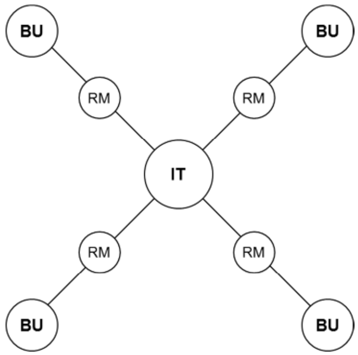

Figure 18: "Bicycle wheel" of Weill & Ross [525]

In Figure 18, IT is depicted as a single cycle in the middle. However, this does not mean that the IS function has to have a centralized structure. In contrast, a main advantage of demand management (or business/IT relationship management as it is named in the figure) is that it can link between different organizational arrangements. Demand management can be used as a means to coordinate between different organizational entities – both at the business and the IT side. In several of the investigated companies, demand management arrangements have in particular been implemented as a response to uncoordinated communication links between business and IT. Such issues in particular accrued in organizations where the corporate structure and the IT structure were not aligned. For example, some companies were in general structured according to regions or products while the IS function was subdivided according to technical considerations or according to plan, build and run activities.[526] The following quote illustrates one major motivation for implementing demand management arrangements:

> *"The client management organization is basically a single point of contact to the functional party. This means that this structure is a response [...] to what we had two years ago, namely a very strong diversification and autonomy of the IT units themselves."* (Case C4)

[525] Reprinted from Weill & Ross, 2004, p. 62 with permission (© 2003 MIT Sloan School Center for Information Systems Research).
[526] Cf. C. V. Brown & Magill, 1994, p. 372; Tavakolian, 1989, p. 311.

The former situation has been witnessed by the same interviewee as follows:

> *"There was an IT production area with its own chief, there was an IT development area with its own chief; and all of these areas, of course, had built some kind of interface towards the customer. In one area, this was called customer relationship manager, in a different area it was called business relationship manager and then, finally, the IT architects also had the idea to run to the customer and, thus, the confusion of the customer actually was complete; because he now was advised by four different parties – and this certainly was not always congruent."* (Case C4)

IT demand management arrangements shall provide a single interface to each internal customer. The relationship between the IS function and the particular customer is coordinated via this interface. Thereby, relational continuity is facilitated. An important aspect from the perspective of the IS function is that requirements and project proposals reach the IS function in a consistent manner. In general, the IT demand management organization has to be aligned to the organizational structure of the company as a whole. However, this does not mean that it has to replicate this structure exactly, as illustrated in the following quote:

> *"We have got one face to the customer, meaning one client manager who attends to a specific unit. It is also possible – in case of the smaller units – that he attends to several units, but there is always one contact person."* (Case C6)

The demand managers in the investigated companies were encouraged to maintain close relationships to the business units they assisted. Still, they were usually organizationally assigned to the IS function. In at least two companies, however, a role corresponding to the demand manager had also been installed in the business units. This mechanism is in particular advantageous if the structure of the IS function as well as the business units is complex. For example, the interviewee cited in the following described the introduction of IT coordinators at the business side as a reaction to the dispersed structure of the business units:

> *"On the opposite side, the functional unit has a so-called IT coordinator. This is the counterpart of the client manager. [The idea is…] that you have a contact person - they also have various different groups - who provides a single point of entry."* (Case C5)

Several interviewees highlighted that, although different demand managers assist different business units, communication between these liaison roles is of vital importance. This way, interdependencies between project proposals can already be identified at an early stage in the project governance process. Consequently, in several case companies, IT demand managers were organized into a dedicated unit within the IS function in order to stimulate intercommunication. In other companies, regular demand manager meetings were established for the same purpose.

4.5.3.2 Procedural mechanisms

In general, demand managers can be responsible for various tasks, including negotiation of prices and service level agreements, communication of complaints to the IS function and communication of new procedural requirements and IT standards to the business units. However, demand management is also of particular importance in the context of IT project portfolio management, as the demand managers usually are the first contact persons within the IS function who are informed about new requirements and IT initiatives by the business side. Concretely, the interviewees in particular attributed the following project-related tasks to demand management:

- Support the business units in planning future IT requirements
- Receive project proposals from the business units
- Analyze requirements in cooperation with the business units
- Support the business units in developing structured project proposals along defined evaluation criteria
- Determine if a given project is of corporate-wide importance
- Make sure that interdependencies between projects are taken into account and that the organizational impact of the project is considered
- Involve relevant stakeholders from the IS function (e.g. IT architects, project managers, project team members etc.)
- Keep track of the project progress during the project lifecycle and take care that stage gates are not bypassed
- Trigger new initiatives and present new IT initiatives to the business units

In several case companies, it was highlighted that it is particularly important – from an IT perspective – that requirements are specified in a neutral way. In particular, requirements should not include open or hidden referrals to specific IT solutions. Often, business stakeholders have a strong preference towards a specific solution (a specific brand or a specific software suite) and try to specify requirements with a bias towards this solution. In this case, the demand manager must ensure that the requirements are formulated in a neutral way, because the choice of a particular solution usually falls into the decision domain of the IS function and should not be part of the project evaluation process.

In the investigated companies, the demand management profession usually had a strong liaison to the IT architecture management discipline. For example, different procedural mechanisms were implemented in order to ensure that IT architects are informed about new initiatives and are involved in the IT demand management process. This way, architectural implications can already be considered and discussed at an early stage of the evaluation process. However, not in all organizations IT architects were involved already at the requirements stage. An enterprise architect in a financial company describes his involvement as follows:

> *"In my point of view, architecture management is actually something proactive, something creative, essentially something that has to start already in requirements management. The fact that it is a long hard climb to get to this point is another issue. Today, our architecture controlling methods, like architecture check, are applied at the point in time when a project is pending for approval. So, at this point, in principle, you are actually already checked off – in terms of functional requirements. This is a bit too late."* (Case C4)

In a number of companies, the IS function had formerly been informed relatively late about major initiatives, like for example, major acquisitions. In this context, it later often turned out, that input from the IS function was needed in order to specify suitable requirements. This demonstrates that the timely involvement of relevant stakeholders during the demand management process is of vital importance. The following quotation illustrates a typical evolution with respect to demand management:

> *"In former times, an awful lot of projects have been initiated – by the board and by others – for example merger and de-merger activities and all these things. And we [the IS function] were then pretty surprised at some point in time, when we have seen these things or when they were published to us. Today, we are involved very, very early in the decision process. That is to say, three or four people from IT – and in the future it will then be the demand manager – are, at a very early stage, strictly confidentially involved in all these things in order to be able to react accordingly."* (Case C7)

Business/IT alignment is a very important aspect in the demand management context. Input of both sides – business and IT – is required in order to prepare project proposals and to provide the information required for project evaluation. Well-implemented demand management processes can facilitate business/IT alignment. On the other hand, a certain degree of alignment is also a prerequisite for establishing effective demand management arrangements.[527]

[527] Also compare section 2.5.

4.5.3.3 Relational mechanisms

Demand management has a very strong relational component. Demand managers have to maintain a good relationship to the business unit they attend to. They need to be well informed about the activities and the intentions of their clients. For example, an important relational mechanism described by several interviewees is to involve demand managers into strategy meetings of the respective business unit:

> *"They [the client managers] also attend to the conferences of the departments. They [leaders of business departments] say, 'o.k., come and join us. For two days we meet in conclave - strategic direction for the next three or four years' – then the client manager will join them."* (Case C6)

Of course, relational links into the other direction are also important. A potential mechanism in order to foster an understanding of the capabilities of information technology at the business side is to involve employees from the business units in IT activities. This can also strengthen the relationship between business and IT. An interviewee in case company C9 perceived the understanding of information technology by the business side as a key success factor:

> *"I think we are really successful once business people are coming to IT, starting to understand the IT stuff, and then go back to the business."* (Case C9)

4.5.3.4 Triggering function of IT demand management

The role of IT demand management does not have to be passive. In contrast, the IS function may also actively foster a higher quantity and quality of IT project proposals. In this context, innovative ideas accruing in the IS function have to be communicated to and discussed with the business units. For example, the head of the CIO office in case company C9 stated the following:

> *"Demand management is not something that IT does. Demand management is something that primarily should be done by the business. And if the business cannot do it themselves, we need to help them. So we need to be infiltrating the business in a way."* (Case C9)

The interviewees also congruently highlighted that the IS function has to act as a business partner in order to trigger new IT initiatives. The following quotation shall serve as an example:

> *"Of course, the IT department also has to make a contribution – where do we think we need to invest? In other areas it might be – depending on the role of the IS function – that you are only order recipient. This is not our understanding. Consequently, the idea is to be involved in the discussion – 'where do we have to invest now?' Because we also see leverage for business growth or for efficiency gains in business growth – depending on what the leverage shall be."* (Case C3)

This demonstrates the impact of the standing of the IS function within the company. In order to be perceived as a business partner, the IS function needs an innovative attitude and should maintain strong relationships to the business.

4.5.4 Governance arrangements for IT project portfolio selection

As described in the preceding section, IT project proposals are usually gathered, documented, and prepared in cooperation between the business units and IT demand managers. The resulting candidate projects have to be reviewed, prioritized, approved, or rejected in subsequent steps. These are essential tasks in the field of IT project portfolio selection.

Typically, multiple parties in different parts of the company are concerned with IT project portfolio selection. For example, stakeholders from the IS function, from different business units as well as the executive board can be involved, depending on the governance mechanisms employed. Abe et al. describe this context as follows:

> "Portfolio selection is typically driven by multiple stakeholders with differing, sometimes conflicting, interests. The purpose of portfolio selection is to find a balanced portfolio that reconciles all these criteria."[528]

From a structural point of view, decision-making arrangements for IT project portfolio selection can be divided into centralized and decentralized arrangements, depending on how extensively decision makers from corporate functions are involved. However, centralized and decentralized arrangements are rather ideal concepts in this context. In practice, federal arrangements involving different decision-making committees at different decision-making levels prevail. Rather decentralized arrangements are described in the following subsection while centralized arrangements are discussed in section 4.5.4.2. Federal arrangements are investigated in more detail in section 4.5.4.3.

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[528] Abe et al., 2007, p. 783.

4.5.4.1 Decentralized arrangements

In four of the ten investigated companies, the decision-making authority for IT project portfolio selection was strongly decentralized into business units or regions.[529] Interviewees in these companies reported that the high degree of decision-making autonomy was largely due to an emphasis on the accountability of the local units for investment success.

The interviewees attributed a high degree of flexibility and relatively fast approval processes for local projects to decentralized IT project portfolio selection arrangements. Thereby, the local units were enabled to respond quickly to their business needs.[530] However, this advantage can come at the expense of redundancies. In this context, an interviewee in a large bank described the following situation:

> *"It [the current decentralized structure] is about proximity to the business unit, and perhaps it is also about duplication, because someone does something the other one also does. In this situation, it is possible that half a year of coordination takes too much time. This is typically the case in investment banking – in the front office – where they did not take care of it. But now, when we are in a consolidation environment, there is definitely a different approach."* (Case C3)

An interviewee in a pharmaceutical company, where the IS function is subdivided into several independent regional units, observed that synergy potentials get lost in a decentralized arrangement. In this company, the corporate structure had significantly changed a few years ago due to a large merger. Before, the IS function of the larger company had a centralized, global structure. At the time of the interview, each country had a separate IS department with separate infrastructure and own IT personnel. In this decentralized arrangement, the local IT units were only loosely coordinated via a global IT leadership committee that fostered an informal information exchange. The interviewee did not perceive the current arrangement as generally inferior to the former arrangement. However, a lack of synergy and more redundancies were noted as major disadvantages:

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[529] This in particular applied to case companies C3, C4, and C10. In case company C5, a rather centralized IT investment governance process had been implemented. The process was governed by the corporate controlling department. However, the process was strongly driven by the different business units as there were no formal selection criteria and projects were approved in close dialogue between the controlling department and the separate business units. This arrangement was currently revised at the time of the interview.

[530] Also compare DeSanctis & Jackson, 1994, p. 86.

> *"One of the main differences [between a global and a regional structure] is definitely that synergies get lost in some areas. Things are virtually done multiple times in several places."* (Case C10)

In the aforementioned company, redundancies accrued at different IT layers. In particular, each region possessed its own hardware infrastructure, leading to a high degree of duplication. At the time of the interview, it was therefore planned to centralize hardware via virtualization in future. Apart from the infrastructure layer, redundancies were also an issue at the application and the project level. For example, collaboration software of the same vendor had recently been introduced independently in several different country units without coordination between these units. This led to significant redundancies and to a loss of synergy potentials. Concretely, these redundancies manifested in the following way:

> *"Everyone has closed own consulting contracts, everyone has tested, everyone has wondered: What could be the best architecture? And so on and so forth. This is certainly one of the disadvantages of the current organization."* (Case C10)

In order to address these issues, a global personal network had recently been established as a relational mechanism. This network had been introduced in order to foster information exchange between the different IT units and to reveal synergy potentials. Thereby, the decentralized IT units intended to coordinate their actions to a higher degree in future.

The implementation of stronger coordination mechanisms in companies with a rather decentralized organizational culture, where autonomous business units dominate, can pose a significant challenge. In companies C4 and C5, for example, recent initiatives to establish centrally coordinated, corporate-wide arrangements for IT project portfolio selection had failed, and the companies had reverted to rather decentralized arrangements. Several interviewees noted that the organizational culture often poses a strong barrier to the implementation of centralized arrangements.[531]

4.5.4.2 Centralized arrangements

In general, it was observed during the interviews that it is vital to build a consensus between the stakeholders in different business units before additional coordination mechanisms can be implemented. The transformation from a decentralized arrangement to a more centralized arrangement for IT project portfolio selection may also require a significant amount of time. Interviewees, who had accompanied a successful transformation towards a more centralized

[531] The impact of the organizational culture will be exemplified in more detail in section 4.5.6.4.

decision-making arrangement, recommended assessing potential synergy gains at the outset of the transformation. Moreover, a staged approach was recommended in order to have sufficient time to convince relevant stakeholders and to overcome resistance. Particularly the interviewee in case company C1 also noted that strong top management involvement was of critical importance during the transformation towards a more centralized governance arrangement for IT project portfolio management.

Two of the investigated case companies had implemented rather centralized decision-making arrangements for IT project portfolio selection.[532] In these arrangements, all IT project proposals were compared and approved at a corporate-wide level.[533] In both companies, the IS function and top management were heavily involved in the transformation process.

As reported by the interviewees in these two companies as well as interviewees in companies who had previously witnessed centralized arrangements for IT project portfolio selection, the main advantage of centralized arrangements in particular arises from the avoidance of redundancies and the utilization of synergies. From a central perspective, interdependencies between different projects can be identified and considered more effectively. Moreover, rules and standards can be enforced and monitored more easily in a centralized arrangement.

In contrast, excessive bureaucracy was reported as a major disadvantage of centralized arrangements. Due to increased documentation requirements, the administrative burden often intensified. The interviewees also consistently noted that by centralizing decision-making competencies for IT project portfolio selection, some degree of flexibility and autonomy is taken away from the local units. This goes along with latent conflict potentials.

In case company C2, for example, a centralized governance arrangement had recently been installed for IT project portfolio selection. In this arrangement, project proposals from different regions had to be handed in for approval to the corporate IT headquarters. The interviewee supervised this centralized IT project portfolio management process. He noted that significant synergy potentials were gained this way and standards had been implemented and enforced more effectively at a global level. However, he also noted a number of disadvantages:

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[532] This in particular applies to case companies C1 and C2. In case company C6, a corporate-wide perspective on major IT initiatives had also been established. Still, the arrangement is classified as a federal structure as decision-making arrangements have been installed at different hierarchical levels.

[533] It should be noted that in all investigated companies, strategic projects with a very high investment volume had to be approved by the executive board or the supervising board. However, this is not the focus here.

> *"I think with this central organization – portfolio – [...] the decision-making processes take longer, of course, and are perhaps more cumbersome for the region. It is not always comprehensible that I have to appeal to the corporate headquarters [located in Germany] for a project that I want to do in Asia, and that I even may have to fill in project documentation according to our standards and processes. At least at the beginning, it was viewed as administrative overhead. And from the perspective of the region, it is, of course, some kind of retrenchment. They do not have an independent IT project budget anymore but have to get everything approved by the headquarters. Therefore, for the region this probably means the loss of some degree of flexibility and autonomy."* (Case C2)

In general, centralized arrangements bear the risk that decision-making becomes slow and cumbersome, while local decision makers can decide more quickly, due to relatively low communication requirements.[534] However, the interviewee in case company C2 also sees an advantage in the circumstance that decision-making takes longer. This way, decisions are better prepared and more informed (*"previously some decisions were taken based on two PowerPoint slides"* (Case C2)). In general, it was noted by several interviewees that in centralized decision-making arrangements the initiation of large strategic projects is accelerated while such projects are often impeded in decentralized arrangements. Therefore, the transition from a decentralized arrangement towards a more centralized arrangement may lead to a stronger strategic focus.

In this context, case company C1 serves as a good example. In this company, decision-making competence for IT project portfolio selection formerly had been withdrawn from the divisions and had been transferred to a centralized IT governance unit. At the time of the interview, decision-making power was centralized to a very large degree. In particular, all IT-related projects had to be approved by the CIO.[535] The CIO described the effect of the reorganization as follows:

[534] Cf. Wyner & Malone, 1996, p. 5.

[535] The governance arrangement for IT project portfolio management in case company C1 can be described as an "IT monarchy" (cf. Weill & Ross, 2004, p. 12). This centralized arrangement has been implemented in the course of a major corporate reorganization initiative. Formerly, the company had been structured into divisions with a very high degree of autonomy. The responsibility for IT infrastructure and IT projects had mainly been located in the different divisions. During the reorganization, the IS function has been separated into an IT services unit and an IT governance unit. The IT services unit bundles the entire IT supply. Moreover, it also provides services to the external market. The IT governance unit represents the interface between the company as a whole and the IT services unit (compare Appendix F for more information).

> *"In the first years after the reorganization [...], we have significantly reduced the project volume compared to former years, because we have omitted certain things that previously were the responsibility of the divisions. We have said, 'That does not generate a benefit, we leave it out.' And that was clearly a contribution to improve efficiency. The projects we have implemented, in contrast, were clearly targeted towards consolidation and economies of scale."* (Case C1)

According to the CIO, the new centralized decision-making arrangement initially led to a strong reduction in the project volume. In later years, the volume significantly increased again, due to a quality improvement initiative. However, these projects were of more strategic nature. According to the interviewee, the business units had started to think more strategically about IT investments.

In this context, centralized decision-making arrangements can also speed up the implementation of strategic projects by ensuring that sufficient resources are reserved for such projects. In case company C6, for example, a large fraction of the IT investment budget was controlled centrally by an investment commission that was composed of the heads of all departments. This central budget was primarily used to fund large strategic projects. This arrangement had been implemented several years ago. Formerly, the different business units had a large degree of autonomy and could independently initiate IT projects. According to the interviewee, the business departments could realize their projects very quickly in the former decentralized arrangement. However, large, corporate-wide strategic projects were very difficult to implement, as project resources were busy with small projects of minor importance.

4.5.4.3 Federal arrangements

As noted in section 2.2.1.2, federal decision-making arrangements may provide a compromise between centralized and decentralized arrangements. Federal arrangements for IT project portfolio selection in particular balance the strategic requirements of corporate decision-makers and the need for flexibility and autonomy of decentralized units. Four of the investigated companies had installed federal decision-making arrangements in order to govern IT project portfolio selection.[536]

These federal arrangements were typically designed as staged decision-making structures with several decision-making committees at different hierarchical levels. IT projects were approved by authorities at different levels depending on the project size and other project

[536] This applies to case companies C6, C7, C8, and C9.

characteristics.[537] In addition, budgets were independently assigned to the different hierarchical levels. Thereby, the composition of the combined IT project portfolio could be controlled to a certain degree.

Case company C6 provides a good example in this context. In this company, the business departments were allowed to independently fund IT projects below half a million Euro out of their dedicated IT investment budget. Projects above this cost threshold had to be approved by an investment commission composed of high-ranking representatives of the IS function and all business departments. Very large projects above a cost threshold of several million Euro had to be approved by the board of directors. The total IT investment budget was expressed in terms of person-days.[538] About 25 percent of the person-days were dedicated to the business departments. This budget was divided between the different business departments and was used for department-specific projects falling below the specified cost threshold. About 20 percent of the corporate-wide IT budget was reserved for application-specific optimizations and related IT activities. The remaining 55 percent of the IT investment budget were controlled by the investment commission.[539]

In general, the coordination mechanism for distributing decision-making competencies in the investigated companies commonly relied on specifying project-related cost thresholds for the different decision-making entities in combination with unit-specific budgets. However, two interviewees pointed out that project costs are not the only relevant criteria for determining the appropriate decision-making level for a particular project. Strategic relevance and cross-functional implications are further criteria that should be taken into account in order to decide which decision-making entity is qualified to approve a given project. The interviewee in case company C8 described the way in which projects of strategic relevance were handled as follows:

> *"So, not every project that can cause very, very much mischief costs a lot of money. So, you cannot always say, 'just because it doesn`t cost 400,000 Euro, and thus exceeds the threshold...'. Maybe it only costs 10,000 Euro, but you can violate the group's strategy to such an extent that we are encouraged to ask, 'Does it have strategic relevance? Does it have compliance relevance? Does it have cost relevance for others – not only for this cycle?' If this is the case, then it is discussed and decided by the superior committee."* (Case C8)

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537 Also compare Harris & Raviv, 1996, p. 1142.
538 The person-days are mapped to costs via internal charge rates.
539 Refer to Appendix F for a more detailed description of the company.

In the investigated companies, committees were commonly employed as a structural mechanism in order to implement federal arrangements. Various committees of different compositions and with different tasks were mentioned and described by the interviewees (e.g. enterprise architecture committees, client manager committees, business process-related committees, country committees etc.). The committees at the highest hierarchy level were typically cross-functional and, consequently, included business representatives of all major divisions, departments, business units, or regions. In these committees, the IS function was typically represented by the CIO as head of the IS function and/or by several other representatives of the IS function. Cross-functional committees were particularly employed in order to uncover interdependencies and synergy potentials and to discuss projects with boundary-spanning impact.

According to the interviewees, an important advantage of federal arrangements in comparison to centralized arrangements consists in workload reduction for central decision makers. Depending on the cost thresholds for the different hierarchical levels, superior committees and authorities can focus on relatively few projects that, nevertheless, consume a large amount of financial resources, bind many human resources and have high strategic relevance. However, clear rules for the approval of smaller projects are required in such arrangements, as a lack of control of relatively small projects can result in severe resource allocation problems.[540] Of course, the degree to which projects compete for resources also depends on the way resources are organized and managed. This aspect will be discussed in more detail in the following section.

4.5.5 Governance arrangements for IT resource management

In order to implement the approved IT projects, typically a large number of project managers and project staff with distinct skills are required. In the investigated companies, the limitedness of human resources often represented a stronger capacity limitation than the limitedness of financial resources. Consequently, in order to avoid resource bottlenecks and to provide for high resource utilization, it is vital to manage the available resources appropriately and to account for future resource requirements. In this context, an effective organizational assignment of project resources is crucial.[541]

With respect to resource management, again, centralized and decentralized arrangements can be distinguished, depending on the organizational structure of the IS function as a whole. In this context, decentralized control means that IT resources are assigned to individual business

[540] For a more detailed discussion of this issue, compare Blichfeldt & Eskerod, 2008, p. 362.
[541] Cf. Engwall & Jerbrant, 2003, p. 408.

units or regions. These resources usually work exclusively for the specific unit. In a centralized arrangement, in contrast, IT resources are controlled centrally by the IS function and, in principle, can be assigned to projects in various business units or regions.[542]

4.5.5.1 Decentralized arrangements

In order to respond quickly to requirements of local business units and to maintain a close relationship between business and IT employees at the operational level, it can be beneficial to organize IT resources primarily according to the organizational structure of the company as a whole.[543]

For example, case company C5 was organized into three different groups of business units with quite distinct application requirements. Consequently, each of the three groups was supported by a separate application development department. In general, application developers only worked for the group of business units they were assigned to. However, recently the role of a skill manager had been introduced in order to identify opportunities where resources can be exchanged between the different application development units. Thereby, it was intended to increase flexibility and to assign human resources more efficiently.

In case company C10, resources were managed completely locally in different countries or regions. According to the interviewee, this was a direct consequence of the regional organizational structure of the company as a whole. In general, there was only a low degree of coordination between the different regions. Each region had a separate budget and projects were selected and managed locally. Very close informal relationships existed between the employees in the IT departments and in the business units.

Most of the interviewees reported that decentralized resource assignments are in general preferred by the business units, as requirements can be discussed in direct contact with the IT specialists who will finally implement these requirements. However, in most of the investigated organizations there was a trend towards more centralized arrangements. The interviewees attributed this trend in particular to high costs, a low degree of efficiency and inappropriate resource utilization in decentralized structures.

For example, in case company C4 resources had formerly been organized in a rather decentralized manner in product-based teams. This organization had proven to be inefficient as resources were often idle. The interviewed IT architect described the situation as follows:

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[542] Cf. Kahai et al., 2002, p. 49; Olson & Chervany, 1980, p. 61f.
[543] This in particular applies to case companies C5 and C10.

> *"If there were no functional requirements at some point in time then one would have applied occupational therapy. Virtual maintenance activities were invented in order to be busy. And if you had a closer look at it, they actually were not busy and could have used their know-how in order to provide valuable support to distressed projects at other places."* (Case C4)

Therefore, this company had reorganized its IT structures and had established centralized resource pools based on skill-profiles.

4.5.5.2 Centralized arrangements

In six of the investigated case companies, resources were organized in a rather centralized manner.[544] Four of these companies had switched their IT organization from a decentralized arrangement to a more centralized arrangement within the preceding five years. Consequently, the interviewees in these companies had witnessed the advantages and disadvantages of both kinds of arrangements.

Case company C6 provides a good example for the general trend towards more centralized IT organizations within the sample. In this company, the IS function formerly had been structured according to the organizational grouping into different business units. Application management and project management (run and build) were combined into the same departments. At the time of the interview, in contrast, the IS function was structured into separate build and run units. Moreover, a customer relationship management department had been installed within the IS function. Project resources were organized in a centralized unit and were not assigned to individual business units anymore.

Human resources within formerly decentralized units were typically organized according to IT systems and products. This way, they had developed technical and functional expertise for the system they supported. In centralized arrangements, in contrast, human resources were typically not organized according to products but according to IT services or skills (like, for example, programming or testing skills). The advantage of an IT organization where resources are organized according to skills and not according to IT products was described as follows by an IT governance expert in a large bank:

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[544] This applies to case companies C1, C2, C4, C6, C7, and C8.

"The advantage is pretty clear, of course: People can provide their know-how to several projects. Moreover, you have less skill bottlenecks to close – i.e. there were people who knew an IT product for 20 years and who were indispensable at some point in time. So, now we have significantly reduced our dependence on these key resources." (Case C4)

Apart from the potential to utilize resources in different projects owned by different business units, managing human resources according to skills can also foster a better steering and training of the available IT staff. Moreover, as described by the head of IT governance in case company C4, scalability can also be a major advantage of centralized IT resource pools. For example, during mergers and acquisitions a smooth integration of acquired companies is facilitated, as the resource management arrangement must hardly be adjusted. The same interviewee in case company C4 also remarked that resources can be replaced more easily in a skill-based resource pool than in a product-centered structure.[545]

While flexibility and scalability in general were noted as advantages of centralized resource pools, also serious disadvantages were reported during the interviews. These disadvantages inter alia result from a relatively low level of functional knowledge, as staff is assigned to projects and other activities in a rather flexible manner. Consequently, employees in centralized resource-pools require rather generic skills instead of detailed functional skills. The IT architect in case company C4 remarked that in such a skill-based organization it becomes more important and more difficult to write accurate specifications for programmers who develop information systems for different business units. The technical specialization interferes with the functional completeness.

Interviewees in five of the investigated companies also highlighted that the degree of centralization of resource management also has a natural limitation. This is in particular due to a number of social aspects. As noted by an interviewee in case company C5, the employees *"need a homeland somewhere"* – some functional aspect or some product they can identify with. Similarly, an interviewee in case company C3 provided the following argument:

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[545] In case company C4, the current organizational structure only existed since about one year. Therefore, the identified advantages in this company have to be handled with care, as there might not have been enough experience with the new arrangement for IT resource management. However, in organizations where comparable structures existed much longer, flexibility and scalability were also identified as major advantages of centralized arrangements for IT resource management.

> *"The staff members want to identify with something in some way [...], but I usually don't say: 'I work for the IT department', but actually I rather work primarily for the customer. I can also identify with products etc. And, therefore, it is natural that we finally always cling to something."* (Case C3)

When establishing centralized resource pools as a structural mechanism, complementary procedural mechanisms are required, as a stronger need for coordination arises. Consequently, new demand management and resource management processes have to be installed. In decentralized arrangements in contrast, a fine-grained operational structure is usually not required as coordination takes place in an informal way. This is illustrated in the following quotation:

> *"What our new organizational structure also includes – or what is a result of it: We were ultimately forced to draw a fully process-oriented operational structure in addition to the organizational structure. Previously, internal or intra-departmental processes were essentially determined by the structure. This now had to be modeled completely in parallel. So, we had to put all activities that can occur within IT into a process model in order to document the interaction between the still relatively generically structured units and to clarify the responsibilities. So, besides the structural organization we now have a process-based operational structure."* (Case C4)

At the time of the study, several companies were revising their governance arrangements for IT resource management. In this context, the interviewees emphasized the need to adjust these arrangements to the organizational requirements and to the organizational structure on an ongoing basis. In some companies, this process led to very individual arrangements.

4.5.5.3 Matrix structures

In case companies C3 and C9, the organizational structure of the IS function had recently been revised and transferred to a more centralized design. The IS functions in these two companies were formerly predominantly organized according to IT products and applications but had recently been restructured according to IT services and skills. However, the sub-structuring in alignment with the different business units had been maintained. In consequence, IT resources were organized in matrix structures.

In case company C3, the structure of the IS function had been transferred into a horizontal design, where IT employees were organized into different units according to skills and roles. For example, there were different units for application management or testing. In addition, the IT organization had also been divided vertically according to the three major business units.

The horizontal design was identically replicated within these units. The interviewee in case company C3 attributed the need to establish a matrix structure for the IS function to the size of the organization. Due to the large number of IT employees in this company, it would have become too difficult to manage all IT resources completely centrally. Still, the general objective motivating the recent reorganization was to foster unit-spanning communication and to avoid isolated units dealing with a single product. At the time of the interview, the organizational design in case company C3 was subjected to ongoing adjustments, as it had become rather complex and, therefore, responsibilities were not assigned in a consistent manner.[546]

The organizational design in case company C9 had also been revised a few years before the interview took place. In this case, the change had been triggered in particular by a major acquisition. While case company C9 formerly had a strongly product-driven IT architecture, the IS function of the acquired company had been strongly service-driven. The company decided to adopt a service-driven architecture, but opted for a matrix structure to maintain the balance between services and components. In order to ensure that the technical and functional knowledge of IT employees could be maintained after the reorganization, the IT governance department decided not to strictly separate IT resources according to run, build and change activities. Instead, only IT project managers were organized in a separate unit and IT employees were assigned to projects on demand. The head of the IT governance department described this structure as a *"virtual change unit"*. The majority of IT employees were usually concerned with maintenance activities but could be assigned to projects on demand. IT employees working on a project were completely taken out of the IT organization for the time they worked on a project. Thereby, project staff could focus completely on project work.[547]

Matrix structures provide a means to adapt the organizational structure to different organizational needs. However, matrix structures can quickly become very complex and difficult to manage. Consequently, there is a tradeoff between a strong alignment to organizational requirements and the principle of clarity. The suitability of a given arrangement for IT resource management also depends on which arrangements are chosen for IT budget allocation, IT demand management, and IT project portfolio selection. For example, if projects are selected centrally, it is also advisable to manage project resources in a centralized arrangement. If resources are managed in a decentralized arrangement, in contrast,

[546] In general, high internal complexity is a disadvantage of matrix organizations (cf. Fjeldstad et al., 2012, p. 738).

[547] In this context, it is important to note that the IS function had a matrix structure, but IT employees did not work in a project matrix.

it is important to set budgets according to the availability of resources in the respective units and to establish a corresponding demand management structure.

4.5.5.4 Impact of excess demand

Particularly in decentralized arrangements and in settings where budgets are not specified top-down, unanticipated excess demand can arise during a budgeting cycle. This can lead to severe resource conflicts. If these conflicts are not recognized during project portfolio selection, they have to be solved by hiring external resources or by terminating or postponing projects.[548] In this context, several interviewees advised against leaving the resolution of resource conflicts to the IS function. The IS function would be confronted with the difficult decision whether to risk a conflict with the affected business units or to try to implement all proposed projects at the cost of overspending. The consequences of the first option were described by an interviewee as follows:

> *"IT then had to decide where the capacity had to be taken from - who had to bleed. That was just a stupid state. The buck was always passed to IT."* (Case C6)

The second option, namely trying to implement additional projects despite missing capacity, may have even more serious consequences as it might not only lead to overspending but also to indistinctive delays in various projects. This situation was described as follows:

> *"In some point in time there is not enough know-how or not enough money and then someone has to decide: What do we do now? IT cannot do this. Because when you give us enough money, we do it all, we also do everything in parallel."* (Case C7)

Consequently, it is important that top management is directly involved in the resolution of resource conflicts and/or clear project priorities are already specified during the project portfolio selection process. In this context, clear strategic guidelines may help to determine priorities for projects as soon as conflicts arise. Moreover, in order to avoid resource shortages in advance, it is vital that the IS function as the main provider of IT resources is involved early in the planning process. Again, this aspect illustrates the importance of appropriate IT demand management arrangements and a high degree of business/IT alignment.

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[548] Cao et al., for example, describe the situation in an Asian bank, where "projects appear almost randomly and they can not find right and enough resources to do these projects" (Cao et al., 2005, p. 368). This situation is also caused by the fact that human resources are organized into separate "silos" (cf. Cao et al., 2005, p. 368).

4.5.6 Contingency factors

The findings obtained during the case study analysis support the proposition that the appropriate design of governance arrangements for IT project portfolio management in a given company is contingent upon a variety of factors. In other words, “There's no single right way to do project portfolio management.”[549]

In the following, contingency factors affecting the design of IT governance arrangements for IT project portfolio management are discussed. During the case study research, it was examined which conditions prevailed in the different organizations, which changes had taken place and which factors had influenced the design of the governance arrangements at hand. Based on the cross-case synthesis, the following contingency factors were identified:

- Organizational structure and firm size
- External environment
- Corporate strategy and IT strategy
- Organizational culture and politics
- Role of the IS function
- Top management involvement
- Project interdependencies and synergy potentials

These contingency factors will be presented and discussed in detail in the following sections. In order to integrate the findings with previous research, existing contributions on organizational theory and IT governance, as well as contributions specifically concerned with IT project portfolio management will included.

4.5.6.1 Organizational structure and firm size

When investigating organizational structures at the enterprise level – in particular with a focus on centralization and decentralization – it is important to note that large enterprises are typically subdivided into multiple diversified business units.[550] The organizational structure relates to the subdivision of the organization, as well as to the mechanisms used to coordinate between the different units. Child provides the following definition:

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[549] Cao et al., 2005, p. 386. Similarly, Gleisberg et al. remark: “Selecting the best projects is a complex process, and there is no single right way to do it. The ‘right’ project selection process depends on the nature of your business and how well you manage your current portfolio.” (Gleisberg et al., 2008, p. 2.)

[550] Cf. Hodgkinson, 1996, p. 249.

> " 'Organizational structure' is defined as the formal allocation of work roles and the administrative mechanisms to control and integrate work activities including those which cross formal organizational boundaries."[551]

The design of the organizational structure itself is contingent upon a number of influencing factors.[552] For example, the age and the size of a company, its technical system, its environment, as well as different power factors exert an influence on the organizational design.[553] However, according to the strategic choice perspective, the organizational structure is not completely determined by environmental conditions but can actively be shaped by top management's strategic choices.[554]

In the IT governance literature, there is significant evidence that the IT governance design is contingent upon the organizational structure.[555] Ein-Dor & Segev empirically found that the organizational structure and the firm size, measured in terms of total revenue, have an impact on the degree of centralization of the IS development and implementation activities.[556] The finding that the IT governance arrangement is contingent upon the organizational structure has been replicated in several studies.[557] In contrast, an association between firm size and IT governance design could not be proven in a number of studies.[558]

Although the contingency of the IT governance design upon the organizational structure has been thoroughly investigated in general, there seems to be a lack of research concerning the impact of the organizational structure in the particular context of IT project portfolio management. The current study contributes to the clarification of this relationship. In particular, in the previous sections it has been demonstrated that governance arrangements for IT project portfolio management can be aligned to the organizational structure in different ways by implementing alternative governance mechanisms in the four different fields of activities.

In the investigated case companies, the interviewees emphasized that the structure of the IS function should be aligned to the organizational structure of the company as a whole. An

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[551] Child, 1972, p. 2.
[552] Cf. Mintzberg, 1980, p. 327f.
[553] Cf. Mintzberg, 1980, p. 327f.
[554] Cf. R. E. Miles et al., 1978, p. 549.
[555] Cf. A. E. Brown & Grant, 2005, p. 704.
[556] Cf. Ein-Dor & Segev, 1982, p. 65.
[557] Cf. A. E. Brown & Grant, 2005, p. 704.
[558] Cf. A. E. Brown & Grant, 2005, p. 704.

interviewee in a pharmaceutical company with a strong regional focus provided the following argument:

> *"It [the current decentralized IT organization with quite informal relationships] will work as long as we have got the current business model. If the business chose a different structure, the model would reach its limits because it has to reflect the business in some way. [...] At least, it has to be aligned to the business. It is a different question if it always has to replicate the business exactly, but it has to react in some way to the business structures. If I have a completely globalized business structure, IT cannot be organized into regions. [...] Therefore, there has to be a certain adaption."* (Case C10)

As exemplified by the above quote, it was also noted by several interviewees that the need for alignment does not imply a complete replication of the organizational structure. This was also reflected in the fact that IT governance arrangements were frequently altered despite a given organizational structure. In this context, the interviewees emphasized that in particular the demand management field of activity has to reflect the organizational structure of the company. Demand management constitutes an organizational interface between the business units or regions and the IS function. Therefore, changes in the overall organizational structure at least require adjustments at this interface. For example, an interviewee in a bank with a segmental structure described the following reaction to a recent organizational change:

> *"Well, in the customer relationship management units we replicate the segmental structure of the bank as far as possible. Until recently, the number of [customer relationship management] units was exactly the same, so the structure was completely congruent to the segmental structure. Only recently it was necessary to increase the number of units according to the large size of the segments at the functional side."* (Case C4)

Firm size was also perceived to influence the organizational design as well as the design of governance arrangements for IT project portfolio management. In two very large companies, it was reported that it is difficult to coordinate and support all units centrally due to the large firm size. Therefore, the IT organization had been subdivided according to the company structure. An interviewee in case company C3, for example, stated the following:

> *"We are decentralized regarding the full width of the company. This is due to the fact that the bank is considerably large."* (Case C3)

In case company C7, in contrast, the work force had significantly been reduced in recent years. According to the interviewee, this led to a higher degree of centralization and a shift of control tasks to the corporate center. Responsibility for guidelines and principles formerly rooted in the regions was assigned to the global level. Moreover, in consequence of the declining firm size, resources were more and more concentrated in shared service centers.

Firm size apparently had an impact on the design choices of several companies. In tendency, it was more challenging to establish corporate-wide arrangements in very large companies. In the existing literature, there is also significant evidence that the size of the company has implications on IT project portfolio management efficiency. Based on their large-scaled empirical study, Martinsuo & Lehtonen provide evidence that firm size, measured in terms of the number of employees, and project portfolio management efficiency are negatively correlated.[559] Interestingly, this effect is removed when including the effect of project management efficiency into the model.[560] Martinsuo & Lehtonen attribute this effect to the "fit to the organizational context".[561] They find evidence for the "presumption that portfolio management practices increase in relevance in larger companies."[562] Consequently, governance arrangements for IT project portfolio management do not only become more decentralized but also more sophisticated in large firms. In the current study, this was reflected by the fact that the largest companies in the sample were most intensively engaged in improving their IT project portfolio management practices. For this purpose, IT project portfolio management and IT governance specialists were commissioned to look for and to implement additional governance mechanisms.

4.5.6.2 External environment

The external environment in which a company operates may underlie significant changes over time. In such a dynamic environment, quick decisions and quick adaptions to environmental changes become a vital requirement. On the other hand, the external environment may also be rather stable and may allow a company to adjust its governance arrangements to the environment. Ansoff & Brandenburg refer to such conditions by the term "steady-state".[563] They provide the following description of the requirements imposed by steady-state environments:

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559 Cf. Martinsuo & Lehtonen, 2007, p. 60. The projects investigated in this study are predominantly internal organizational development or IT systems development projects (65.6 percent). However, 34.4 percent of the investigated projects are product development projects (cf. Martinsuo & Lehtonen, 2007, p. 59). Therefore, the results of the study may only be partly transferable to the IT project portfolio management context.

560 Cf. Martinsuo & Lehtonen, 2007, p. 61.

561 Cf. Martinsuo & Lehtonen, 2007, p. 61.

562 Martinsuo & Lehtonen, 2007, p. 62.

563 Cf. Ansoff & Brandenburg, 1971, p. B710.

> "Under steady-state there is a relatively low premium on speed of response to external or internal conditions. It is possible, therefore, to keep the management lean with just enough capacity to handle the decision load."[564]

Steady-state conditions foster centralized governance arrangements, where synergy potentials can be identified and exploited to a high degree.[565] Dynamic environments, in contrast, require operating responsiveness and therefore foster decentralized arrangements, which allow for rapid decision-making.[566] Speedy reaction to environmental changes and accounting for internal interdependencies are conflicting requirements that are difficult to achieve at the same time. Miles et al. describe this dilemma as follows:

> "For most organizations, the dynamic process of adjusting to environmental change and uncertainty—*of maintaining an effective alignment with the environment while managing internal interdependencies*—is enormously complex, encompassing myriad decisions and behaviors at several organization levels."[567]

In line with this description, the governance arrangements for IT project portfolio management in most of the investigated companies were rather complex and frequently new governance mechanisms were implemented.

In order to react to changes in the external environment, adjustments to IT governance arrangements may be required. During an economic downturn, for example, the efficient use of the available resources becomes more critical. Therefore, a centralized arrangement usually is the appropriate choice in this situation. In a dynamic environment with large growth opportunities, in contrast, decentralized arrangements may be better suited, since the decentralized units can decide more quickly and can react to changes more flexibly. This relationship is well illustrated in the following interview quote:

> *"Currently, the company is decentralized to a large degree. This means that each business unit more or less has assigned its own separate IT unit – in addition to the cross-sectional units for things that affect all business units, like infrastructure. This is certainly the right strategy if you are in a growth phase. Because then it is less about standards but it is a matter of doing business [...], meaning to implement business requirements and not to look left and right: Does this fit into any intergalactic, big, global picture?"* (Case C3)

564 Ansoff & Brandenburg, 1971, p. B710.
565 Cf. Ansoff & Brandenburg, 1971, p. B710.
566 Cf. Ansoff & Brandenburg, 1971, p. B711.
567 R. E. Miles et al., 1978, p. 547.

According to several interviewees, the external environment also has major impacts on the portfolio of running IT projects. For example, in economic downturns, unanticipated budget cuts are very likely.[568] In such an environment, it is important to be able to reprioritize the IT project portfolio quickly. Therefore, a centralized overview of the existing IT projects and clear rules of how to proceed if changes occur, are particularly advantageous in this situation. In the investigated companies, strongly restricted budgets fostered centralized planning mechanisms and strong top management involvement. Consequently, companies striving for efficiency tended to establish more centralized governance mechanisms for IT project portfolio management. This demonstrates that not only the environmental dynamics exert an influence on the appropriateness of governance arrangements for IT project portfolio management, but also the economic pressures imposed by the current environment.

The external environment usually also has a strong influence on the chosen corporate strategy. Consequently, both contingency factors are interlinked. However, this relationship is not deterministic. Organizations have different choices of how to react to environmental changes and large organizations may even be able to change their environment to a certain extent.[569] Consequently, the external environment and strategy are considered as distinct contingency factors. In the following subsection, the impact of strategy on IT governance in general and on the governance of IT project portfolio management in particular will be examined, based on existing foundations.

4.5.6.3 Corporate strategy and IT strategy

The design of governance arrangements for IT project portfolio management is also contingent upon the corporate strategy and the IT strategy. Major strategic reorientations do not only change the decision-making criteria for project portfolio selection and the nature of the selected projects, but may also trigger changes in the organizational structure and the IT governance arrangement.[570]

The general impact of different strategic directions on the governance of IT has been analyzed empirically by Tavakolian based on Miles & Snow's typology of defenders, prospectors, analyzers, and reactors.[571] Tavakolian comes to the following conclusion:

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568 Due to the recent financial crisis, several of the investigated companies had witnessed unexpected budget cuts. For a similar example, compare Petit & Hobbs, 2010, p. 54.

569 Cf. Child, 1972, p. 4.

570 Strategic changes can inter alia be caused by changes in the economic environment as discussed in the previous section. Moreover, as described in more detail in the current section, the corporate strategy usually also has an impact on the organizational structure.

571 Cf. R. E. Miles et al., 1978; R. E. Miles & Snow, 1978; Tavakolian, 1989, p. 310f.

> "The results indicate that the IT of an organization with a conservative competitive strategy is more centralized than that of an organization with an aggressive competitive strategy. To be more specific, the user departments of a conservative organization have less responsibility for their IT activities than the user departments of an aggressive organization. Based on these findings, this article speculates that a conservative competitive strategy exerts pressure for the centralization of IT responsibilities, while an aggressive competitive strategy exerts pressure for the decentralization of IT responsibilities."[572]

Peterson et al. note that in companies focusing on innovation, the involvement of business management is particularly strong.[573] If companies pursue operational excellence and innovation strategies at the same time, hybrid configurations and differentiated designs for IT governance are likely to be installed.[574] Similarly, Brown & Magill find that companies with strategies of related diversification tend to adopt federal IT governance structures in unstable environments.[575] Companies in search for efficiency tend to govern IT project portfolio management at a corporate-wide level. For example, Brown & Magill describe two companies that shifted from a federal IT governance structure to a centralized structure due to deficient IT performance manifested inter alia in high total IT budgets and in runaway projects.[576]

Consistently with these previous findings, in the current study it was observed that companies pursuing an innovation strategy tended to manage IT project portfolios locally and to assign a high degree of decision-making authority to local business managers in contrast to companies pursuing a strategy with a focus on efficiency. The latter companies tended to opt for centralized or federal arrangements and IT employees were involved in decision-making to a higher degree.

In case company C1, for example, the corporate strategy had been considerably revised four years before the interview took place. This had led to a change in the organizational structure of the company as a whole and to a complete revision of the IT strategy. The new IT strategy included three strategic directions: efficiency improvement, focus on activities with long-term benefit, and focus on growth. This change in the IT strategy also led to a change in the organizational structure of the IS function and to a revised IT governance model. In this

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572 Tavakolian, 1989, p. 314.
573 Cf. Peterson et al., 2000, p. 445.
574 Cf. Peterson et al., 2000, p. 445.
575 Cf. C. V. Brown & Magill, 1994, p. 387.
576 Cf. C. V. Brown & Magill, 1994, p. 387.

context, the governance arrangements for IT project portfolio management became centralized in order to be able to implement the new strategy. The CIO in case company C1 observed that the new arrangement led to efficiency gains, more synergy exploitation, and more standardization. Furthermore, he recognized that the strategic and organizational changes in the long term facilitated the emergence of IT projects with strategic focus.

The same interviewee strongly emphasized that the IT strategy should follow the corporate strategy and that the appropriate degree of centralization and standardization are contingent upon the corporate strategy. In this context, he stated the following:

> *"Here in our company it [the current centralized arrangement] works and it is the right way. Precisely this is the art: The IT strategy must fit to the company's strategy. So, I cannot think about IT strategy with the attitude: 'Everybody standardizes and centralizes and therefore we do the same.' Of course, it is often easier this way. For example, you can manage complex infrastructure only when you have clear standards and clear processes. If I cannot do that – if, so to say, the IT strategy must be decentralized because the corporate strategy requires it, then I must also be willing to accept the fact that the IT costs may be greater than in the centralized structure."* (Case C1)

While the interviewees generally agreed that the IT strategy and the IT structure have to reflect the corporate strategy to a certain extent, it was also noted that the design of IT governance arrangements is not completely determined by the corporate strategy. Organizational changes were not always triggered by strategic changes but for example also by mergers, acquisitions, and new management. Moreover, in some companies different strategies were pursued by different organizational units. In case company C10, for example, each country had its own strategy. The interviewee noted that these country strategies should not contradict the group strategy but, still, the different strategies were relatively independent. Consequently, in this company IT project portfolio management was governed differently across the country organizations, in accordance with the distinct country strategies.

Again, it is important to note that the impact of strategy on IT project portfolio management should not be regarded in isolation. As mentioned above, the corporate strategy is inter alia influenced by the external environment.[577] Moreover, organizational strategy and IT strategy

[577] Cf. R. E. Miles et al., 1978, p. 547.

also influence each other.[578] Thus, it is vital to consider the identified contingency factors in combination rather than in isolation.

4.5.6.4 Organizational culture and politics

Organizational culture and politics in general have a large impact on IT governance. According to Peterson, “Power struggles, political turbulence, and cultural clashes are endemic to the governance of IT [...].”[579] This in particular holds true to the governance of IT investments, since several different stakeholders have to compete for scarce resources in this context. Conflicts of interests and political behavior can typically be witnessed during budget negotiation sessions and portfolio selection decisions. Levine, for example, notes that projects sometimes “[...] get approved solely because of the political power of the project sponsor.”[580] Weill & Olson state that political considerations in the context of investment decisions “[...] sometimes eclipse the technical and economic considerations and are generally perceived as becoming more and more important.”[581]

Several impacts of the organizational culture and political behavior on the chosen governance design were observable during the current study. For example, the interviewee in case company C5 had witnessed a situation where the executive board formerly was not involved in IT project portfolio prioritization. The executive board had specified a budget for IT projects top-down, but had not decided how to distribute this budget to the different units and projects. This situation lead to a tactical behavior of the business unit heads:

> *“Everyone also tactically maneuvers and says: I will wait until my neighbor moves; and then I will also move a little bit – or maybe not.”* (Case C5)

IT project portfolio management in general is strongly subject to goal conflicts between managers at different organizational levels.[582] Positivist agency theory can be employed in order to describe the impact of such conflicting goals on the design of governance mechanisms.[583] El Arbi et al., for example, have recently investigated agency problems concerning IS project alignment. In this context, they have also described conflicts of interest concerning IT project portfolio selection. They have made the following observation:

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[578] Cf. Henderson & Venkatraman, 1993.
[579] Peterson, 2004, p. 10.
[580] Levine, 2005, p. 2.
[581] Weill & Olson, 1989a, p. 12.
[582] Cf. El Arbi et al., 2012, p. 7.
[583] Cf. Eisenhardt, 1989b, p. 51.

> "While the top management selected IS projects according to the function of their alignment with the IS strategy, the middle managers' choice of projects tended to be based on whether it would benefit their own department."[584]

El Arbi et al. attribute this problem to a lack of consolidated project information available to the top management.[585] They propose that information overload at the top management level leads to morale hazard problems.[586] This can lead to opportunistic behavior during the project evaluation phase.

An important governance mechanism in order to cope with opportunistic behavior is to hold project sponsors accountable for realizing the promised benefits.[587] During the case studies, this mechanism was in particular emphasized by the interviewees in case company C1 and C7. However, it was also noted that this mechanism is frequently challenged by the circumstance that benefits provided by IT projects are difficult to measure. A potential mechanism in order to reduce conflicts of self-interest between corporate managers and local managers consists in rewarding local managers according to the performance of the overall organization and not only according to the performance of their particular business unit. Such incentive systems were reported by several interviewees.

While conflicts are characteristic for the IT project portfolio management context, some organizations tend to avoid conflicts due to their consensus-based organizational culture. The impact of a consensus-based organizational culture in the context of IT project portfolio management has in particular been highlighted by Prifling.[588] Based on a case study in a "large European bank from the cooperative banking sector", Prifling has identified consensus-based organizational culture as an antecedent of risk management in IT projects and project portfolio management.[589] Prifling comes to the following conclusion:

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584 El Arbi et al., 2012, p. 7.
585 Cf. El Arbi et al., 2012, p. 7.
586 Cf. El Arbi et al., 2012, p. 8.
587 Cf. De Reyck et al., 2005, p. 532; Thomas et al., 2007, p. 8.
588 Cf. Prifling, 2010a.
589 Cf. Prifling, 2010a. This situation is very similar to the situation encountered in case company C5, which is also a company in the European banking sector.

> "We interpret the organizational culture, which in this case places most emphasis on consensus and balance, as the structural precursor that paves the way for an oversized IT project portfolio. Too many projects are granted by the division heads, because no division wants to refuse another division's desired project. Even though there is room for negotiating and discussing priorities, there are no definite decisions from the executive board about how to derive a strategic prioritization of the overall (IT) project portfolio."[590]

In the current study, it also became apparent that a corporate culture with a tendency towards autonomy, consensus, and conflict avoidance complicated the implementation of formal and explicit decision-making structures at a corporate-wide level.[591] For example, an interviewee in case company C5 described the following experience:

> *"You need the staff, the cooperation, and consent of the respective departments or divisions for which you are planning. [...] Therefore, this has to be solved in a dialogue. But that is enormously difficult, because each department has the inherent interest to get as much budget as possible for itself and always more budget than is available."* (Case C5)

Centralized decision-making was complicated in such companies, as conflicting interests of the different decentralized units had to be taken into account. Implementing formalized coordination mechanisms without the consent of the decentralized units quickly lead to resistance and eventually to failure.[592] Therefore, companies with consensus-based cultures favored informal decision-making processes and opted for decentralized or federal structures.[593]

The impact of organizational culture witnessed in the current study is in line with predictions and findings from existing contributions. As the adoption of new governance arrangements involves changes in routines, this process can be associated with significant degrees of resistance, costs, and deferrals.[594] In the particular context of IT project portfolio management, it has also frequently been reported that the implementation of centralized decision-making

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590 Prifling, 2010a, p. 6.

591 In particular, the interviewees in case companies C4 and C5 strongly highlighted the need for consensus-based decisions.

592 In case company C5, for example, two attempts had formerly been started to implement a more objective, coordinated decision-making process for IT project portfolio selection. However, these attempts had failed due to the strong resistance of the business units.

593 Also compare Prifling, 2010a.

594 Cf. Teece, 2007, p. 1335.

arrangements for IT project portfolio selection causes considerable set-up and coordination costs and may lead to resistance and frictions.[595]

4.5.6.5 Role of the IS function

The role and standing of the IS function in the company also exert an influence on the involvement of IT representatives in IT project portfolio management. In general, the IS function is a principal as well as an agent with regard to IT project portfolio management. On the one hand, the IS function provides resources required in order to implement IT projects. On the other hand, the IS function usually also competes for the same resources with other business units and therefore can be perceived as self-interested. Moreover, the goals of the IS function may conflict with the goals of the business units as both sides may prefer different project types and technologies. Therefore, the IS function does not necessarily take the lead for IT project portfolio selection, even if IT resources are provided centrally by the IS function.[596] In this context, Xue et al. remark:

> "Rationally, one would expect IT investment decision processes to be led by the IT function. Yet, the political view suggests that the governance of IT investment decision processes depends on the power of the IT function."[597]

If the IS function is strongly involved in decision-making processes, it is important that the business units have trust in the capabilities and the neutrality of the IS function. In the investigated cases, responsibility, credibility, and trust were frequently mentioned as critical requirements for a strong involvement of the IS function during IT project portfolio selection. As highlighted in the previous section, cultural and political aspects have a crucial impact on the governance of IT project portfolio management. This is particularly important as a strong involvement of the IS function often comes along with centralized decision-making.[598] In this context, the CIO in case company C1, who was primarily responsible for IT project portfolio selection, noted:

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[595] Cf., e.g., El Arbi et al., 2012, p. 8; Elonen & Artto, 2003, p. 397; Levina & Ross, 2003, p. 350; Unger, Gemünden, et al., 2012, p. 628; Wong et al., 2011, p. 1211.
[596] Cf. Xue et al., 2008, p. 72f.
[597] Xue et al., 2008, p. 72f.
[598] Cf. C. V. Brown & Magill, 1994, p. 373; Winkler et al., 2011, p. 4.

> *"If my colleagues have trust in me and believe that I stand up for them and make sure that IT works neatly, I have a chance of success. If colleagues basically see: IT just follows their hobbies, shirks things that are really difficult, and never wants to take responsibility, then you don't have a chance with such a centralized model."* (Case C1)

The absorptive capacities of the IS function and the business units involved can also have a crucial impact on the design of governance arrangements. Winkler et al., for example, demonstrate that the IT knowledge within the business units as well as the business knowledge within the IS function are contingency factors concerning the governance of SaaS solutions.[599] The same apparently holds true for the governance of IT project portfolio management. The interviewees consulted during the current study congruently noted that the IS function is more intensively involved in IT project portfolio management – particularly in IT demand management and IT project portfolio selection – if it is perceived as a business enabler instead of a mere support function.[600]

Several interviewees also highlighted that in general a culture of reciprocal responsibility between the IS function and the business units is required in order to avoid frictions. With respect to the responsibility of the IS function, it was particularly highlighted that the required resources need to be provided in time. With respect to the responsibility of the business units, it was emphasized that it is important to make sure that the selected projects are started in time. Else, resources may be blocked unnecessarily. This requires a culture, where failure to deliver can be sanctioned. In this context, the role and standing of the IS function inter alia depend on the attitude of top management towards IT project portfolio management. Top management involvement as a contingency factor concerning the governance of IT project portfolio management is discussed in the following section.

4.5.6.6 Top management involvement

Top management involvement has long been identified as a very important success factor concerning IT project management in general.[601] Top management involvement is vital in order to define expectations and to overcome resistance. In this context, top management also has an important role in implementing and enforcing new procedures and governance

[599] Cf. Winkler et al., 2011, p. 9.
[600] Cf. section 4.5.3.4.
[601] Cf. Crawford et al., 2008, p. 43; Madanayake et al., 2009; Young & Jordan, 2008.

arrangements.[602] Analogously, top management is also involved in the implementation of governance arrangements for project portfolio management.[603]

In an empirical study in 33 organizations, Doll investigated the effects of top management involvement in the context of MIS development.[604] The results inter alia demonstrate the importance of top management involvement during the specification of governance arrangements for IT project screening and selection. Doll describes the effect as follows:

> "Perhaps the most effective avenue for top management involvement is in working with MIS management to develop a mutually agreed upon and mutually accepted operational priority scheme for project screening and selection. Mutual agreement on a priority scheme not only changes development priorities, it makes them more functional. The information system area can then be viewed as a business within a business."[605]

As illustrated in the previous section, the ability of top management to effectuate desirable behavior inter alia depends on the organizational culture and the power and attitude of other stakeholders – in particular powerful local managers. In this context, the decisiveness of top management to overcome resistance and to sanction political behavior can be of vital importance in order to implement compulsory corporate-wide arrangements for IT project portfolio management. According to upper echelons theory, organizational outcomes are influenced by top management's experiences, values, personalities, and backgrounds.[606] Top management characteristics can exert a huge impact on the corporate strategy and corporate performance, as long as a sufficient degree of managerial discretion exists.[607]

During the interviews, top management involvement was in particular noted as a critical requirement for the successful implementation of centralized decision-making arrangements. Without a clear top management mandate, middle managers and other decision makers with little formal authority tend to avoid conflicts, in particular if powerful business directors are affected.[608] A lack of top management involvement can easily lead to ambiguity and, in consequence, significant overspending. This situation was witnessed by the interviewee in case company C5. He described the situation as follows:

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[602] Cf. Madanayake et al., 2009, pp. 5, 8.
[603] Cf. Beringer et al., 2012, p. 19.
[604] Cf. Doll, 1985.
[605] Doll, 1985, p. 28.
[606] Cf. Hambrick & Mason, 1984; Hambrick, 2007.
[607] Cf. Hambrick, 2007, p. 335.
[608] Consequently, the degree of top management involvement is also linked to the organizational culture.

"There is a planning board, but only since this year. The IT planning board, however, could only perform [...] – in terms of a decision-oriented reduction of projects – if someone is ultimately entrusted by the board and says, 'No, we only have so much to spend. There we have to get now. And I now want to have an adequate contribution of everyone.' Only with this strict course, you have a chance." (Case C5)

In companies where top management apparently did not sufficiently support transition processes, initiatives fostering the implementation of corporate-wide arrangements for IT project portfolio management were likely to fail. In several of the investigated companies, past attempts of IT governance experts or other middle managers to foster a higher degree of coordination without sufficient top management involvement were impeded due to a lack of incentives and conflicts of interest between different business units.[609] Thus, a positive attitude of top management towards IT project portfolio management and the active involvement of top management during the design and implementation phase were described as important prerequisites concerning the implementation of corporate-wide governance arrangements for IT project portfolio management.

Top management involvement is not only a contingency factor concerning the implementation of appropriate governance arrangements but can also be an important success factor concerning project evaluation. Thomas et al., for example, identify "top-leadership commitment" as an organizational driver associated with "effective IT project evaluation" outcomes.[610] Top management commitment often leads to consistent and timely decision-making while lack of commitment can render evaluation processes inefficient.[611] Unger, Kock, et al. empirically find that senior management involvement in project portfolio management has a significant positive impact on the strategic fit of the project portfolio.[612] In addition, they find that senior management involvement also has a positive effect on project termination quality.[613] However, the relationship is "inverted u-shaped" as senior managers with a very high attention on projects tend to stick to certain "pet projects".[614]

In this context, Jonas makes a distinction between three different types of management activities: "empowerment, intervention, and encouragement".[615] He argues that top

[609] In particular, in case companies C4 and C5 several attempts have failed to establish stronger coordination mechanisms (cf. section 4.5.6.4).
[610] Cf. Thomas et al., 2007, p. 9f.
[611] Cf. Thomas et al., 2007, p. 9f.
[612] Cf. Unger, Kock, et al., 2012, p. 680.
[613] Cf. Unger, Kock, et al., 2012, p. 680.
[614] Cf. Unger, Kock, et al., 2012, pp. 678, 680.
[615] Jonas, 2010, p. 819.

management as well as line-management involvement can have positive but also negative impacts in this context.[616] Jonas discusses the impact of management involvement against the particular background of the role of project portfolio managers.[617] This role is described as "[...] a central coordination unit that supports the senior management with its specialized knowledge about project portfolio practices."[618] Jonas hints at the need to change "[...] the complex power balance between senior managers, line managers, and project managers [...]"[619] if this coordination role shall be introduced. This description well characterizes the situation encountered in several of the investigated companies. However, it is important to note that this "power balance" is not only of importance with respect to the role of a project portfolio manager. It affects governance arrangements for project portfolio management in general. Consequently, the attitude of top management towards IT project portfolio management can strongly influence the design of the chosen governance arrangement and, in effect, IT project portfolio management success.

4.5.6.7 Project interdependencies and synergy potentials

IT projects are often interlinked by different kinds of interdependencies.[620] By considering these interdependencies during IT project portfolio selection, synergy potentials can be gained. In general, the organizational structure of a firm should be designed in such a way that related activities are bundled within the same unit. However, depending on the organizational structure and the nature of the project landscape, there may be boundary-spanning interdependencies that can be exploited by appropriate governance arrangements and coordination mechanisms. The prevalence of interdependencies and synergy potentials has implications on governance arrangements in all four fields of activities described in section 4.5.1.

The theory of complementarities introduced by Milgrom & Roberts provides the theoretical backgrounds for investigations of synergy effects between IT units.[621] Milgrom & Roberts explain why "[…] strong complementarities make it more likely that (i) individual adaptations will fail to converge upon optimal results, (ii) the distance from the team's equilibrium to its

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[616] Cf. Jonas, 2010, p. 825f.
[617] Cf. Jonas, 2010, p. 822f.
[618] Jonas, 2010, p. 823.
[619] Jonas, 2010, p. 818.
[620] Detailed descriptions of different types of interdependencies and their impact on IT project portfolio selection are contained in section 5.2.2. In the current section, it is in particular hinted at the fact that the prevalence of project interdependencies leads to synergy potentials, which in turn have an influence on the chosen governance design.
[621] Cf. Milgrom & Roberts, 1995, p. 205.

optimum can be large, and (iii) central strategic direction will be valuable."[622] In organizations where strong complementarities prevail, coordination, central direction, and strategic guidance become particularly important.[623]

Consequently, governance arrangements for IT project portfolio management should reflect the degree of synergy potential obtainable from interdependencies between projects of different organizational units. In order to be able to identify and exploit these synergy potentials, appropriate coordination mechanisms are required.[624] If synergy potentials are substantial, rather centralized governance structures are preferable.[625] If synergy potentials are low, in contrast, it may become difficult to implement a centralized arrangement due to a lack of buy-in of the relevant stakeholders from different business units. In this case, a decentralized, loosely coordinated arrangement fostering autonomy and responsiveness to local needs may likely be the preferred choice.[626] As described by Hodgkinson, there is a tradeoff between the potential benefits of central planning and the direct and indirect costs incurred:

> "The challenge for the head office is to add sufficient value through planning and control activities to offset direct central costs and the costs inherent in constraining business unit autonomy."[627]

If significant synergy potentials exist between different business units, it is more likely that a large fraction of the total IT project budget is reserved for corporate-wide initiatives. This fosters a centrally controlled, top-down budgeting approach. Moreover, it becomes vital to identify interdependencies as early as possible in the project lifecycle. This has implications on the requirements for appropriate IT demand management arrangements. In this context, IT demand management can accomplish important coordination tasks between the business units and the IS function. In case company C6, for example, the demand managers were explicitly instructed to conduct feasibility studies and to check if a given project depended on other projects. The interviewee described this arrangement as follows:

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622 Milgrom & Roberts, 1995, p. 190.
623 Cf. Milgrom & Roberts, 1995, p. 190f.
624 Cf. Ross & Weill, 2002, p. 88.
625 Cf. C. V. Brown & Magill, 1998, p. 184f.
626 Cf. Allen & Boynton, 1991, p. 444.
627 Hodgkinson, 1996, p. 250.

> *"There are feasibility statements. If a [business] department submits a proposal to the investment commission, this has to be coordinated with the IT department in advance – this is a task of the client manager: Is this feasible or not? What about the dependencies, for example? Are the resources available? Of course, you need certain skills. [...] This must happen before the project proposal is submitted. And only when it is stated that the feasibility is guaranteed and so on, the investment commission will decide."* (Case C6)

Thereby, certain interdependencies and redundancies can be revealed already during the project specification phase. However, in order to identify unit-spanning interdependencies, it is also important to coordinate directly between the different business units. Here, the governance arrangements installed for IT project portfolio selection play a crucial role.

In case company C4, for example, two structural arrangements had been established in order to identify and address project interdependencies during the project approval process. In the weekly project portfolio management meeting, IT specialists controlled for technical interdependencies. IT projects were conditionally accepted after passing this meeting and could be initiated. However, the projects also needed a final approval of the IT committee in order to proceed. The IT committee met on a monthly basis. In this committee, interdependencies affecting multiple business units were revealed and discussed. The IT architect in case company C4 described the role of the IT committee in this context as follows:

> *"[...] the IT committee may also reveal other interdependencies and ultimately gives the final approval. For example, a project may be planned by a business unit – together with IT – and it may not be noticed that if this project were conducted, this would have serious effects, for example in back-office processing centers and the like, and, therefore, at a different place something also would have to happen. [...] And exactly in this case, the other business unit can cry out in the IT committee and say, 'You cannot do that. [...] We have not made arrangements for that.' "* (case C4)

According to the interviewees, identifying project interdependencies can be a demanding and time-consuming task. Thus, the appropriate design of governance arrangements inter alia depends on the obtainable synergy potentials and on the disadvantages that would result from ignoring these interdependencies.

A high level of interdependence also poses specific requirements on the governance arrangements for IT resource management. The process of assigning resources to projects can be complicated by resource interdependencies. Such interdependencies arise when two or more projects depend on the same resources.[628] As described in section 4.5.5, resources might in general be organized in centralized pools, in independent decentralized departments, or in matrix structures. If certain key resources are required by several IT projects proposed by different business functions, conflict resolution is required. This task can be facilitated by a prioritization of projects during the project portfolio selection phase. The head of IT governance in case company C4 described this task as follows:

> *"The critical task [of the IT committee] is to prioritize resources, for example in the finance area, which is a typical technical bottleneck. All projects, or at least a variety of projects, interfere with the booking logics. Therefore, corresponding support services must be provided by experts from the finance area. And - because they are scarce - they are subject to a certain prioritization."* (Case C4)

In order to assign scarce experts to high-priority projects, it is important to have a complete overview of the projects requiring these resources. A potential way to gain this overview and to coordinate between the existing projects is to establish a corporate-wide skill management position like in case company C5.

Resource constraints ideally should already be considered when projects are selected. Else, projects included in the IT project portfolio later might have to be postponed due to resource constraints. This may result in a suboptimal project portfolio. In order to address this issue, in case company C4, for example, project resources had to be requested already during the project preparation phase, based on skill-profiles. The project managers[629] and the project staff had to be named in the project proposal before the project could be approved. Thereby, resource conflicts already became visible in an early planning stage and appropriate measures could be taken in order to resolve these conflicts or to replace the project.

The impact of project interdependencies is one of the key topics covered in the IT project portfolio management discipline.[630] Different types of interdependencies have been analyzed in the relevant literature.[631] Cho & Shaw have investigated the impact of different types of IT

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[628] Also compare Kundisch & Meier, 2011a, 2011b.

[629] In this company, projects are generally led by a functional project manager and an IT project manager.

[630] In the relevant literature, the terms *interdependency* and *synergy* are often treated synonymously. Here, in contrast, project interdependencies are considered as a condition while synergies are perceived as a potential consequence of this condition. Synergy potentials are exploited by taking account of interdependencies.

[631] Cf. Bardhan et al., 2004; Kundisch & Meier, 2011a, 2011b; J. W. Lee & Kim, 2000, 2001; Santhanam & Kyparisis, 1995, 1996; Wehrmann et al., 2006.

synergies between “IT units”[632] on IT portfolio selection, based on the theory of complementarities.[633] In this context, Cho & Shaw also make use of the concept of cross-unit synergy introduced by Tanriverdi & Venkatraman.[634] Tanriverdi describes cross-unit IT synergies as follows:

> “[…] firms whose business units operate in different industries have an opportunity to exploit cross-unit **IT synergies** by applying their IT resources and management processes across multiple units.”[635]

Cho & Shaw view IT synergy “as a choice of a firm to achieve an optimal portfolio.”[636] From this perspective, IT synergy can be perceived as an option that can be leveraged by employing appropriate governance arrangements. Consequently, synergies are not only an input to but also an outcome of IT project portfolio management. While synergy potentials represent a contingency factor with regard to the design of IT governance arrangements, the synergies finally obtained from the selected IT project portfolio are a consequence of IT project portfolio management and depend on the chosen governance arrangement.[637] Consequences of the use of different governance arrangements for IT project portfolio management will be discussed in the following section.

4.5.7 Consequences

In this section, consequences of the use of alternative governance arrangements for IT project portfolio management are discussed. First, the advantages and disadvantages of centralized, decentralized, and federal governance arrangements are briefly summarized in the particular context. Second, four different outcome categories concerning the impact of different governance arrangements are presented and described.

During the case studies, the elicitation of advantages and disadvantages of distinct governance arrangements was favored by the fact that most interviewees had witnessed several different governance arrangements in recent years. Thus, they were able to compare the current arrangement to former alternative designs. Table 12 summarizes general advantages and

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[632] Cho & Shaw use the generic term “IT unit” and state: “The decision unit in our study can be any IT investment unit, but the main focus of our study lies on the allocation problem that matters for CIOs or senior IT managers.” (Cho & Shaw, 2009a, p. 2). This may apply to IT projects, applications, as well as IT investment budgets.
[633] Cf. Cho & Shaw, 2009a, p. 1.
[634] Cf. Tanriverdi & Venkatraman, 2005; Tanriverdi, 2006.
[635] Tanriverdi, 2006, p. 57.
[636] Cho & Shaw, 2009a, p. 4.
[637] As explained by Child in the context of organizational theory, performance in general is an input as well as an outcome of the organizational design (cf. Child, 1972, p. 11).

disadvantages of centralized, decentralized and federal structures identified during the case study analysis.

Table 12: Advantages and disadvantages of different governance arrangements for IT PPM[638]

	Centralized	Decentralized	Federal
Advantages	• Synergies • Economies of scale • Support of strategic projects	• Acceleration of decision-making • Rapid implementation of small, local projects • Customer proximity / direct dialogue	• Workload reduction for central decision makers • Balance between synergy and autonomy • Broad consensus between different stakeholders
Disadvantages	• Bureaucratic overhead • Impediment of small, local projects • Potential conflicts between different stakeholders	• Impediment of corporate-wide projects • Resource shortage and budget overruns in the absence of coordination • Redundancies	• Unclear responsibilities • Delays in the decision-making process • Bad compromises

The advantages and disadvantages displayed in Table 12 match the advantages and disadvantages described in the general IT governance literature in section 2.2.2 to a high degree, but are more specific to the field of IT project portfolio management.

It is important to note that these advantages and disadvantages do not apply exclusively to one field of activity but depend on the combination of governance arrangements in the different fields of activities. For example, redundancies can be avoided either by filtering for redundant proposals via demand management or by controlling for redundant proposals via centralized IT project portfolio selection. The linkages between the different fields of activities need to be taken into account. Especially, governance arrangements for IT budget allocation and IT project portfolio selection have to be aligned. In addition, the available human resource capacity should be reflected in the budgets. Thus, in practice it is important to assess the governance arrangements for all four fields of activities simultaneously.

Based on a thorough analysis of the effects reported by the interviewees, the following four general outcome categories concerning the impact of different governance mechanisms for IT project portfolio management were derived:

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[638] Based on Frey & Buxmann, 2011, p. 9.

- Project portfolio balance
- Speed of decision-making and implementation
- Stakeholder satisfaction
- Use of synergies

These categories provide a means to investigate the outcomes of IT project portfolio management at an aggregated level. The four categories are described in the following subsections.

4.5.7.1 Project portfolio balance

The problem of unbalanced portfolios with too many small, short-term projects and too few major, long-term projects has frequently been discussed in the project portfolio management context, particularly in the new product portfolio management literature.[639] Markowitz's modern portfolio theory provides the theoretical foundation for research on portfolio balance.[640]

With specific regard to IT project portfolio management, already in 1981, McFarlan introduced a framework for assessing IT project risks both at the level of the single project as well as at the portfolio level.[641] However, risk is not the only dimension of portfolio balance. Balance is also required, for example, between large and small projects, between strategic and non-strategic projects and between local projects and corporate-wide projects.

Meskendahl describes the "portfolio balance" concept in more detail. He states that there is no consensus on the dimensions along which portfolios should be balanced.[642] Different dimensions have been proposed by different authors. Inter alia, the following dimensions have been discussed in the literature:[643]

- project type
- project size
- risk level
- project duration and schedule
- short-term benefits versus long-term benefits[644]

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[639] Cf. R. G. Cooper et al., 1999, p. 351, 2000, p. 23.
[640] Cf. Meskendahl, 2010, p. 809.
[641] Cf. McFarlan, 1981.
[642] Cf. Meskendahl, 2010, p. 809.
[643] Cf. Meskendahl, 2010, p. 809.
[644] This dimension is in particular emphasized in the new product development literature.

These dimensions are interdependent and therefore, should not be regarded in isolation.[645] For example, McFarlan notes that project risk is influenced by project size, project structure and the experience with the required technology.[646] Consequently, a project portfolio has to be balanced along several dimensions.

According to the interviewees, obtaining a good balance of the IT project portfolio has a great impact on portfolio performance. Consequently, several companies aimed at an active control of the configuration of the project portfolio. These companies in particular tried to increase the fraction of projects with high strategic impact. In order to reach this objective, a large fraction of the IT budget was reserved for large, corporate-wide projects. These funds were typically controlled by corporate-wide decision-making committees, composed of top managers and high-ranking business representatives.

In general, the investigated cases revealed that the governance arrangements installed for IT budget allocation, IT demand management, and IT project portfolio selection can have a strong effect on the composition of the corporate IT project portfolio. If IT project budgets are managed independently at a business unit level, typically many small local projects are conducted at the expense of large unit-spanning projects with considerable synergy potentials.[647] In contrast, a top-down budget allocation approach based on strategic considerations, fosters a better balance of the corporate-wide IT project portfolio. In particular, the relation between small unit-specific projects and boundary spanning projects and programs can be actively controlled in such an arrangement. In case company C6 for example, more than half of the total IT investment budget was dedicated to large, strategic projects. Another way of dealing with related projects and of actively balancing the portfolio is to distribute the available budget to different strategic fields of actions and to select and manage projects according to these fields of actions.[648] This approach was adapted for example by case company C3.

An active control of the portfolio configuration is particularly fostered by the implementation of centralized governance arrangements. In decentralized and federal arrangements, in contrast, interviewees reported that it often becomes difficult to launch corporate-wide projects as managers in different business units have to be convinced in order to gain the

645 Cf. Meskendahl, 2010, p. 809.
646 Cf. McFarlan, 1981, p. 143.
647 Typical examples for such strategic projects are platform projects as well as projects concerning large integrated information systems.
648 This approach corresponds to the “strategic buckets” approach described by R. G. Cooper et al. in the R&D and new product management context (cf. R. G. Cooper et al., 1999, p. 335).

required funds and commitment. Consequently, in such arrangements it becomes more difficult to balance the IT project portfolio.

4.5.7.2 Speed of decision-making and implementation

Timely decision-making and implementation can be of vital importance in order to meet objectives and exploit opportunities.[649] As noted in section 4.5.6.2, high speed of reaction is in particular required in dynamic environments, which demand for operating responsiveness.[650] Moreover, as information technology supports structural responsiveness, i.e. "the capabilities of an organization to change itself",[651] fast approval and implementation of IT projects is vital in situations where self-renewal is required as a response to strategic or operational changes.[652]

In the investigated companies, interviewees emphasized the importance of speedy decision-making and project implementation. In general, fast decision-making and speedy project implementation were considered as advantageous, in particular in volatile economic environments.[653] It was emphasized that in such environments, project delays can lead to competitive disadvantages and projects can even become obsolete if they are not implemented in time.

Different organizational designs can increase or limit the speed of decision-making and implementation.[654] In the IT governance context, Allen & Boynton for example state that decentralized ("low road") approaches are more innovative than centralized ("high road") approaches.[655] They attribute this advantage to fast decision-making and speedy implementation and provide the following explanation:[656]

> "Low-road managers needn't wait for committees, councils, standards bodies, advisory groups, impact studies from other divisions, or similar bureaucratic processes."[657]

However, Allen & Boynton also recognize that decentralized arrangements lead to a short-run focus and may impede infrastructure projects due to a lack of attention of local managers.[658]

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[649] Cf. Barnett, 2008, p. 610.
[650] Cf. Ansoff & Brandenburg, 1971, p. B711.
[651] Ansoff & Brandenburg, 1971, p. B711.
[652] Cf. Ansoff & Brandenburg, 1971, p. B712.
[653] Cf. section 4.5.6.2.
[654] Cf. Ansoff & Brandenburg, 1971, pp. B709–B714.
[655] Cf. Allen & Boynton, 1991, p. 438.
[656] Cf. Allen & Boynton, 1991, p. 438.
[657] Allen & Boynton, 1991, p. 438.
[658] Cf. Allen & Boynton, 1991, p. 439.

During the case study interviews, it was also noted that fast decision-making can reduce the decision-making quality.[659] In this context, the importance of active demand management was emphasized. IT demand managers can foster the structured elevation of the required project information and thereby enable decisions that are more informed.

The link between time-related aspects and portfolio performance has already been addressed in a number of empirical contributions. Based on a multiple case study in 36 companies, Thomas et al. infer that “timely decision making” and “timely stopping of projects” are “effective IT project evaluation outcomes”.[660] Moreover, they state that these and other evaluation outcomes are linked with “more efficient use of resources” and “improved IT project outcomes”.[661] However, they do not provide further detail on this link. Acur et al. empirically find that “systematic project portfolio management” has a positive impact on speed of development in the new product portfolio management context.[662] However, they could not empirically establish a direct link between speed of development and new product development program performance.[663] Cooper et al. draw a link between the number of projects in a portfolio and the speed of project realization by arguing that too many projects in the portfolio can lead to a gridlock and thereby may impede the implementation of all projects.[664]

The latter argument is not limited to the product innovation management context but also applies to IT project portfolio management. However, according to several interviewees, not only the number of projects but also the project size and the specific resource demands have an impact on potential gridlocks. At the project portfolio level, time-related aspects become more complex than at the single project level due to interdependencies between the projects and conflicts of interests between the stakeholders involved. For example, top management intervention may lead to the acceleration of some projects, but at the same time may impede other projects and may lead to negative long-term effects due to “relationship-based role conflicts”.[665]

Summarizing, the chosen governance arrangements can have a significant impact on the speed of decision-making and project implementation. However, this effect strongly depends on the nature of the projects under consideration. Decentralized arrangements tend to foster the

[659] Cf. section 4.5.4.2.
[660] Cf. Thomas et al., 2007, p. 4.
[661] Cf. Thomas et al., 2007, p. 6.
[662] Cf. Acur et al., 2010, p. 924.
[663] Cf. Acur et al., 2010, p. 924.
[664] Cf. R. G. Cooper et al., 1999, p. 344.
[665] Cf. Jonas, 2010, p. 825f.

speedy implementation of smaller projects while centralized arrangements allow for effective resource provisioning to large, unit-spanning projects.

4.5.7.3 Stakeholder satisfaction

A high level of satisfaction with respect to the existing governance arrangements and the outcomes of investment decisions is of fundamental importance, since the implementation of the selected portfolio requires the support of different groups of stakeholders. Stakeholders' dissatisfaction with the chosen portfolio is likely to result in conflicts and political behavior, which in turn may impede the implementation of the selected projects. Stakeholder satisfaction and support, in contrast, can have positive long-term effects on portfolio performance.[666] Therefore, early stakeholder involvement and buy-in in the portfolio management processes are desirable.[667] In several case companies, broad acceptance of the chosen governance arrangement was reported as a precondition for long-term success.

As noted in section 4.5.6.4, the IT project portfolio management context is particularly susceptible to conflicts between different internal stakeholders. Project stakeholders in general tend to act in a self-interested way and the relationship between middle management and top management is often complicated by intra-organizational agency problems arising from goal conflicts and information asymmetries between different organizational levels.[668] If not resolved, these agency problems can lead to the inclusion of underperforming projects into the portfolio.[669] As stated by Jonas, "[…] there is the risk that rivalry between multiple powerful projects negates advantages for a single project by drawbacks through poor PPM performance."[670] The resolution of such conflicts, on the other hand can cause significant agency costs due to monitoring expenditures and bonding costs.[671] Therefore, it is important that the chosen governance arrangements do not lead to severe stakeholder resistance. If influential stakeholders are dissatisfied with a given governance design, it is likely that these stakeholders will resist project implementation and the governance design will be aborted in the long run, due to a lack of support.[672] This effect was reported by several interviewees in the course of the current study.

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[666] Thomas et al., for example, consider "reduced politics" as an "effective IT project evaluation outcome" (Thomas et al., 2007, p. 6).
[667] Cf. Levine, 2005, p. 259.
[668] Cf. El Arbi et al., 2012, p. 6.
[669] Cf. El Arbi et al., 2012, p. 7.
[670] Jonas, 2010, p. 824.
[671] Cf. Jensen & Meckling, 1976, p. 308.
[672] Cf. Phillips & Bana e Costa, 2007, p. 51.

Particularly in companies with a strong culture of autonomy, there was typically considerable skepticism concerning the adoption of centralized, formalized governance arrangements. In a number of cases, the introduction of such arrangements had led to a conflictive atmosphere and a failure of reorganization initiatives. In case company C4, for example, a new approach to IT project portfolio selection had recently been introduced by the IS function. Business unit managers initially welcomed the new approach, but some business units were later displeased with changes induced by the process. This led to conflicts and, according to the two interview partners, the initiative was finally undermined by the business units. In consequence, the new planning process was abandoned and the company reverted to a rather informal arrangement similar to the one existing before the reorganization.

Other companies, in contrast, were able to convince the relevant stakeholders of the advantages of more centralized governance arrangements. The CIO in case company C1, for example, reported that there is a large degree of consent that the current governance arrangement fosters the exploitation of synergies and, therefore, is preferable to the former arrangement. The current arrangement had been in place for several years and the interviewee noted an increase in the number of strategic projects. Still, the transition process took a long time and it required a huge effort to convince the stakeholders in the different business units of the preferability of the new arrangement.

Peterson et al. conceptualize stakeholder satisfaction as one of three indicators of IT performance constituting an outcome of the IT governance design in general.[673] They operationalize the satisfaction of IT governance stakeholders in terms of "Satisfaction with responsibilities, decision making, communication, participation, collaboration, and IT achievements".[674] Based on the results of a case study in six large, multi-divisional firms in the Dutch financial services industry, Peterson et al. conclude that it is vital to account for stakeholder interests when designing governance arrangements.[675] In this context, compliance with stakeholder interest is a contingency factor as well as a consequence of the design of governance arrangements.[676] Consequently, governance arrangements should be designed in such a way that stakeholder resistance is avoided or can be mitigated.

[673] Cf. Peterson et al., 2000, p. 438.
[674] Peterson et al., 2000, p. 450.
[675] Cf. Peterson et al., 2000, p. 446.
[676] Stakeholder interests as a contingency factor have been discussed in the context of "organizational culture and politics" in section 4.5.6.4.

4.5.7.4 Use of synergies

As noted in section 4.5.6.7, synergy is an input to as well as an outcome of IT project portfolio management. Synergy as an outcome affects portfolio success as well as firm performance. Tanriverdi, for example, identifies the exploitation of cross-unit IT synergy as a performance indicator at the corporate-wide level.[677] He empirically investigates the impact of the IT governance mode[678] as a moderating effect between cross-unit IT synergy and firm performance.[679] Although this moderating role of the IT governance mode is not supported in Tanriverdi's study, the data reveals that IT synergy is exploited to the largest degree in firms using a centralized governance mode.[680] Similarly, Milgrom & Roberts formally show, based on the theory of complementarities, that a lack of coordination between decentralized managers in the presence of complementarities leads to systematic under-responsiveness to environmental changes and failure to make use of common payoff potentials.[681]

During the interviews, the importance of synergies in the context of IT project portfolio management was frequently highlighted. By exploiting synergy potentials, project benefits can be increased and costs can be reduced. The degree, to which synergy potentials are utilized, largely depends on the governance arrangements installed in the four fields of activities. In the budgeting field of activity, for example, synergies can be exploited by assigning a large fraction of the total budget to centralized decision-making authorities such as cross-functional investment committees. In the demand management field, an active intercommunication between the demand managers responsible for different business units can reveal cross-unit interdependencies.[682] In general, demand management plays a vital role in identifying interdependencies, redundancies, and resource bottlenecks.

In order to exploit synergy potentials, the identified interdependencies also have to be taken into account during IT project portfolio selection. This requires a high degree of coordination, which is in particular effectuated by installing centralized arrangements for IT project

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[677] Cf. Tanriverdi, 2006, p. 58.

[678] In this study, the IT governance mode is operationalized in terms of a centralized, decentralized, or hybrid locus of decision-making authority (cf. Tanriverdi, 2006, p. 64).

[679] Cf. Tanriverdi, 2006, p. 72.

[680] Cf. Tanriverdi, 2006, p. 73. It is important to note that in Tanriverdi's study, IT synergy is measured in terms of the combined relatedness of "IT Strategy-Making Processes", "IT Relationship Management Processes", "IT Human Resource Management Processes", and "IT Infrastructure" between different business units (cf. Tanriverdi, 2006, p. 65). This concept of synergy is only partly conferrable to the IT project portfolio management context. In the latter case, cross-unit IT synergy in particular results from interdependencies between IT projects. Therefore, the findings cannot be conferred without limitations. Nevertheless, Tanriverdi's study provides important theoretical backgrounds for further research on the impact of IT synergy in the context of IT project portfolio management.

[681] Cf. Milgrom & Roberts, 1995, p. 187.

[682] Cf. section 4.5.3.1.

portfolio selection.[683] In companies where projects are selected locally to a large degree, in contrast, significant synergy potentials can get lost. A potential counter-measure consists in installing a cross-functional committee in order to look for synergy potentials and to reduce conflicts in the portfolio of selected projects.[684]

Research on synergies has long been conducted in the corporate strategy and finance literature with a strong focus on corporate diversification (through mergers and acquisitions).[685] In the IT project portfolio management domain, in contrast, the focus lies on the recognition and exploitation of interdependencies in the project landscape of a particular company. Cho & Shaw, for example, state that they "[…] view IT synergy as a choice of a firm to achieve an optimal portfolio."[686] According to this conception, IT synergy can be gained by considering complementarities between "IT investment units":

> "IT synergy refers to additional return that a firm can achieve from multiple IT investment units, which cannot be obtained from stand-alone individual units."[687]

In the existing literature concerned with performance effects of portfolio management practices, "use of synergies" has been identified as an important component of project portfolio success.[688] However, two important aspects should be taken into account in this context:

1. The existence of project interdependencies provides an option to exploit synergistic effects. However, these synergies are not gained automatically. Interdependencies lead to increased complexity and, therefore, appropriate governance mechanisms for IT project portfolio selection are required in order to exploit IT synergies.[689]
2. In addition to interdependencies with positive effects, there are also interdependencies in the form of duplications and redundancies. The nonobservance of such interdependencies can lead to negative synergistic effects.[690]

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[683] Cf. section 4.5.4.2.
[684] Such an arrangement had recently been introduced in case company C4 (cf. section 4.5.6.7).
[685] Cf. Cho & Shaw, 2009a, p. 3.
[686] Cho & Shaw, 2009a, p. 4.
[687] Cho & Shaw, 2009a, p. 4.
[688] Cf., e.g., Meskendahl, 2010; Teller et al., 2012; Voss & Kock, 2012.
[689] In alignment with this statement, Teller et al. and Voss & Kock comprehend interdependencies as a dimension of portfolio complexity, constituting a moderating factor, while they comprehend synergy as a success factor (cf. Teller et al., 2012; Voss & Kock, 2012).
[690] Cf. Kundisch & Meier, 2011a. In this context, Kundisch & Meier use the terms "competitive interactions" and "complementary interactions".

In order to understand the impact of different kinds of synergistic effects, typologies of interdependencies are useful. Such typologies will be discussed in the following chapter in section 5.2.2.

4.6 Integration of findings

Figure 19 displays an overview of the fields of activities, contingency factors, and consequences discussed in in the preceding findings section. The contingency factors influence the choice of structural, procedural, and relational arrangements in the four fields of activities in various ways. These effects are often combined. Therefore, only the general relationship between contingency factors and governance arrangements is depicted in Figure 19. Likewise, the outcome effects of different governance arrangements are also depicted at an aggregated level. This conception follows the "extended configurations hypothesis" introduced by Mintzberg, implying that "effective structuring requires a consistency among the design parameters and the contingency factors".[691] Consequently, it is assumed, that the choice of a particular governance design cannot be attributed to a single contingency factor but depends on the combination of contingency factors.[692] Moreover, the chosen governance design might also exert an influence on the contingency factors, resulting in an "interactive system".[693] For that reason, general predictions concerning the impact of individual contingency factors on the design of governance arrangements have to be handled with care. Nevertheless, in Appendix G, potential impacts of the different contingency factors on the design of governance arrangements employed for the four different fields of activities are briefly summarized in table form. This table reflects relationships identified during the case study analysis.

[691] Mintzberg, 1980, p. 328.

[692] Cf. Sambamurthy & Zmud, 1999. For this reason, only a single common relationship has been drawn between the contingency factors and IT governance arrangements for IT project portfolio management in Figure 19.

[693] Cf. Mintzberg, 1980, p. 328. Consequently, the arrow between the contingency factors and the governance arrangements points in both directions.

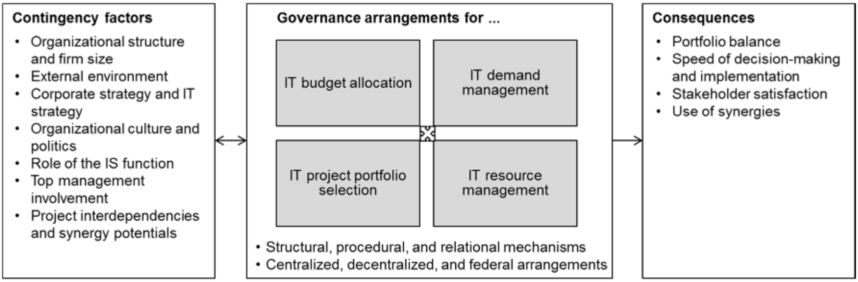

Figure 19: A contingency model for IT project portfolio management governance

Due to the explorative nature of the study at hand, it is advisable to conduct a theoretical integration by relating the findings to existing theories, concepts, and contributions. Related concepts and contributions have already been discussed throughout the previous section. In Appendix H, the identified contingency factors are related to existing theories and concepts in table form. Objects of study covered by these theories are also listed in this appendix in order to foster an operationalization. Moreover, several references are provided for each contingency factor. These references relate to articles covering the theoretical foundations as well as to contributions applying the respective theories to the IT governance and the IT project portfolio management context. Likewise, in Appendix I, the identified outcome categories are mapped to existing theories and related contributions.

4.7 Summary and limitations

The qualitative study described in this chapter has revealed current governance practices for IT project portfolio management as well as the underlying contingency factors. Moreover, consequences of the use of different governance arrangements have been discussed. First, four distinct but related fields of activities in the wider context of IT project portfolio management were described:

- IT budget allocation
- IT demand management
- IT project portfolio selection
- IT resource management

It has been demonstrated that these fields of activities can be governed in quite different ways. However, the governance arrangements employed need to be aligned to each other and to a number of contingency factors. In particular, the following contingency factors were identified in the course of the study:

- Organizational structure and firm size
- External environment
- Corporate strategy and IT strategy
- Organizational culture and politics
- Role of the IS function
- Top management involvement
- Project interdependencies and synergy potentials

The fact that the design of governance arrangements for IT project portfolio management depends on several contingency factors raises a particular concern with respect to the strong orientation on maturity stage models in the IT project portfolio management literature.[694] In previous contributions, aspects like centralized project tracking and monitoring have commonly been considered as a matter of maturity.[695] This may lead to the wrong impression that a high maturity level – including centralized monitoring and control of project proposals – is a desirable state for all firms.[696] As highlighted throughout this chapter, the implementation of new governance arrangements – in particular centralized ones – for IT project portfolio management can lead to serious resistance and frictions. Therefore, it is vital to take account of the organizational context when designing governance arrangements and not to implement "best practices" without considering the given environment. A high maturity level should not be perceived as a sine qua non.

The perception that a contingency perspective is required for portfolio management research has recently gained strong support.[697] Still, many practitioner-oriented contributions take a rather absolute perspective on good portfolio management practices. Some conceptions seem to misdirect portfolio managers to believe that practices effectively applied in one company can easily be transferred to other companies. In this respect, Cooper et al. have noted quite early that "[…] effective portfolio management has proven to be an elusive goal for many businesses."[698] Consequently, is important to reemphasize the appropriateness of a contingent viewpoint on IT project portfolio management.

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[694] Cf. section 3.2.7.

[695] Cf. De Reyck et al., 2005, p. 530; Jeffery & Leliveld, 2004, p. 43.

[696] Maizlish & Handler note that maturity models are only diagnostic (cf. Maizlish & Handler, 2005, p. 46). They also state that "Raising the level of IT project portfolio management should not become the primary issue." (Maizlish & Handler, 2005, p. 46)

[697] Cf., e.g., Ajjan et al., 2008; Blomquist & Müller, 2006; Canonico & Söderlund, 2010; Cubeles & Miralles, 2009; Martinsuo & Lehtonen, 2007; Martinsuo, 2012; Müller et al., 2008; Teller et al., 2012; Xue et al., 2008.

[698] R. G. Cooper et al., 2000, p. 19.

However, a contingency perspective on project portfolio management does not imply that research on effective portfolio management practices is pointless. Rather, it is important to acknowledge the existence of contingencies and to identify rules and relationships that are broadly applicable. This has long been recognized in the IT governance literature as exemplified in the following statement of Allen & Boynton:

> "All organizations are different, and there can be no solution that will be ideal for everyone, but there are general rules that everyone can follow."[699]

From the study presented in this chapter, we learn that the appropriateness of different structural, procedural, and relational mechanisms is dependent on the given context. In order to characterize the governance arrangements in the different case companies, the concept of centralization/decentralization has been used. The advantages and disadvantages of centralized, decentralized, and federal arrangements encountered in the context of IT project portfolio management largely resemble the general advantages and disadvantages discussed in the IT governance literature. Centralized arrangements foster efficiency, synergies, and economies of scale but may lead to conflicts due to a low degree of autonomy in local units. Decentralized arrangements, in contrast, leave autonomy to the decentralized units and thereby foster rapid implementation of local changes and close personal relationships between business and IT. At the same time, decentralized arrangements usually lead to redundancies and a low use of synergy. Federal arrangements allow for balancing the interest of centralized and decentralized decision makers but quickly become complex, inefficient and tend to lead to bad compromises.

A particular finding related to the IT project portfolio management context is the recognition that certain governance arrangements foster specific kinds of projects. For example, arrangements with a high degree of centralized control tend to result in a relatively high number of large, strategic, long-term projects. These projects promise high corporate-wide benefits but are often also more risky than small, local initiatives. Decentralized arrangements, in contrast, foster the speedy implementation of small projects. In order to avoid conflicts, the chosen IT project portfolio must comply with diverging requirements of different stakeholders at different organizational levels. At the same time, synergy potentials should be taken into account during IT project portfolio selection.

Based on these recognitions, the following general outcome categories were identified in the course of the study:

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[699] Allen & Boynton, 1991, p. 444.

- Project portfolio balance
- Speed of decision-making and implementation
- Stakeholder satisfaction
- Use of synergies

The prevalence of interdependencies between different projects and the synergy potentials obtainable from these interdependencies are key research topics in the IT project portfolio management domain.[700] As illustrated in the previous sections, centralized arrangements offer great potential to gain synergies from interdependencies between projects of different local units. However, centralized arrangements are often difficult to establish, due to a claim of autonomy of local stakeholders. In many companies, one can witness a constant fight between local business unit managers trying to maintain their budget autonomy and centralized governance experts trying to introduce corporate-wide formalized arrangements in order to coordinate between the different units. These two key topics discussed throughout this chapter, namely centralization of decision-making competency and exploitation of synergy potentials also provide the background for the research presented in the following chapter.

However, before commencing to the following chapter, it is important to note a number of limitations applying to the current study. The following aspects should be considered when interpreting the foregoing results:

- As the current study was limited to ten cases, the generalizability of the findings is also limited to a certain degree. Lack of generalizability is a common criticism of case study research.[701] However, the advantage of case study research is that a phenomenon can be investigated "[...] in depth and within its real-life context [...]",[702] as demonstrated in this chapter. For the current study, inference was mainly conducted via replication. As the study was of strong explorative nature, no rival explanations[703] were developed in advance. However, the findings were theoretically integrated with existing literature ex post as an alternative way of increasing the generalizability. Still, it should be mentioned that the identified contingency factors and outcome categories might not be exhaustive.

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[700] Cf. section 3.2.3.2.
[701] Cf. Kaiser & Buxmann, 2011, p. 7.
[702] Yin, 2009, p. 18.
[703] Cf. Yin, 2009, pp. 133–135.

- Only a single interview partner was consulted in nine of the ten investigated case companies. This can be considered as an additional limitation. In particular, the circumstance that all interview partners were from the IT domain leads to a particular focus on the IT perspective. The business perspective, in contrast, was not directly taken into account. While the descriptions of the structural and procedural mechanisms provided by the interviewees nevertheless are perceived to be accurate and reliable, as they were triangulated with internal and external documents, the advantages and disadvantages reported by the interviewees, in contrast, are of subjective nature and, therefore, have to be interpreted with care. In this context, the constant comparison of the cases as well as the integration with existing literature were important measures in order to address issues of validity and reliability. Still, an investigation of the perceptions of business unit representatives would be a valuable complement to the current study.
- A third limitation results from the use of the concept of centralization and decentralization in this chapter. The meaning of the term "centralization" strongly depends on the unit of analysis. In companies composed of several subsidiaries, a problem of boundary definition arises.[704] In order to address this issue, the organizational structures of the investigated firms were analyzed in advance of the interviews, based on publicly available information. Moreover, the interviewees were asked for a detailed description of the organizational structure and for their perception of the term "centralization" in the given context. In addition, most of the interviewees had formerly witnessed different governance arrangements and therefore were able to compare the current arrangement with previous arrangements. Still, the classification of centralized, decentralized, and federal governance arrangements is not sharp. Therefore, much emphasis has been put on detailed descriptions of the governance arrangements.[705]

Despite these limitations, the current study provides significant insights into the governance mechanisms employed for IT project portfolio management in practice and into the general relationships between different governance arrangements and outcomes at the portfolio level. These insights are also an important foundation for a formalized modeling of decision-making arrangements, which is presented in the following chapter.

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[704] Cf. Child, 1972, p. 9f.
[705] Cf. Appendix F.

5 The impact of different governance arrangements on IT project portfolio selection outcomes – A quantitative modeling approach and simulation studies

In this chapter, the impact of different governance arrangements on the outcomes of IT project portfolio selection are simulated and assessed based on a quantitative approach. The general conception underlying the approach is inspired by the results of the qualitative study described in the previous section. The objective in this chapter is to develop a more formal conception of governance arrangements in IT project portfolio management in order to illustrate and survey the contingent effects of different degrees of interdependency within the project landscape.

The structure of this chapter is as follows: First, a brief motivation is given in section 5.1. The problem background for the following research is discussed in section 5.2. In section 5.3, related contributions are presented and compared to the current work. A general conception for the following studies and a formal decision model are introduced and illustrated in section 5.4. In section 5.5, a computational study of the impact of different kinds of interdependencies in centralized and decentralized decision-making arrangements is conducted. An alternative model based on efficient frontiers is introduced in section 5.6. Finally, section 5.7 contains a summary and a discussion of limitations.

5.1 Motivation

In the previous chapter, it has been argued that different governance arrangements for IT project portfolio management may prove to be more or less efficient in a given company, depending on a number of contingency factors. As governance arrangements are not entirely static, but can be adjusted to the given context to a certain degree,[706] the analysis of the performance effects of alternative governance arrangements in different contexts is a relevant and important endeavor. In the following, a generic coordination mechanism for IT project portfolio management is formally modeled in order to provide a framework for quantitative analyses of the impact of the use of different governance arrangements. Based on this research, IT governance experts shall be supported in understanding the general tradeoffs associated with alternative governance choices in different contexts. A quantitative

[706] For example, existing IT structures and governance arrangements are often revised in the course of major strategic shifts (cf. Bergeron et al., 2004, p. 1015; Chan & Reich, 2007b, p. 312). However, changes in governance arrangements for IT project portfolio management may also be triggered without larger organizational changes, for example due to management replacement and smaller renewal initiatives.

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assessment of the benefit potentials of different governance designs is of high practical relevance as it can lead to more objective and more rational choices in a rather political environment.

As illustrated in section 4.5.6, a variety of contingency factors influences the optimal design of governance arrangements. Inter alia, numerous social factors exert an influence on the structural, procedural, and relational mechanisms employed. In the following, not all identified contingency factors will be addressed. Rather, it is focused on factors that can formally be assessed in order to objectify debates on appropriate governance designs in a given organizational context. Particularly the degree of synergy obtainable in different governance arrangements lends itself to a formal analysis. Other factors – for example social aspects like stakeholder resistance and political agendas – can better be assessed with qualitative instruments. Hence, these factors are not incorporated into the formal model.

As the degree of synergy exploitation primarily is a consequence of IT project portfolio selection, this field of activity will be the focus in this chapter. Consequently, the following investigations will particularly address the impact of the governance arrangement employed for IT project portfolio selection on the exploitation of synergy potentials.

5.2 Problem background

Two major themes provide the problem background for the research in this chapter. First, the impact of different degrees of centralization in the IT project portfolio selection context is formally investigated. The concept of centralization and decentralization has already been introduced in section 2.2 in the general IT governance context and has been used as an underlying concept throughout the preceding chapter. In section 5.2.1, this concept is recapitulated and discussed against the specific background of synergy exploitation via IT project portfolio selection. Consequently, the second main theme in this chapter are interdependencies between IT projects and the synergy potentials arising thereof. Interdependencies have already been briefly addressed in section 3.2.3.2 and synergy potentials have been discussed throughout the preceding chapter. In section 5.2.2, now, interdependencies will be examined in more detail and will be linked to the particular context of IT project portfolio selection in different organizational designs.

5.2.1 Centralized, decentralized, and federal arrangements for IT project portfolio selection

The concept of centralization and decentralization is an overarching topic in this dissertation. In this section, this concept is discussed in the particular context of IT project portfolio selection in order to provide a background for the following investigation of synergy exploitation in different governance arrangements.

In the context of IT project portfolio selection, a main advantage of centralized IT governance arrangements lies in their support of a corporate-wide perspective on IT investments.[707] Accordingly, the major disadvantage of decentralized arrangements is that the corporate perspective is often not taken into account by the decentralized units. In particular, middle managers "[…] act in a decentralized manner and are assumed to optimize the objectives of an organizational subsystem, such as their department or function."[708] This local optimization is typically in conflict with the corporate-wide objectives. As stated by Tanriverdi, "[...] the center seeks to maximize corporate performance" while "[...] business units seek to maximize their own performances."[709] Similarly, Von Simson notes that "A centralized IS department can see beyond the sometimes parochial objectives of different departments or business units […]."[710] In contrast, splitting resources between different organizational units usually leads to suboptimal results.[711] An extreme case of completely decentralized control for IT project portfolio selection can probably be described as in the following interview quote presented by Thomas et al.:

> "All IT projects are not formally evaluated. IT budgets are distributed (not centralised) and Business Units have a fair degree of autonomy about how they spend this money. Project sponsors can initiate a project without any formal documentation no matter what the value is. It is not clear what constitutes an IT project. There are no consistent, controlled, uniform procedures and no centralised governance."[712]

Such completely decentralized arrangements are rather the worst case in respect to corporate-wide synergy exploitation. In contrast, many companies have installed more centralized governance arrangements for IT project portfolio selection in order to take account of corporate-wide objectives and to exploit synergy potentials.[713] In particular, combinations of centralized and decentralized decision-making in federal structures are very common in practice.[714]

Different organizational levels are typically involved in IT project portfolio selection and often divisional as well as enterprise-wide portfolios coexist.[715] As recognized during the case

[707] Cf. Weill & Ross, 2004, p. 8.
[708] Beringer et al., 2012, p. 19.
[709] Tanriverdi, 2006, p. 60.
[710] Von Simson, 1990, p. 162.
[711] Cf. Phillips & Bana e Costa, 2007, p. 52.
[712] Interview quote adopted from Thomas et al., 2007, p. 8.
[713] Examples for different governance designs for IT project portfolio selection are provided in section 4.5.4.
[714] Cf. section 4.5.4.3.
[715] Cf. Young et al., 2012, p. 890. Also compare section 4.5.4.

study research, in such federal decision-making arrangements projects are often independently approved by decision makers and committees at different organizational levels. For this purpose, individual IT investment budgets are allocated to the different units.

The different kinds of decision-making arrangements outlined above and the underlying coordination mechanism will be modeled and analyzed in this chapter. In particular, the impact of the chosen governance mode on synergy exploitation will be investigated in detail.

5.2.2 IT project interdependencies and synergies

Project interdependencies and synergies are a reoccurring topic in the project portfolio management literature and are in particular considered as a characteristic feature of IT project portfolios.[716] Numerous IT project portfolio selection approaches that account for project interdependencies have been introduced.[717]

In previous contributions, three different kinds of interdependencies between IT projects have typically been distinguished:[718]

- Benefit interdependencies
- Resource interdependencies
- Technical interdependencies

Benefit interdependencies are present if two or several projects implemented in the same portfolio together yield higher or lower benefits than the sum of the individual benefits.[719] For example, the implementation of an automated solution used to speed-up warehouse processes can yield valuable data that can also be used in order to increase the benefits gained from a business intelligence project.

Resource interdependencies relate to the impact of the implementation of one project on the resource requirements (in terms of funds, human resources, hardware, etc.) of another project.[720] For example, the implementation of a project management suite in combination with a portfolio management solution can lead to significant cost savings as the same hardware platform can be used and discounts can be negotiated with the software vendor.

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[716] Cf. section 3.2.3.2.

[717] E.g. Angelou & Economides, 2008; Bardhan et al., 2004; Klapka & Pinos, 2002; Kundisch & Meier, 2011b; J. W. Lee & Kim, 2000, 2001; Santhanam & Kyparisis, 1995, 1996.

[718] Cf. Eilat et al., 2006, p. 1027; J. W. Lee & Kim, 2000, p. 368, 2001, p. 112; Santhanam & Kyparisis, 1995, p. 808, 1996, p. 383.

[719] Cf. Eilat et al., 2006, p. 1027; J. W. Lee & Kim, 2000, p. 368, 2001, p. 112; Santhanam & Kyparisis, 1995, p. 808, 1996, p. 383.

[720] Cf. Eilat et al., 2006, p. 1027; J. W. Lee & Kim, 2000, p. 368, 2001, p. 112; Santhanam & Kyparisis, 1995, p. 808, 1996, p. 383.

Technical interdependencies between projects exist if one project requires the results of another project in order to be implemented.[721] For example, in order to implement services in a service-oriented architecture, a platform like an enterprise service bus is required. Therefore, the platform project has to be implemented before services can be deployed.

Benefit and resource interdependencies are often described as positive, complementary relationships between projects.[722] However, benefit and resource interdependencies can also have negative effects leading to sub-additive benefits or super-additive costs if the affected projects are implemented together. In such cases, there is a competitive relationship between the projects involved.[723]

Competitive interdependencies may be caused in particular by redundancies between projects in multi-project environments. Redundant IT projects and IT applications are common problems in large, complex, and distributed organizations.[724] In particular, autonomous business units in companies operating in different industry segments may cause duplication and thereby increase overall costs.[725] Redundant projects also block resources that could be better used in order to speed up other ongoing projects or to fund additional projects.[726]

Such redundancies can result in negative benefit interdependencies, because the benefit originally attributed to each of the redundant projects cannot be gained in full. Likewise, redundancies can also lead to competitive resource interdependencies as the redundant projects may compete for the same experts. Therefore, it is important to recognize redundancies and to eliminate redundant projects, for example by merging the affected projects into a common project or program. In this case, resources can be saved due to synergistic effects.[727]

Kundisch & Meier have conducted a structured literature review in order to integrate the existing literature on interdependencies and synergies in the IT project portfolio selection

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721 Cf. J. W. Lee & Kim, 2000, p. 368, 2001, p. 112; Santhanam & Kyparisis, 1995, p. 808, 1996, p. 102. Another frequently used term for this kind of interdependencies is “outcome interdependencies“ (cf. Eilat et al., 2006, p. 1027; Killen & Kjaer, 2012, p. 556).

722 Cf. Canonico & Söderlund, 2010, p. 804; J. W. Lee & Kim, 2000, p. 368, 2001, p. 112; Santhanam & Kyparisis, 1995, p. 808, 1996, p. 383.

723 Cf. Killen & Kjaer, 2012, p. 556; Kundisch & Meier, 2011a, p. 484.

724 Cf. Bonham, 2005, p. 26; Legner & Löhe, 2012, p. 5.

725 Cf. Allen & Boynton, 1991, p. 439; Cameron, 2005, p. 2; Tanriverdi, 2006, p. 57f.; Zmud et al., 1986, p. 22.

726 Cf. Cao et al., 2005, p. 370.

727 Cf. Chiang & Nunez, 2009, p. 106; Verhoef, 2002, p. 4.

context.[728] They have analyzed the different kinds of interdependencies covered in this literature and have derived a general typology (cf. Table 13).[729]

Table 13: Typology of interactions[730]

Interaction type	**Interaction effect**	**Constraint effect**
Competitive resource utilization interactions	Costs increase. Due to diseconomies of scale in the resource utilization, additional resources may have to be procured to conduct the related projects.	In case scarce resources may not be made available, such interactions may also inhibit the selection of distinct projects.
Complementary resource utilization interactions	Costs decrease due to economies of scale.	-
Competitive output interactions	Benefits decrease (in the symmetric or asymmetric case).	Restricts the solution space in the mutual exclusive case, otherwise none.
Complementary output interactions	Benefits increase due to economies of scope.	-
Binary contingency interaction	-	Necessitates the selection of distinct projects if related projects are selected.
Continuous competitive contingency interactions	Costs increase.	May inhibit the selection of distinct projects, if related projects are selected.
Continuous complementary contingency interaction	Costs decrease.	-

The interactions described by Kundisch & Meier correspond to the benefit, resource and technical interdependencies illustrated above. For the sake of consistency, the more common terminology of benefit, resource, and technical interdependencies is used in this dissertation. The typology of Kundisch & Meier is of particular interest here, because it takes account of the fact that benefit and resource interdependencies can be of complementary or competitive nature. Moreover, the different effects of different kinds of interdependencies are explicitly described.[731] These effects will be formally modeled and investigated in more detail in subsequent sections.

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[728] Cf. Kundisch & Meier, 2011a.

[729] Note that Kundisch & Meier and some other authors refer to “interactions” instead of “interdependencies”. In this dissertation, the more common term “interdependencies” is used consistently.

[730] Adapted from Kundisch & Meier, 2011a, pp. 482–484.

[731] The typology of Kundisch & Meier is not described in more detail here. Additional descriptions and examples are contained in the respective paper (Kundisch & Meier, 2011a, pp. 482–484).

Another important distinction has to be made between project interdependencies – the distinction between cross-unit and intra-unit interdependencies.[732] The existence of cross-unit interdependencies poses specific requirements on the design of IT governance arrangements for IT project portfolio management. In order to be able to benefit from synergy potentials stemming from cross-unit interdependencies, a centralized view on project candidates and appropriate coordination mechanisms are required.[733]

However, there is often a general tradeoff between the gains stemming from a better exploitation of synergy potentials and the costs and disadvantages associated with establishing centralized decision-making.[734] Therefore, it is vital to assess the potential benefits obtainable in alternative governance arrangements before altering an existing arrangement. Firms tend to adopt a trial-and-error attitude towards IT project portfolio management.[735] This may be a costly approach and may paralyze the organization in the long run. Consequently, a thorough in-advance assessment of the advantages and disadvantages of different governance arrangements can save significant efforts and can help to overcome conflicts.

5.3 Related contributions

A small number of quantitative modeling approaches that deal with the impact of governance designs on outcomes at the project portfolio level have been published in the past. The respective articles will be briefly presented in the following. In this context, the similarities and differences between the approaches described therein and the approach presented in this chapter will be discussed.

Already in 1981, Winkofsky et al. have introduced a decision process model for a hierarchical setting in the context of R&D resource allocation.[736] They model the project portfolio selection process in hierarchical organizations as a level-spanning, iterative coordination process. Decision makers at different organizational levels exchange information about potential project portfolios until the goals defined by the highest organizational level are satisfied. This coordination mechanism is well grounded in theory and reflects important concepts of organizational decision-making – particularly the concept of goal-based coordination. However, the coordination mechanism investigated by Winkofsky et al.

[732] Cf. section 4.5.6.7.
[733] Cf. Canonico & Söderlund, 2010, p. 804; De Reyck et al., 2005, p. 526.
[734] Cf. C. V. Brown & Magill, 1994, p. 372.
[735] Such trial-and-error approaches were reported by several interviewees in the course of the case study described in chapter 4.
[736] Cf. Winkofsky et al., 1981.

significantly differs from the coordination mechanism investigated in the current research.[737] Consequently, the two approaches are not directly comparable but can be seen as complements for different settings.

Stummer & Vetschera are concerned with a "[…] decentralized setting between group members of equal rank, who seek to obtain a fair compromise."[738] The setting is modeled as a cooperative bargaining problem. It is assumed that the different decentralized decision makers cannot specify their preferences in terms of a utility function. Stummer & Vetschera discuss different models (goal programming, proportional goal attainment, proportional resource allocation and an iterative model) that could be used in order to achieve a fair compromise. They compare the results obtained from these approaches to the Nash bargaining solution as a benchmark for fairness.[739] Although Stummer & Vetschera are concerned with the impact of organizational designs in multi-project environments, the setting described in their article differs significantly from the setting investigated in the following. In particular, Stummer & Vetschera do not address coordination between different hierarchy levels but analyze a setting in "[…] non-hierarchical organizations, in which no central decision maker exists and where decisions can be made only by consensus of all members involved."[740] Stummer & Vetschera in particular aim at finding a fair compromise between decentralized decision makers and not at comparing different governance arrangements. Though Stummer & Vetschera's concept is considerably different from the conception used in this chapter, it represents a good complement as the coordination mechanisms described by Stummer & Vetschera can be employed in order to obtain high stakeholder satisfaction in settings that are inherently decentralized.

Cho & Shaw demonstrate how the exploitation of synergies may affect portfolio risk and return in a fictive setting with two organizational units.[741] For this purpose, they make use of the concept of efficient frontiers.[742] The study provides valuable insights into the impact of risk diversification from the perspective of a centralized decision maker. In particular, Cho & Shaw show that the exploitation of synergies may increase portfolio risks and thereby induce a tradeoff between risk and return.[743] However, the impact of synergy exploitation is analyzed in a quite abstract and hypothetical way. The underlying coordination mechanism is not

[737] The coordination mechanism and the model concept for the current study will be described in more detail in section 5.4.1.
[738] Stummer & Vetschera, 2003, p. 253.
[739] Cf. Stummer & Vetschera, 2003, p. 256.
[740] Stummer & Vetschera, 2003, p. 255.
[741] Cf. Cho & Shaw, 2009a.
[742] Cf. section 3.2.2.
[743] Cf. Cho & Shaw, 2009a, pp. 11–13.

explicitly modeled and the impact of the use of synergies is analyzed from a centralized perspective only. The perspective of decentralized units is not taken into account. Cho & Shaw in particular examine the allocation of a corporate-wide IT budget to different business departments from the perspective of a CIO.[744] As they use the general concept of "IT investment units", the model in theory could also be employed in the context of IT project portfolio selection. However, due to the very abstract level of investigation, the model is primarily applicable to the context of IT budget allocation. The approach presented in the following, in contrast, is designed for analyzing the impact of the use of different governance arrangements for IT project portfolio selection as well as the link between project interdependencies and the synergy potentials obtainable from these.[745] Despite the limitations arising from the high level of abstraction, the approach of Cho & Shaw provides valuable theoretical and conceptual backgrounds that are also of interests for the current research.

Heimerl & Kolisch devote a section of their contribution to a comparison of centralized and decentralized planning in the multi-project staffing and scheduling context.[746] Based on a simulation experiment, they illustrate that decentralized planning leads to increased labor costs, in particular in cases where resources are not highly specialized.[747] Heimerl & Kolisch are primarily concerned with developing and analyzing an approach for multi-project staffing and scheduling with the objective of minimizing labor costs. Project portfolio selection is out of scope in their contribution.[748] Still, the rationale behind the comparison of decentralized and centralized settings conducted by Heimerl & Kolisch is of interest in the following as it corresponds to the rationale behind the approach described in this chapter. The model proposed by Heimerl & Kolisch can be seen as related work that addresses a different field of activity, namely resource allocation. This model could be incorporated into the current conception in order to develop a comprehensive model of decision-making in organizations.

In summary, the current work differs from previous approaches with regard to the underlying coordination mechanism, the level of granularity, the field of activity addressed, and the way interdependencies are modeled and considered. Still, the related contributions described in this section can be understood as complements to the conception and the approach introduced in the following.

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[744] Cf. Cho & Shaw, 2009a, p. 2.

[745] As noted by Malone et al., dependencies have typically been modeled between organizational subunits. However, a more fine-grained modeling of interdependencies and coordination mechanisms is required as interdependencies do not arise directly between organizational subunits, but between activities (cf. Malone et al., 1999, p. 432).

[746] Cf. Heimerl & Kolisch, 2010, pp. 362–364.

[747] Cf. Heimerl & Kolisch, 2010, p. 363f.

[748] Cf. Heimerl & Kolisch, 2010, p. 347.

5.4 Conception and model development

In this section, the general concept employed for the following investigations is presented and a quantitative model facilitating a comparison of different governance arrangements in the context of IT project portfolio selection is introduced. At the end of this section, the general approach is exemplified based on an illustrative example.

5.4.1 Conception

The conception developed in this section is largely based on the insights into governance practices derived during the case study research presented in chapter 4. In particular, the recognition that IT project portfolio selection decisions are typically taken at different hierarchical levels by different decision-making authorities has largely inspired this conception.

The distinguishing element of this conception is the underlying **coordination mechanism**.[749] This coordination mechanism has been identified in several of the case companies described in the previous chapter.[750] According to this coordination mechanism, decision-making authorities at different organizational levels take decisions independently of each other, within their spheres of competency. Decision-making authorities may be individual persons but also committees composed of different stakeholders at the same hierarchical level. The decision-making competency of authorities at different levels is determined by assigning budgets and by specifying which kinds of projects may be approved independently at the respective level. Different project types are usually distinguished based on the project costs. In this case, a cost threshold is specified for each decision-making unit. Project requests originating from local units may be approved directly by local decision-making authorities within this unit as long as they are in their sphere of competency. In the following, the set of projects falling into the sphere of competency of a particular unit is termed the **decision domain** of this unit.[751] If the project costs for a particular project exceed the specified cost threshold or if not enough budget is available for the respective unit, the project proposal has to be passed up the hierarchy. Consequently, it will fall into the decision domain of a superior unit. The core principles of the described coordination mechanism are **separation of power** and a distinction between **different levels of authority**. **Budgets** and **cost thresholds** are the main elements used in order to implement this mechanism.

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[749] In the context of organizational modeling, the term "coordination mechanism" can be described as follows: "The coordination mechanism is the device used to coordinate the activities of the various subsystems, and can be viewed as the catalyst that energizes the total system." (Sweeney et al., 1978, p. 1492)

[750] In particular, compare section 4.5.4.3.

[751] A formal description of the decision domain concept is provided in section 5.4.4.

The conception applies to decision-making arrangements for IT project portfolio selection in companies composed of multiple units. It is assumed that a company consists of different **decentralized units** (functions, departments, divisions, regions, etc.) at different hierarchy levels and a **central unit** at the topmost hierarchy level (corporate center, headquarters, portfolio selection committee, the CIO, etc.). The decision-making competency for IT project portfolio selection can be distributed between the decentralized units and the central unit in different ways, according to the coordination mechanism described above. In the extreme case of a completely **centralized decision-making arrangement**, all project proposals have to be passed up to the central unit. In this case, all project proposals fall into a single decision domain and the entire IT project portfolio is selected by one decision-making authority. In a completely **decentralized decision-making arrangement**, all project proposals may be approved directly by the unit, from which they originate. All other constellations are termed as **federal decision-making arrangements** in the following.

IT innovations may originate from any unit within the organization, so all organizational units are allowed to propose own candidate IT projects. Moreover, there may be **project interdependencies** between the candidate projects proposed by the same organizational unit (**intra-unit interdependencies**) as well as interdependencies between projects proposed by different organizational units (**cross-unit interdependencies**).[752] The exploitation of the synergy potentials originating from these interdependencies is of major interest for the comparison of different governance arrangements in the following.

Figure 20 illustrates the main modeling elements and their relationships. In particular, a hierarchy of different organizational units taking decisions independently is the key element of the conception introduced in this section.[753] Each organizational unit in the hierarchy may propose own candidate projects, symbolized by the document symbols in Figure 20. There may be different kinds of project interdependencies between these candidate projects, symbolized by the thin arrows in Figure 20. The decision-making competency for project portfolio selection is distributed between the organizational units according to their hierarchical relationships and the coordination mechanism described above (not illustrated in the figure). The formal modeling of the elements depicted in Figure 20 is described in more detail in section 5.4.3.

[752] Cf. section 5.2.2.

[753] In Figure 20, only two hierarchy levels are depicted for illustration, but in general, the number of hierarchy levels and organizational units is not limited.

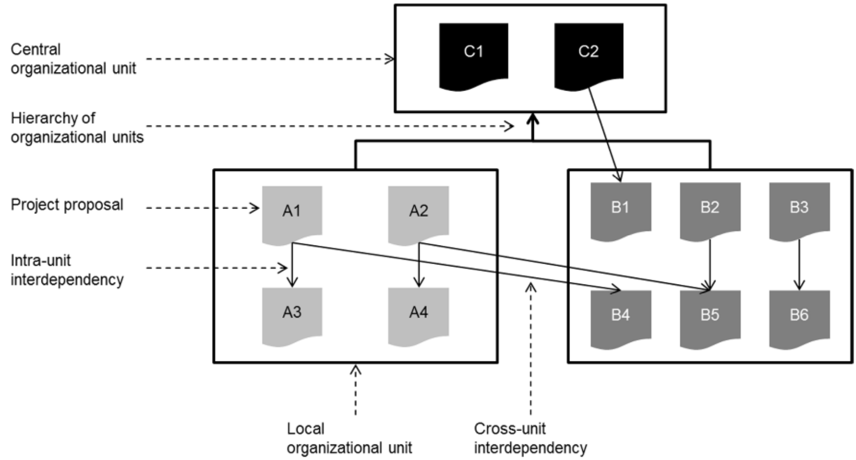

Figure 20: Conceptual overview

Regarding the decision-making behavior within the organization, it is assumed that the different organizational units select IT project portfolios independently of each other. Each organizational unit only considers the set of candidate projects falling into its specific decision domain. In order to determine the project portfolios, the different units independently solve an IT project portfolio selection problem. A quantitative problem formulation will be presented in section 5.4.4. Before, the main assumptions underlying the general conception will be highlighted in section 5.4.2 and the required model parameters will be introduced in section 5.4.3.

5.4.2 *Assumptions*

In this section, the main assumptions concerning the current conception are explicated and discussed in more detail. The conception introduced in section 5.4.1 relies on a specific coordination mechanism. This coordination mechanism and the behavior of the decision makers involved can be characterized by the following assumptions:

> **A1: Each decision-making unit chooses the optimal portfolio for its individual decision domain.**
>
> A main assumption underlying the coordination mechanism is that decision-making units act independently of each other within the boundaries of their decision-making competencies (their decision domains). All units search for a solution that is optimal from their individual perspective.[754]
>
> **A2: There is no horizontal coordination within the same hierarchy level.**
>
> The second assumption is that decision-making authorities at the same hierarchical level do not coordinate their decisions. Information may be passed up the hierarchy but not horizontally between different decision-making units within the same hierarchy level.

Assumption A2 describes the assumed effect of decentralized or federal decision-making on the exploitation of synergy potentials. This assumption leads to the following, more specific assumptions:

> **A3: Synergy potentials arising from complementary cross-unit interdependencies between projects in different decision domains are not exploited.**
>
> In the following, it is assumed that each decision-making unit only takes account of interdependencies between the projects within its decision domain. Consequently, complementary cross-unit interdependencies between different decision domains are ignored by the responsible decision-making authorities during IT project portfolio selection. The synergistic effects obtainable from cross-unit interdependencies are not exploited.[755]

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[754] This is similar to the conception of a decentralized decision-making arrangement by Buxmann et al. (cf. Buxmann et al., 1999, p. 9; Buxmann, 1999, p. 716f.).

[755] Alternatively, it could be assumed that complementary cross-unit interdependencies between projects in different decision domains are not taken into account during the selection phase, but that these interdependencies are later taken into account during the implementation phase (some projects with cross-unit interdependencies may be selected despite the fact that interdependencies are ignored). This assumption

A4: Competitive cross-unit interdependencies between projects in different decision domains are ignored at the point in time when projects are selected, but will later take effect when the respective projects are implemented.

It is assumed that, analogously to complementary cross-unit interdependencies, competitive cross-unit interdependencies are ignored by the responsible decision-making authorities during portfolio selection. However, it is assumed that competitive interdependencies will still have a negative impact if the project causing the interdependency and the affected project are both selected. In other words, it is assumed that negative side effects caused by unanticipated competitive interdependencies cannot be mitigated ex post.

A5: Technical cross-unit interdependencies are equally considered in all governance arrangements.

Technical interdependencies in particular exist between platform projects and the projects building on this platform. As platform projects usually are large and centrally controlled initiatives, it is likely that the approval of such projects is announced to all parts of the organization. If technical interdependencies were ignored by local decision makers, this would lead to projects yielding no benefit at all. Consequently, it seems to be unlikely that technical interdependencies are ignored during IT project portfolio selection even in largely decentralized arrangements. Therefore, in the following, technical interdependencies are not further considered.

The above assumptions apply to the general concept. Additional assumptions and limitations apply to the approaches used to model the IT project portfolio selection decisions of the different decision-making authorities in the organization. These assumptions and limitations will be separately discussed in sections 5.5 and 5.6 where these approaches are employed.

5.4.3 Model parameters

The parameters used to model different organizational settings and decision-making arrangements, different portfolios of candidate projects as well as different kinds of interdependencies between the projects are summarized in Table 14. These parameters will be explained in more detail in the following subsections.

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is also modeled in the software prototype implementing the coordination mechanism. However, in the following sections, only assumption A3 is further considered.

Table 14: Input parameters

	Parameter	Description
Organization-related parameters	O	Set of organizational units the investigated company is composed of
	$B_o \in \mathbb{R}^+$	Budget of organizational unit o ∈ O
	$ct_o \in \mathbb{R}^+$	Cost threshold for organizational unit o ∈ O
	$su_o \in O$	Unit directly superior to organizational unit o ∈ O
Project-related parameters	$pu_i \in O$	Organizational unit proposing project i ∈ P
	$P_o \subseteq P$	The decision domain of unit o ∈ O (i.e., the set of project proposals falling within the decision-making competency of organizational unit o)
	P	Set of all candidate projects in the entire organization
	$b_i \in \mathbb{R}^+$	Expected benefit provided by candidate project i ∈ P
	$c_i \in \mathbb{R}^+$	Expected costs (resource requirements) for candidate project i ∈ P
Interdependency-related parameters	$v_{ij} \in [-1, \infty]$	Benefit interdependency between project i ∈ P and project j ∈ P
	$r_{ij} \in [-1, \infty]$	Cost (resource) interdependency between project i ∈ P and project j ∈ P

5.4.3.1 Organization-related parameters

The distinctive feature of the modeling approach consists in the consideration of different decision-making arrangements and the assessment of their impact on the outcome of IT project portfolio selection. Via the modeling approach described in the following, different governance arrangements can be represented. Thereby, the connection between IT project portfolio governance and the exploitation of synergy potentials is addressed.

O denotes the set of all organizational units the investigated company is composed of. The budget B_o refers to the total funds unit $o \in O$ may allocate to projects falling into its decision domain. The cost threshold ct_o specifies the maximum size of a project unit o is allowed to approve. If the costs of a given candidate project exceed the cost threshold of unit o, the candidate project is routed to the unit su_o directly superior to unit o. These relationships represent the hierarchy of decision-making units. The organization-related parameters can be varied in order to model different structural decision-making arrangements (i.e. centralized, decentralized, and different federal arrangements).

5.4.3.2 Project-related parameters

Each candidate project is handed in by exactly one organizational unit $o \in O$. This particular unit is denoted by $pu_i \in O$. Moreover, for each candidate project $i \in P$, exactly one organizational unit $o \in O$ is entitled to decide whether the project is approved or not. Note that the unit proposing the project and the unit entitled to decide upon the selection of the project can be distinct. The decision domain of unit o, i.e., the set of candidate projects pending for approval of this unit, is denoted by P_o. The set P of all candidate projects available in the organization corresponds to the union of the decision domains of all organizational units ($P = \bigcup_{o \in O} P_o$).

The project benefit associated with each candidate project $i \in P$ is denoted by b_i. Similarly, the resource requirements for each candidate project $i \in P$ are modeled by a single parameter c_i expressing the project costs.

5.4.3.3 Interdependency-related parameters

As highlighted in section 5.2.2, interdependencies are an important characteristic of IT project portfolios. In the following, benefit and resource interdependencies between two projects are represented by the parameter groups v_{ij} and r_{ij} (cf. Table 14). The parameter group v_{ij} describes benefit interdependencies between two different projects i and j. Benefit interdependencies are modeled as a percental increase or decrease in the benefit of project i caused by the parallel implementation of project j.[756] Analogously, a resource interdependency (r_{ij}) is modeled as a percental increase or decrease in the costs of project i caused by the parallel implementation of project j. As resource requirements are expressed in terms of costs here, the more precise term “cost interdependencies” instead of “resource interdependencies” will be utilized in the following.

Benefit interdependencies with positive weights ($v_{ij} > 0$) indicate that the benefit of the dependent project rises by the given percentage if both projects are selected (complementary benefit interdependency). In contrast, benefit interdependencies with negative weights ($v_{ij} < 0$) indicate that the value of the dependent project decreases by the given percentage if both projects are selected (competitive benefit interdependency). Cost interdependencies indicate an increase ($r_{ij} > 0$) or decrease ($r_{ij} < 0$) in the costs of the dependent project. In case of an increase, the combined costs are higher than the sum of the costs of the single

[756] Similar ways of modeling are proposed, for example, by Angelou & Economides, Bardhan et al. and Dickinson et al. (cf. Angelou & Economides, 2008, p. 487; Bardhan et al., 2004, p. 40; Dickinson et al., 2001, p. 523).

projects (competitive cost interdependencies). In case of a decrease, costs can be saved if both projects are selected (complementary cost interdependencies). Without loss of generality, it is assumed that the benefit and the costs of a dependent project never fall below zero. Consequently, the lower bound for both kinds of interdependencies is specified as -1.

5.4.4 Model formulation

In the following, the IT project portfolio selection problem constituting the decision-making rationale for all organizational units is introduced. This optimization problem is solved independently by all decision-making authorities in all units in order to determine an IT project portfolio that is optimal from the (limited) perspective of the respective unit.

Before the problem can be solved, the decision domain $P_o \subseteq P$ for each organizational unit has to be determined first.[757] This can be accomplished by comparing the costs of each project with the cost threshold of the unit proposing the project. If the project costs exceed the threshold, the project costs are compared to the cost threshold of the superior organizational unit at the next hierarchy level. This comparison is recursively repeated until a decision-making unit with a sufficiently large cost threshold is identified. If we assume that the cost threshold of a superior organizational unit is always larger or equal to the cost threshold of its inferior units, the decision domain of an organizational unit $o \in O$ can be formally described as follows:

$$\begin{aligned} P_o = \{ & i \in P: o = pu_i \wedge c_i \leq ct_o \\ & \vee\, o = su_{pu_i} \wedge c_i \leq ct_o \wedge c_i > ct_{pu_i} \\ & \vee\, o = su_{su_{pu_i}} \wedge c_i \leq ct_o \wedge c_i > ct_{su_{pu_i}} \\ & \vee \dots \} \qquad \forall\, o \in O \qquad (1) \end{aligned}$$

After having determined the decision domain P_o, each unit with $P_o \neq \emptyset$ independently selects an IT project portfolio composed of candidate projects from its decision domain. The following 0-1 linear programming problem is solved by all units in order to obtain a portfolio that is optimal from the perspective of the particular unit:

[757] In practice, this task falls into the domain of IT demand management (cf. section 4.5.3).

$$Maximize\ F_o(\boldsymbol{x}) = \sum_{i \in P_o} (b_i - c_i) \cdot x_i + \sum_{i \in P_o} \sum_{\substack{j \in P_o \\ i \neq j}} \big((v_{ij} \cdot b_i) - (r_{ij} \cdot c_i)\big) \cdot y_{ij} \qquad (2)$$

subject to

$$y_{ij} \leq x_i \qquad \forall\, i,j \in P_o, i \neq j \qquad (3)$$

$$y_{ij} \leq x_j \qquad \forall\, i,j \in P_o, i \neq j \qquad (4)$$

$$x_i + x_j \leq 1 + y_{ij} \qquad \forall\, i,j \in P_o, i \neq j \qquad (5)$$

$$\sum_{i \in P_o} c_i \cdot x_i + \sum_{i \in P_o} \sum_{\substack{j \in P_o \\ i \neq j}} r_{ij} \cdot c_i \cdot y_{ij} \leq B_o \qquad (6)$$

$$x_i, x_j, y_{ij} \in \{0,1\} \qquad \forall\, i,j \in P_o \qquad (7)$$

The objective function (2) maximizes the financial return of the portfolio selected from the decision domain of unit $o \in O$. The portfolio return is composed of the net benefits of all selected projects (first term) as well as the benefits gained or lost from benefit interdependencies between the selected projects and the savings gained or lost due to cost interdependencies between the selected projects (second term). The binary decision variable x_i is set to one if project $i \in P_o$ is selected and to zero if not. Note that in the objective function only interdependencies between projects under the decision domain of unit o are considered. If unit o has control over all project proposals, all cross-unit interdependencies are taken into account. In contrast, if unit o is a decentralized unit with limited decision-making authority, several cross-unit interdependencies might be omitted.

Conditions 3-5 ensure that the auxiliary variable y_{ij} is set to one exactly when the two projects i and j are both selected.[758] If both projects are selected, the effect of the interdependencies between the projects is taken into account via the objective function and the budget restriction (condition 6). Condition 6 ensures that the costs of the selected projects plus the additional costs or savings due to cost interdependencies do not exceed the available budget of unit o. Finally, condition 7 ensures that the decision and auxiliary variables are all binary. Consequently, projects are not partly funded.

The model (2-7) is a linearized variant of the quadratic knapsack problem.[759] The quadratic knapsack problem is $\mathcal{NP}$-hard in the strong sense. Thus, solving very large problem instances

[758] Cf. Billionnet & Calmels, 1996, p. 314f.; G. G. Brown & Dell, 2007, p. 155; Kellerer et al., 2004, p. 356f.
[759] Cf. Kellerer et al., 2004.

can be time-consuming in the worst case.[760] However, specialized branch-and-bound algorithms exist that are capable of solving even the largest problem instances reported in the literature.[761]

Numerous more or less sophisticated knapsack-based models with different kinds of conditions and objective functions have been proposed in contributions on IT project portfolio selection.[762] In comparison to these contributions, the current model has been kept comparatively simple in order to focus on the key object of investigation – the impact of different governance arrangements in the presence of different kinds of interdependencies.[763] For the following computational study, this model is well suited, as it requires relatively few input parameters.

In order to calculate the portfolio return for the entire company based on the above model (2-7), the sum of the individual portfolio returns generated by each decision-making unit ($\sum_{o \in O} F_o(x)$) is calculated in a first step. In a second step, the term is corrected by the negative impact of competitive cross-unit interdependencies between projects in different decision domains. Thereby, the effect of the inobservance of these interdependencies during decision-making is incorporated.[764] The same approach can be applied in order to determine the overall budget consumption, i.e. the money spent for all selected projects. More precisely, the budget consumption for all individual decision-making units is summed up and the additional costs caused by competitive cost interdependencies between selected projects in different decision domains are added.

5.4.5 Illustration

In order to illustrate the conception presented in the preceding sections, potential impacts of different kinds of interdependencies in different decision-making arrangements are demonstrated in the following based on a simple fictive example. The scenario for this example is displayed in Figure 21. It is important to note that the parameter values for this scenario have been chosen purposefully in order to demonstrate several effects.

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760 Cf. Kellerer et al., 2004, p. 350.

761 Cf. Kellerer et al., 2004, pp. 374–378.

762 Cf. Chiang & Nunez, 2009; Gutjahr & Reiter, 2010; Kremmel et al., 2011; Santhanam & Kyparisis, 1996, to only name a few.

763 Again, it is important to highlight that the objective in this section is not to develop a new IT project portfolio selection approach, but to compare the impact of different governance arrangements in the context of IT project portfolio selection.

764 Compare assumption A4 in section 5.4.2.

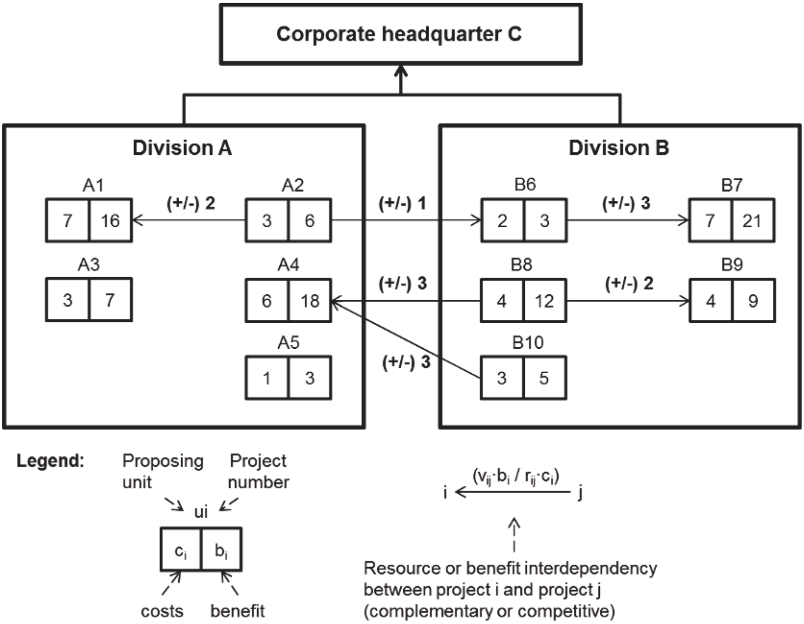

Figure 21: Illustrative decision-making scenario

Figure 21 portrays a decision-making scenario in a fictive company consisting of two divisions A and B and a corporate headquarter C. Each division has proposed five IT project candidates while the corporate headquarter has not handed in own IT project proposals. The combined costs of the five projects proposed by each division add up to 20 monetary units; the combined benefits add up to 50 monetary units for each organizational unit. A total budget of 20 monetary units is provided for IT project funding. This budget equates to half of the funds required to implement all ten candidate projects.

In general, this budget and the decision-making competency can be divided in different ways between the corporate headquarter and the divisions according to the coordination mechanism described in section 5.4.1. Here, only two extreme decision-making arrangements are compared – a centralized arrangement, where the complete budget and decision-making competency is assigned to unit C and a completely decentralized arrangement, where the total budget and the decision-making competency is equally divided between division A and division B. For the following illustration, it is assumed that no cost thresholds exist. Consequently, in the decentralized case the decision domains equal the set of projects proposed by the respective unit.

In the centralized case, the corporate headquarter C has a complete overview of all project candidates as well as all interdependencies between them. Unit C may use the entire budget of 20 monetary units in order to select a project portfolio that is optimal from a corporate-wide perspective. In the decentralized case, both divisions may use their individual budget of 10 monetary units in order to fund projects within their decision domain. In contrast to the centralized arrangement, the two divisions only consider interdependencies between candidate projects originating from their own division. Cross-unit interdependencies are not taken into account by the divisions.[765]

The impact of the presence of different kinds of interdependencies will be analyzed in the following. For this purpose, the directed edges depicted in Figure 21 will be interpreted as benefit or cost interdependencies of competitive or complementary nature. All four kinds of interdependencies will be analyzed independently of each other. Note that for easier reading, the projects depicted in Figure 21 are not denominated by a number but by a combination of a number and the name of the proposing organizational unit. Likewise, the interdependency weights in Figure 21 are not expressed in percentages but in absolute terms of costs $(r_{ij} \cdot c_i)$ and benefits $(v_{ij} \cdot b_i)$.

Table 15 presents the outcomes of the selection process for different settings.[766] The rows correspond to the settings, each with a centralized and a decentralized variant. The crosses indicate that the respective candidate project listed in the column is selected in the given setting. Together, the crosses in each line define the combined project portfolio selected in the given case. The column entitled with “Portfolio benefit” contains the total benefit obtained when the respective portfolio is implemented. Accordingly, the column “Money spent” describes the combined costs of the portfolio, including the effect of project interdependencies.

[765] Compare the assumptions contained in section 5.4.2.

[766] The portfolios have been identified based on a Java-implementation of the model described in section 5.4.4. The IBM CPLEX solver (version 12.2) has been employed in order to solve the project portfolio selection problems.

Table 15: Portfolio outcomes contingent upon different governance arrangements and different kinds of interdependencies

Setting: \ **Portfolio:**	**A1**	**A2**	**A3**	**A4**	**A5**	**B6**	**B7**	**B8**	**B9**	**B10**	**Portfolio benefit**	**Money spent**
Setting 1 – No interdependencies:												
Centralized:			X	X			X	X			38	20
Decentralized:			X	X	X		X			X	34	20
Setting 2 – Complementary benefit interdependencies:												
Centralized:				X	X	X	X	X			43	20
Decentralized:			X	X	X	X	X				36	19
Setting 3 – Competitive benefit interdependencies:												
Centralized:		X	X	X	X		X				35	20
Decentralized:			X	X	X		X			X	31	20
Setting 4 – Complementary cost interdependencies:												
Centralized:	X	X		X		X	X	X		X	61	20
Decentralized:			X	X	X	X	X	X			44	20
Setting 5 – Competitive cost interdependencies:												
Centralized:			X	X			X		X		35	20
Decentralized:			X	X	X		X			X	31	**23**

Based on the outcomes contained in Table 15, a number of effects can be clearly demonstrated. Hence, the outcomes are interpreted and discussed in the following subsections.

5.4.5.1 Effect of centralized decision-making in the absence of interdependencies

In the first setting, it is assumed that no interdependencies exist between the projects. In the centralized as well as in the decentralized case, the entire budget of 20 monetary units is spent. However, the portfolio benefit obtained in the centralized arrangements is 11.8 percent higher than in the decentralized arrangement. This can be explained by the fact that the corporate headquarter has a better overview and can route the available funds to the projects where the money is most efficiently used, regardless of where the projects originate from.

Although the aggregated benefits proposed by the divisions A and B add up to the same amount, as well as the aggregated project costs,[767] the larger fraction of the budget is allocated to projects of division B in the centralized case. The corporate headquarter allocates 9 monetary units to candidate projects of division A and 11 to candidate projects of division B respectively. The observed effect demonstrates that aggregated metrics are not appropriate for comparing the portfolios of candidate projects of both divisions. Instead, the characteristics of the individual projects also have to be taken into account. A close look at the project characteristics becomes even more important, when interdependencies exist among the projects. This effect demonstrates, for example, that a top-down IT budget allocation to the divisions purely based on aggregated information about the candidate portfolio of each division would prove to be sub-optimal in most cases.[768] In general, the results obtained for this setting demonstrate that "[…] if resources are allocated to each of several organisational units considered individually, the collective result appears not to make the best use of the total resource […]."[769]

5.4.5.2 Effect of complementary benefit interdependencies

The second setting illustrates effects resulting from complementary benefit interdependencies. In the centralized as well as in the decentralized case, the selected portfolios differ from the portfolios selected in the setting with no interdependencies. In the decentralized case, only intra-unit interdependencies are considered and exploited, while in the centralized case also the cross-unit interdependency between projects B8 and A4 is exploited. The portfolio benefit gained in the centralized arrangement is 19.4 percent higher than in the decentralized arrangement. In contrast to the setting with no interdependencies, only 19 monetary units are used in order to fund projects in the decentralized case. This can be explained by the fact that division B makes use of the intra-unit interdependency between project B6 and B7 but overlooks (or disregards) the cross-unit interdependency between projects B10 and A4. Therefore, project B6 is preferred over project B10 that would be selected by division B if no interdependencies existed. However, if division B opted for project B10 in the given setting, the corporate-wide portfolio benefit would rise by one monetary unit. In this case, both divisions would use their complete budget of 10 monetary units in order to fund projects

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[767] I.e., at an aggregated level, the candidate portfolios of both units have the same characteristics. Still, the aggregated costs and benefits are distributed to the individual projects in different ways.

[768] For a brief discussion of top-down and bottom-up planning, refer to section 4.5.2.1.

[769] Phillips & Bana e Costa, 2007, p. 52.

within their decision domain.[770] Consequently, divisions A and B could increase the corporate-wide benefit by coordinating their decisions. Still, division B might refuse to cooperate and still select project B7 instead of project B10 as the benefit from its local portfolio would decrease by two monetary units if project B10 was chosen. Only division A would benefit from the three monetary units added by the interdependency between project B10 and project A4.[771] In this case, a compensatory payment or other incentives would be required in order to convince division B to select project B10.

5.4.5.3 Effect of competitive benefit interdependencies

In the third setting, effects caused by the presence of competitive benefit interdependencies are demonstrated. In the decentralized as well as in the centralized case, the competitive benefit interdependencies lead to a decline of the portfolio benefit compared to the benefit gained in the first setting with no interdependencies. However, this decline is due to different reasons in both cases. In the centralized case, the corporate function reacts to the competitive interdependency by selecting projects A2 and B5 instead of project B8. This is because the selection of project B8 would negatively affect the benefit provided by project A4. In the decentralized arrangement, in contrast, both divisions ignore the cross-unit interdependencies and select the same portfolios as in the first setting (no interdependencies) as the selected projects are not affected by intra-unit interdependencies. In total, this leads to a negative effect due to the cross-unit interdependency between project B10 and project A4. If, in contrast, division B would simply abstain from implementing project B10, the corporate-wide portfolio benefit would increase by one monetary unit. Again, this would require a coordinated decision and potentially a compensation for division B. A common example for this situation would be that both divisions plan to implement redundant or even incompatible systems.[772] In this situation, division A might implicitly assume that the (costly) information system implemented in project A4 will later also be adapted by division B. This would result in a higher project benefit and likely to a sharing of costs. This problem resulting from decentralized planning could be relinquished by an agreement between both divisions. However, this would require a cooperative attitude and would potentially involve time-

[770] An interesting question that arises in this situation is how division B would use the remaining funds. In some of the case companies described in chapter 4, remaining funds were typically used in order to fund minor "un-enacted projects" (cf. Blichfeldt & Eskerod, 2008, p. 361) or to support active projects in need. In other cases, the funds were redirected to a superior decision-making unit in order to fund larger projects.

[771] Of course, in many situations the benefit interdependency would be two-sided and, therefore, both divisions could immediately benefit from the interdependency. Still, it is likely that both divisions do not benefit equally.

[772] Kundisch & Meier, 2011a, for example, illustrate competitive benefit interdependencies (alias competitive output interactions), based on the redundant implementation of ERP systems (cf. Kundisch & Meier, 2011a, p. 482).

consuming negotiations. In a centrally coordinated arrangement, in contrast, an enterprise-wide system could be mandated. In any case, it is important that redundancies are identified before the affected candidate projects enter the approval stage. In this context, appropriate IT demand management arrangements are of vital importance.[773]

5.4.5.4 Effect of complementary cost interdependencies

The fourth setting illustrates potential impacts of complementary cost interdependencies on the portfolio outcomes in centralized and decentralized arrangements. In both arrangements, the complementary cost interdependencies lead to reduced project costs. The saved money is immediately used in order to fund additional projects. Consequently, the portfolio benefits are significantly higher than in the first setting with no interdependencies in both cases. However, there is a large gap of 38.6 percent between the portfolio returns in the centralized and in the decentralized case. In the centralized arrangement, the corporate headquarter makes use of all cross-unit interdependencies and, thereby, coordinates the resource requirements of the two divisions. In the decentralized arrangement, in contrast, the cross-unit interdependencies are not taken into account by the divisions who independently select their project portfolios. Still, as projects A4 and B8 are contained in the combined portfolio, the cross-unit interdependency between the two projects could later be exploited during the implementation phase if it were recognized then.[774] A common example for this setting is that several software development projects require similar functionality and, therefore, programming code and skills can be reused in different projects.[775] In order to make use of these interdependencies, appropriate IT resource management arrangements are required.[776]

5.4.5.5 Effect of competitive cost interdependencies

Finally, the fifth setting demonstrates potential effects of competitive cost interdependencies. In this setting, as in the previous settings, a gap between the benefits obtained in the centralized and the decentralized case can be observed (the gap is 12.9 percent for this setting). More importantly, it is demonstrated that decentralized planning in the presence of competitive cost interdependencies may lead to budget overruns. In total 23 monetary units are spent, although the IT project budget has been rationed top-down to 20 monetary units. This effect is caused by the non-consideration of the cross-unit interdependencies between projects B10 and A4. The two divisions select the same projects as in the first setting (no

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[773] Cf. section 4.5.3.

[774] However, in general it is assumed that competitive cross-unit interdependencies are not recognized ex post (compare assumption A4 in section 5.4.2).

[775] Cf. Kundisch & Meier, 2011a, p. 482; Santhanam & Kyparisis, 1996, p. 383.

[776] Cf. section 4.5.5.

interdependencies). The resulting portfolios include no intra-unit interdependencies, but the cross-unit interdependency leads to an unexpected cost increase for division A. In the centralized case, in contrast, project B9 is chosen instead of project B8 in order to avoid the negative impact of project B8 on project A4. Competitive cost interdependencies, for example, may result from diseconomies of scale.[777] Different projects may compete for the same scarce resources, thereby leading to excess demand, extra expenses and potentially abandoned or delayed projects.[778] If not appropriately addressed, this conflict may lead to the "resource allocation syndrome" described by Engwall & Jerbrant and, thereby, may result in a competition for resources between the projects in the portfolio.[779] This situation may be addressed by centralized resource planning.[780] However, centralized resource planning as a reactive mechanism may not yield the expected success.[781] Consequently, taking account of competitive cost interdependencies already during the project portfolio selection phase may countervail conflicts and budget overruns right from the beginning, as illustrated in this setting.

5.4.5.6 Résumé

The example introduced in this section illustrates the conception presented in section 5.4.1. This conception proved to be suitable to investigate and formally explain the impact of different governance decision-making arrangements in the presence of different kinds of interdependencies. The general approach can be used to investigate a rich variety of settings and decision-making arrangements.[782] The approach in particular proved to be useful in combination with insights obtained from qualitative empirical studies.[783] It provides a means to formally structure, explain, and pursue observations from practice as well as to generate new hypotheses to be proved or rejected by means of empirical research.

Though the illustration provided in this section serves well in order to discuss general impacts of project interdependencies in different decision-making constellations, it is important to reemphasize the artificial character of the scenario. The example has intentionally been designed in order to demonstrate the discussed effects. A systematic investigation of the general impacts of different kinds of interdependencies, in contrast, demands for a variation of

[777] Cf. Kundisch & Meier, 2011a, p. 482.
[778] Also compare section 4.5.5.4.
[779] Cf. Engwall & Jerbrant, 2003, p. 406f.
[780] Cf. Engwall & Jerbrant, 2003, p. 407.
[781] Cf. Engwall & Jerbrant, 2003, p. 407.
[782] In particular, the underlying coordination mechanism allows for the investigation of a continuum of federal decision-making arrangements.
[783] Cf. chapter 4.

the parameter values, e.g. a variance analysis. This will be addressed in the following section based on a computational study.

5.5 A computational study based on a 2^k-factorial simulation design

In this section, the impact of different kinds of interdependencies in different decision-making arrangements will be systematically investigated based on a factor analysis. The simulation design is described in detail in section 5.5.1. The results of the experiments are described and interpreted in section 5.5.2. Limitations are discussed in section 5.5.3.

5.5.1 Simulation design

In the following, the outcomes of project portfolio selection in a completely centralized decision-making arrangement are compared to the outcomes in a decentralized arrangement similar to the approach taken for the illustrative example in section 5.4.5. In contrast to this illustration, different influencing factors are systematically varied in order to analyze their impact in more detail.

The general approach employed for comparing the outcomes of centralized and decentralized arrangements is similar to the approach chosen by Heimerl & Kolisch.[784] The decentralized units independently solve their individual planning problems and the combined results are compared to the solution obtained by a centralized planning authority. In contrast to the investigation of Heimerl & Kolisch, the problem under investigation is a project portfolio selection problem instead of a staffing and scheduling problem.[785] In this context, different effects are investigated. In particular, the influence of the scarcity of funds and of different kinds and degrees of interdependency between IT projects will be analyzed systematically.[786] Concretely, the impact of three different factors will be simulated in the following: The relation between the available budget and the total costs of all candidate projects, the total number of interdependencies and the strength of these interdependencies. The three factors and the rationale for investigating these factors are described in more detail in Table 16.

[784] Cf. Heimerl & Kolisch, 2010.

[785] Cf. section 5.3.

[786] In a different context, Oral et al. also discuss "[...] the impact of the level of available funds on the way the project selection is made." (Oral et al., 2001, p. 344). They conclude that "These observations indicate that one can perform a sort of sensitivity analysis to study the impact of the level of available funds on project selection." (Oral et al., 2001, p. 345)

Table 16: Factor descriptions

Factor #	Description	Rationale for the investigation of the factor
1	Scarcity of funds expressed by the relation between the available budget and the total costs of the candidate projects ($\frac{\sum_{o \in O} b_o}{\sum_{i \in P} c_i}$)	If the IT budget is strongly limited, centralized decision-making seems to be the natural choice. In a centralized arrangement, the scarce funds can be allocated to the projects with the highest benefit/cost ratio. In addition, also larger projects can be funded if the complete budget is controlled by a single decision-making authority.
2	Total number of interdependencies between the candidate projects	As the number of interdependencies increases, it becomes more likely that cross-unit interdependencies are disregarded in a decentralized setting. Consequently, an increasing gap between the outcomes of centralized and decentralized decision-making can be expected.
3	Strength of the interdependencies	The 'stronger' an interdependency, the greater the effect of its non-consideration. This effect is supposed to be linked to the impact of the number of interdependencies. Therefore, it also will be investigated how the two factors interact.

In advance of constructing the experimental design for the investigation, an IT governance expert and an IT project portfolio manager in two large German companies were consulted and a series of interviews were conducted (two in the first company and three in the second) in order to become familiar with real-world portfolios. Individual project data was not handed over due to data confidentiality. Therefore, the experimental design had to be constructed based on artificial data. Still, the key characteristics of the project landscapes, the organizational structures, and the governance structures at hand were discussed during the interviews and were taken into consideration when constructing the design described in the following.

In the experimental design, a company consisting of two divisions A and B and a corporate headquarter C is regarded, as in the illustrative example in section 5.4.5. It is assumed that division A and B each propose 50 projects with similar characteristics while unit C does not hand in any own project proposals. In the centralized setting, the entire IT budget is managed by unit C. Unit C has a complete overview of all IT project proposals stemming from unit A and B. In the decentralized setting, the budget is equally split between unit A and B. The cost thresholds for both units equal their budgets in the decentralized setting. Consequently, each of the two units can fund every candidate project as long as the assigned budget is not exceeded. The value assignments for the experimental design are formally described in Table 17.

Table 17: Value assignments for the experimental design

Parameter	**Description / parameter values**
O	O = {A, B, C} The organization consists of two decentralized units A and B and a centralized unit C
$b_o \in \mathbb{R}^+$	Centralized: $b_A = b_B = 0$, b_C = 100,000,000 · factor 1; Decentralized: $b_A = b_B$ = 50,000,000 · factor 1; $b_C = 0$ Factor 1 specifies the relation between the available budget and the combined costs of all project proposals and is an indicator for the scarcity of funds (cf. Table 16).
$ct_o \in \mathbb{R}^+$	$ct_A = b_A,\ ct_B = b_B,\ ct_C = b_C$ The cost thresholds have no effect in this experimental design.
$su_o \in O$	$su_A = su_B = C$
$P = P_A \cup P_B$	$\lvert P_A \rvert = 50$, $\lvert P_B \rvert = 50$, $\lvert P_C \rvert = 0$ There are 50 project proposals originating from unit A and the same number of proposals stemming from unit B. Unit C does not propose any own projects.
$b_i \in \mathbb{R}^+$	Project costs and benefits are independently normally distributed Benefit distribution: $\mu = 3 \cdot \frac{100{,}000{,}000}{\lvert P \rvert} = 1{,}000{,}000$, $\sigma = \frac{\mu}{2}$
$c_i \in \mathbb{R}^+$	Project costs and benefits are independently normally distributed Cost distribution: $\mu = \frac{100{,}000{,}000}{\lvert P \rvert} = 1{,}000{,}000$, $\sigma = \frac{\mu}{2}$
$v_{ij} \in [-1, \infty]$	The number of interdependencies is set according to factor 2 (cf. Table 16). The interdependencies are weighted according to factor 3 (cf. Table 16) and randomly distributed over the project proposals.
$r_{ij} \in [-1, \infty]$	Same parameter assignment as for the benefit interdependencies v_{ij}

Based on this experimental design, the effect of four different kinds of interdependencies (complementary and competitive benefit and cost interdependencies) was investigated in individual settings as in the illustrative example in section 5.4.5. The general structure of the simulation design is illustrated in Table 18.

Table 18: Simulation settings

Setting	**Cases compared**	**Results of the comparison**
Complementary benefit interdependencies	centralized	Results depicted in Figure 22
	decentralized	
Competitive benefit interdependencies	centralized	Results depicted in Figure 23
	decentralized	
Complementary cost interdependencies	centralized	Results depicted in Figure 24
	decentralized	
Competitive cost interdependencies	centralized	Results depicted in Figure 25
	decentralized	

In order to investigate the combined effects of the three different factors described in Table 16 systematically, 2^k factorial designs were computed for the different settings.[787] The basic idea behind a 2^k factorial design is to define two different levels – a high and a low level – for each of the k factors under investigation (in this case, k = 3).[788] In order to take account of combined effects between the different factors, all 2^k possible permutations (in this case 2^3 = 8) of the low and high factor values are investigated.[789] The structure of a 2^k factorial design for the given parameters is depicted in Table 19. A plus sign indicates a high factor level and a minus sign a low level.

Table 19: Structure of a 2^k factorial design[790]

Factor combination	Factor 1 (budget in relation to total costs)	Factor 2 (number of inter-dependencies)	Factor 3 (interdependency weight)
1	-	-	-
2	+	-	-
3	-	+	-
4	+	+	-
5	-	-	+
6	+	-	+
7	-	+	+
8	+	+	+

The assignment of specific values to the high and low factor levels is a challenging task. According to Law “The levels, which should be chosen in consultation with subject-matter experts, should be far enough apart that we would expect to see a difference in the response, but not so separated that nonsensical configurations are obtained.”[791] In order to understand the nature of the three factors, the two IT project portfolio managers in the two reference companies were consulted and were asked for their valuation. While meaningful values for the relation between the available budget and the summed up costs of the project proposals could easily be estimated this way, the experts were unable to estimate the interdependency-related parameters. Therefore, independent variance analyses for the two latter factors were conducted in order to assess their impact on the resulting project portfolio characteristics. Thereby, sensible bounds of the spectrum were identified. The factor values employed in this study are listed in Table 20. It should be noted that the exact values of these parameters are of

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[787] Cf. Law, 2007, pp. 622–636.
[788] Cf. Law, 2007, p. 623.
[789] Cf. Law, 2007, p. 623. In contrast to a “factorial ceteris paribus design” (cf., e.g., Heimerl & Kolisch, 2010, p. 354), also the combined effects are taken into account in a 2^k factorial design.
[790] Based on Law, 2007, p. 623.
[791] Law, 2007, p. 623.

secondary importance, as an estimation of the exact impact of these three factors is not intended here. Instead, the focus lies on the identification of general tendencies and effects.

Table 20: Coding chart[792]

Factor	-	+
Factor 1 – Budget in relation to total costs	0.3	0.5
Factor 2 – Number of interdependencies	50	100
Factor 3 – Interdependency weight	+/- 0.1	+/- 0.3

For each of the four settings described in Table 18, two 2^k factorial designs were computed – one for the centralized and one for the decentralized case. The results obtained for both arrangements were directly contrasted to each other by measuring the gap between the outcomes at the portfolio level.[793]

For each factor combination, 1,000 scenarios were created in order to approximate the distribution of the cost and benefit values. In each scenario, normally distributed pseudo-random values were assigned to the cost and benefit parameters of each candidate project.[794] Next, the specified number of interdependencies was spread randomly between the candidate projects.[795] The weights were assigned to the interdependencies according to the factor values defined in Table 20.[796] For each scenario, the optimal portfolio was determined and the portfolio return and the money spent for the entire company was calculated analogously to the illustrative example in section 5.4.5. Moreover, the standard deviation of the portfolio benefits obtained for all 1,000 scenarios was determined in order to gain a measure for the variation of the results.

In order to create the different settings and to calculate the outcomes, a software prototype was implemented in the Java programming language. The random numbers required for creating the scenarios were generated with the colt library (version 1.2.0).[797] The IBM CPLEX solver (version 12.2) was used in order to solve the optimization problem described in section

[792] Based on Law, 2007, p. 626.

[793] The measurement of this gap is described in more detail at the beginning of section 5.5.2.

[794] Left-truncated normal distributions were used in order to avoid negative cost or benefit values. The truncated normal distributions were fitted by a correction term in order to obtain the mean values specified in Table 17 (cf. Johnson & Thomopoulos, 2002).

[795] This constitutes a limitation to the current study and an opportunity for further research. This limitation is discussed in more detail in section 5.5.3.

[796] In general, the interdependency weights were assigned as crisp values. In order to test the effect of variations in the interdependencies, the weights were also drawn from normal distributions with the parameter values specified in Table 20 as mean values and different variance parameters. As this did not lead to a significant change in the results, crisp values were used for the simulation settings described herein.

[797] This library is provided at http://acs.lbl.gov/software/colt/.

5.4.4. The results were stored in a database. Based on these results, the average portfolio return, the average budget utilization, and the sample standard deviation of the portfolio return were calculated for each factor combination.

5.5.2 Results

In this section, the results obtained from the simulation experiments are presented and discussed. In order to describe the outcomes of the simulation experiments, the following quotient Z_{ef} representing the relative difference between the results obtained in the centralized and in the decentralized arrangement is introduced:[798]

$$Z_{ef} = \frac{Z_{ef}^{c} - Z_{ef}^{d}}{Z_{ef}^{c}} \cdot 100\% \tag{8}$$

Index e stands for the type of the outcome (e ∈ {portfolio return, money spent, standard deviation of portfolio return}) and index f stands for the factor combination (f ∈ {1, …, 8}). The numerator measures the difference between the results obtained in the centralized decision-making arrangement (Z_{ef}^{c}) and the results obtained in the decentralized arrangement (Z_{ef}^{d}). This difference is divided by Z_{ef}^{c} in order to obtain the relative difference between both outcomes.

The quotient Z_{ef} facilitates the interpretation of the gap between the results obtained in the centralized setting and in the decentralized setting. For example, a value of 10 % for the result type *portfolio return* indicates that the portfolio return gained in the centralized arrangement is ten percent higher on average than the portfolio return gained in the decentralized case. A value of 5 % for the result type *money spent* indicates that in the centralized arrangement five percent more money is spent than in the decentralized case. Finally, a value of 10 % for the result type *standard deviation of portfolio return* indicates that the (unbiased) sample standard deviation of the portfolio returns obtained for the 1,000 scenarios is ten percent higher if the portfolio is selected centrally.

Based on the quotient Z_{ef}, the mean effects, the two-factor interactions, and the three-factor interactions between the three investigated factors were calculated as described by Law.[799]

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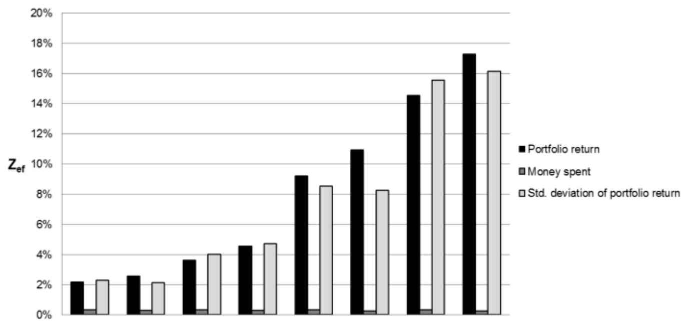
[798] This quotient is nearly identical to the quotient κ introduced by Heimerl & Kolisch for the comparison of centralized and decentralized staffing and resource allocation (cf. Heimerl & Kolisch, 2010, p. 363). The current quotient slightly differs from the quotient used by Heimerl & Kolisch as they solve a minimization problem instead of a maximization problem (cf. Heimerl & Kolisch, 2010, p. 349f.).

[799] Cf. Law, 2007, pp. 623–625.

The resulting figures for the portfolio benefits are exemplarily listed in Appendix J. However, in order to ease the interpretation, the outcomes are depicted in diagrams in the following.

5.5.2.1 Effects of complementary benefit interdependencies

Figure 22 displays the gap between centralized and decentralized IT project portfolio selection outcomes in the presence of complementary benefit interdependencies. The factor combinations listed at the axis of abscissae correspond to the eight factor combinations introduced in Table 19. The parameter values for the low and high levels respectively are provided in Table 20. For each factor combination, the relative difference between the outcomes of centralized and decentralized decision-making are depicted at the axis of ordinates based on the quotient Z_{ef}.



Factor combination	1	2	3	4	5	6	7	8
Budget in relation to total costs	-	+	-	+	-	+	-	+
Number of interdependencies	-	-	+	+	-	-	+	+
Interdependency weight	-	-	-	-	+	+	+	+

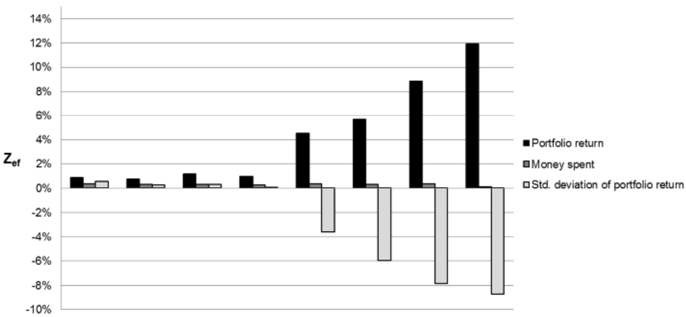
Figure 22: Effects of complementary benefit interdependencies

The results depicted in Figure 22 can be described as follows: While the level of money spent in the centralized and the decentralized arrangement merely differs for all factor combinations, the gap between the portfolio returns intensifies with a rising number and strength of the complementary benefit interdependencies. Moreover, the gap also increases if the budget restriction is relaxed to a certain degree, so that more projects can be funded. The standard deviation of the portfolio returns obtained in the centralized case is higher than in the decentralized case for all factor combinations. The gap in particular increases with a higher number of interdependencies and higher interdependency weights.

The higher level of variation in the outcomes can inter alia be explained by the higher interconnectedness of the project benefits and, consequently, the higher sensitivity to deviations. This outcome is consistent with the finding of Cho & Shaw that firms may not be able to obtain a superior portfolio in the presence of super-additive value IT synergy, if their risk tolerance is low.[800] However, in the given setting, the standard deviation of the portfolio return in case of centralized decision-making only rises to a similar degree as the portfolio return itself. Consequently, only in cases of a very high variation in the portfolio returns and a very strong risk-aversion, the superior benefits obtained in the centralized arrangement may be compensated by the increasing variance. In general, according to the model results, in the presence of complementary benefit interdependencies a centralized arrangement for IT project portfolio selection leads to significantly higher returns than a decentralized arrangement. This is in line with the predictions of the theory of complementarities.[801]

5.5.2.2 Effects of competitive benefit interdependencies

Figure 23 visualizes the impact of centralized and decentralized IT project portfolio selection in the presence of competitive benefit interdependencies. As noted in section 5.4.5.3, competitive benefit interdependencies might be caused, for example, by the implementation of redundant projects in different parts of the organization.[802]



Factor combination	1	2	3	4	5	6	7	8
Budget in relation to total costs	-	+	-	+	-	+	-	+
Number of interdependencies	-	-	+	+	-	-	+	+
Interdependency weight	-	-	-	-	+	+	+	+

Figure 23: Effects of competitive benefit interdependencies

[800] Cf. Cho & Shaw, 2009a, pp. 11–13.
[801] Cf. Milgrom & Roberts, 1995, p. 190. Note that the circumstance that decentralized arrangements never yield higher portfolio returns than centralized arrangements in case of complementary benefit interdependencies is a direct result of the conception. Still, the fact that the results are in line with theoretical predictions demonstrates the theoretical validity of the model.
[802] Cf. Kundisch & Meier, 2011a, p. 482.

Figure 23 demonstrates that in the presence of competitive benefit interdependencies significantly higher portfolio returns can be gained by centralized project portfolio selection than by decentralized selection. However, in this setting, there is only a large gap between the returns obtained by centralized and decentralized decision-making if the interdependencies are strong. For the factor combinations 1 to 4, where the benefits of the dependent project only decreases by 10 percent if the interdependency is ignored, the gap is only about 1 percent. The gap sharply rises if relatively strong competitive benefit interdependencies exist. A possible conclusion from this result is that the affected company might tolerate a certain amount of redundancies in the IT project portfolio as long as the project benefits projected by one unit usually are not strongly cannibalized by actions taken by other units.

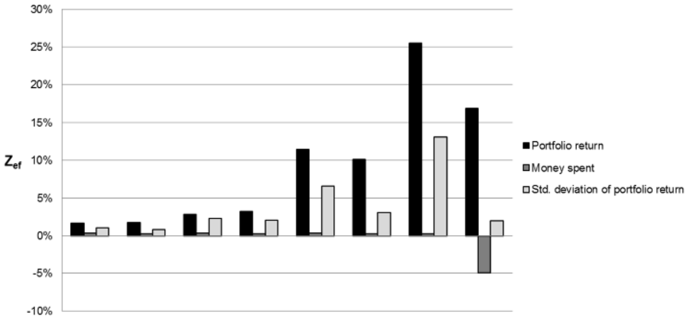
Apparently, the gap between the portfolio returns gained by centralized and decentralized decision-making is not only affected by the strength and number of interdependencies, but also by the scarcity of funds. Particularly if many interdependencies exist, the gap rises when more funds become available. This can be explained by the fact that more projects are selected in this case and, thereby, the likelihood rises that local decision makers disregard competitive interdependencies. In the centralized case, in contrast, these interdependencies can be taken into account systematically. A conclusion from this observation is that in particular large project landscapes should be controlled centrally if significant interdependencies exist. This effect is amplified by the circumstance that interdependencies between a small number of projects might also be recognized without central control in practice.

As visualized in Figure 23, centralized IT project portfolio selection also leads to a lower standard deviation of the returns for the given setting. This lower variation is a consequence of the fact that the centralized decision maker may avoid the negative impacts of competitive benefit interdependencies and can compose a balanced portfolio. In the decentralized case, in contrast, avoiding these negative impacts is a matter of luck and likelihood. A possible conclusion is that choosing a centralized decision-making arrangement for IT project portfolio selection may reduce the risk of falling short of predicted benefits in the presence of competitive benefit interdependencies.

5.5.2.3 Effects of complementary cost interdependencies

Figure 24 displays the gap between centralized and decentralized IT project portfolio selection in the presence of complementary cost interdependencies. As noted in section

5.4.5.4, complementary cost interdependencies may be caused, for example, by the reuse of resources or by learning effects.[803] They may also accrue if a company can negotiate discounts because several business units simultaneously introduce the same solution.[804]



Factor combination	1	2	3	4	5	6	7	8
Budget in relation to total costs	-	+	-	+	-	+	-	+
Number of interdependencies	-	-	+	+	-	-	+	+
Interdependency weight	-	-	-	-	+	+	+	+

Figure 24: Effects of complementary cost interdependencies

Figure 24 visualizes that the presence of complementary cost interdependencies has a strong impact on the gap between the portfolio returns obtained in both arrangements. The exploitation of strong complementary cost interdependencies leads to savings in the project costs. This money, in turn, is used by the centralized decision-making unit in order to fund additional projects and, thereby, may significantly increase the portfolio return. Similar to the effect of complementary benefit interdependencies,[805] the complementary cost interdependencies lead to a higher interconnectedness of the projects and, thus, may slightly increase the standard deviation of the returns in the centrally selected portfolio. Though this effect is quite weak, falling short of the anticipated synergies obtained from complementary cost interdependencies can lead to a budget overrun. Depending on the uncertainty inherent in the cost and benefit estimates, this effect can make centralized decision-making more risky and more ambitious than decentralized decision-making in this setting.

[803] Cf. Kundisch & Meier, 2011a, p. 482; Santhanam & Kyparisis, 1996, p. 383.
[804] Cf. Shapiro & Varian, 1998, p. 140f.
[805] Cf. section 5.5.2.1.

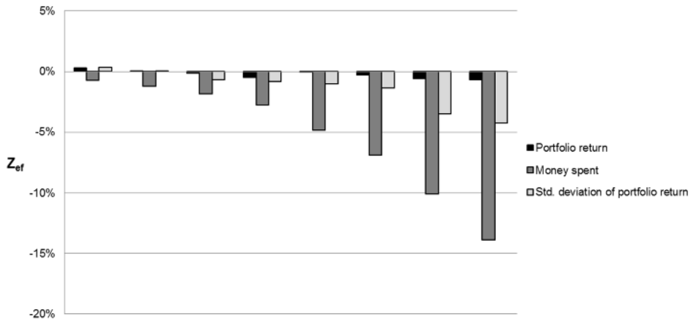
Interestingly, the scarcity of funds (factor 1) has a quite strong effect in the prevalence of a high number of strong complementary cost interdependencies. This is probably due to the circumstance that, in contrast to decentralized decision makers, the centralized decision maker is able to exploit significant cost-saving potentials, even if the budget is strongly rationed (e.g. factor combination 7 in Figure 24). If more funds become available, the decentralized decision makers can exploit additional complementary cost interdependencies whereas the centralized decision-making unit can only make limited use of the additional funds as most of the interdependencies are already exploited. Factor combination 8 is a rather extreme case, as in this case, the centralized unit can select all candidate projects yielding a positive return, without spending the entire budget. Hence, relatively more budget is consumed in the decentralized arrangement in this case. In general, instead of reinvesting the money saved due to complementary cost interdependencies into additional candidate projects, the centralized unit could also save the money for future funding decisions. In practice, this would be rather unlikely as it is quite tempting to transfer the money to urgent initiatives or “pet projects”.[806]

From the above observations it can be hypothesized that especially in constellations where budgets are strongly restricted and strong complementary cost interdependencies prevail, a centralized governance arrangement may likely be preferable to a decentralized arrangement.

5.5.2.4 Effects of competitive cost interdependencies

Figure 25 visualizes the gap between centralized and decentralized IT project portfolio selection in the presence of competitive cost interdependencies. As noted in section 5.4.5.5, competitive cost interdependencies accrue, for example, if several projects compete for the same scarce human resources and thereby impede each other if implemented at the same time.[807]

[806] Cf. Kendall & Rollins, 2003, p. 322.
[807] Cf. Kundisch & Meier, 2011a, p. 482.



Factor combination	1	2	3	4	5	6	7	8
Budget in relation to total costs	-	+	-	+	-	+	-	+
Number of interdependencies	-	-	+	+	-	-	+	+
Interdependency weight	-	-	-	-	+	+	+	+

Figure 25: Effects of competitive cost interdependencies

Figure 25 in particular displays that the prevalence of competitive cost interdependencies can lead to a significant gap concerning the money spent in centralized and decentralized decision-making arrangements. This effect is largely due to overspending in the decentralized case. Figure 26 displays the degree of overspending in the decentralized setting in relation to the available budget.

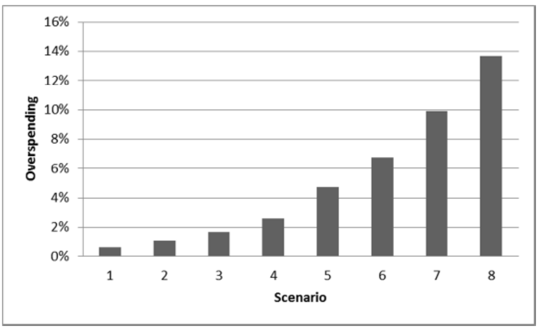


Figure 26: Overspending in the decentralized arrangement

Though the budget restriction is indirectly disregarded to a certain extent in the decentralized decision-making arrangement, the additional benefit gained in comparison to the centralized arrangement is relatively low. This is due to the circumstance that the additional gains obtained from the relaxation of the cost restriction are compensated by the additional costs not taken into consideration. In some cases, this can lead to a selection of projects with a negative value proposition.

In practice, overspending is often prohibitive and may lead to severe consequences. In this case, the project portfolios selected in the decentralized arrangements would have to be strongly reduced or several projects would have to be postponed in order to compensate for the overspending. Consequently, in companies where budget overspending is prohibitive, it is particularly advisable to account for competitive cost interdependencies during project portfolio selection. Again, a centralized arrangement might be preferable in this situation.

5.5.3 Discussion and limitations

The foregoing analysis illustrates how the general conception can be used to compare the effects of different influencing factors depending on different decision-making constellations. The analysis also demonstrates that the impact of different kinds of interdependencies on the preferability of centralized decision-making can be quite distinct. This fortifies the need for a contingency perspective on governance arrangements for IT project portfolio selection, as emphasized in the empirical study described in chapter 4.

The previous computational study is intended mainly as a demonstration of how the conception introduced in section 5.4 can be adopted. Although the simulation results obtained in 5.5.2 fit well to a number of theoretical and practical predictions, this approach is not intended for predictions in real-world settings. Rather, the main potential of the approach is to reveal possible impacts of and general relationships between the investigated parameters in order to derive analytic propositions. A wide range of future research opportunities exist. In particular, also federal decision-making arrangements where decision-making competencies are distributed between several hierarchy levels can be investigated. Moreover, additional influencing factors such as the impact of the number of decision-making units involved can be included in future studies. Still, it is important to note that the resulting findings and propositions should always be critically confronted to empirical observations.

The current study is subject to a number of limitations. First, there are several limitations concerning the level of detail modeled and considered in the above approach. In particular, the project benefits are expressed in financial terms, the resource allocation level is not considered and time-dependent aspects are not modeled. These limitations can be addressed by a number of model extensions. For example, the objective function can easily be adjusted in order to incorporate weighted scoring approaches. Thereby, different benefit dimensions (e.g. the strategic impact of the project) can be incorporated.[808] In order to also address the resource allocation level, for example the model proposed by Heimerl & Kolisch could be incorporated into the given conception.[809] In this context, also time-dependent aspects could be considered by taking account of the portfolio of active projects and by considering project delays, overwork and outsourcing to external providers.[810] For a demonstration of the general conception, it has been opted for a rather simple model in this dissertation. It should be reemphasized that the approach is not intended to be applied in real-world scenarios and, therefore, may remain at a high level of abstraction. Still, some of the above-mentioned model extensions – in particular the incorporation of the resource management level – promise to reveal additional interesting effects and consequently are considered as opportunities for future research.

Second, apart from limitations to the model, there are also limitations concerning the way input parameters were chosen for the computational study. In particular, the cost and benefit values had to be drawn from theoretical distributions in the absence of empirical data. In order to create realistic settings, practitioners were consulted and the existing literature was searched for real-world project samples. While the practitioners provided general information about the nature of their portfolios, no disaggregated data was provided due to the high level of data confidentiality. The literature search yielded a number of existing project samples.[811] However, these samples typically were rather small or artificial and project characteristics differed significantly between these samples.[812] No generalizable information about the distributions of project costs and benefits in practice was inferred and, consequently, it was reverted to theoretical distributions. In order to evaluate to which degree the distribution of the project benefits and costs influences the outcomes, the author decided to replicate the entire simulation design for alternative cost and benefit distributions. For a first replication, the project costs and benefits were drawn from a uniform distribution (U(0; 2,000,000)). For

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808 It should be noted that in this case, benefit interdependencies also have to be modeled in a different way. For example, different groups of benefit interdependencies could be considered in order to address the different benefit dimensions.

809 Cf. section 5.3.

810 Cf. Heimerl & Kolisch, 2010, pp. 348–350.

811 E.g. Abe et al., 2007; Angelou & Economides, 2008; Bardhan et al., 2004; Kenneally & Lichtenstein, 2002; Kira et al., 1990; Kulak et al., 2005; Santhanam & Kyparisis, 1995, 1996; Shoval & Giladi, 1996.

812 As an exception, Verhoef provides benchmarks for estimating costs, durations, and staff sizes of software development projects (Cf. Verhoef, 2002). These benchmarks are derived from a large knowledge base on software projects collected by Capers Jones (cf. Verhoef, 2002, p. 15). Verhoef also provides aggregated data describing the distribution of project sizes in this knowledge base (cf. Verhoef, 2002, p. 16). Consequently, a cost distribution could potentially be fitted to this data. In contrast, information concerning the distribution of project benefits and the relationship between project costs and benefits is considerably rare. This relationship may also differ from company to company. Thus, for future studies, it seems to be recommendable to limit the focus to a particular kind of project landscape with common project characteristics.

another replication, the costs were drawn from an exponential distribution and the project benefits were derived by multiplying the cost values with values drawn from a uniform distribution (U(0,10)). Thereby, the circumstances that projects may largely differ in their size and that project benefits and costs may be correlated were accounted for. Although these variations had significant impacts on the absolute values of the obtained results, interestingly, the shape of the diagrams depicted in section 5.5.2 merely changed. Consequently, the results seem to be quite robust to variations in the structure of the project landscape as long as the characteristics of the projects proposed by different units are comparable.

In addition to the distribution of project costs and benefits, also the topology of project interdependencies, e.g. the distribution of interdependencies between the different projects in the portfolio, might exert a significant influence on the outcomes of project portfolio selection. Unfortunately, empirical data about project interdependencies is very sparse and not sufficient in order to identify general topologies of the network of projects and interdependencies.[813] In absence of such data, the interdependencies were distributed randomly for the purpose of the current investigation. This is a limitation of the current study as well as an opportunity for further research. The given conception would foster an investigation of the impact of different topologies of project interdependencies on the outcomes of project portfolio selection in different governance arrangements. Consequently, empirical data on topologies of project interdependencies would be an important impetus for future work. Without such data, a simulation of different topologies would be speculation. Hence, it has been opted against such a comparison for the current study.

Finally, the way the uncertainty inherent in the input parameters is considered in the above study is subject to limitations. Deviations in the cost and benefit parameters are taken into account by generating a large number of scenarios and independently solving the respective optimization problems in a deterministic way. Based on the outcomes for the different scenarios, an empirical probability distribution can be calculated. This is a common approach for risk analysis. However, a significant downside of this approach is that the optimal solution is obtained independently for each individual scenario. Thereby, the portfolio return that could be gained in practice is overestimated. In practice, the project portfolio has to be

[813] The few identified samples that contain estimations of project interdependencies are hardly comparable as the respective authors are typically concerned with specific aspects of project interdependencies.

selected ex ante, before the realization of the project parameters is known.[814] Consequently, in order to display the tradeoff a decision maker would face in reality, an efficient frontier-based approach seems to be better suited in this context. A corresponding approach for the current conception will be briefly presented in the following section.

5.6 A visual comparison approach based on a risk/return perspective

In the following, again, the conception described in section 5.4.1 is employed in order to compare different governance designs in the presence of different kinds of interdependencies. However, in contrast to the preceding section, the decision-making behavior of the different authorities involved is not modeled by solving a quantitative optimization model. Instead, the concept of efficient frontiers is employed in order to visualize the perspectives of different decision makers. For this purpose, a software prototype is introduced. The main objective in this section is to demonstrate the different risk and return perspectives of centralized and local decision makers. As in the previous section, insights into the impact of different organizational designs on potential outcomes of IT project portfolio selection are derived. Moreover, by incorporating an alternative approach for IT project portfolio selection it is also demonstrated that the conception described in section 5.4.1 is generic and can be combined with different approaches.

In contrast to the optimization model described in section 5.4.4, the approach introduced in the following does not identify a single portfolio. Instead, several good portfolios are identified and presented to the decision maker. Consequently, the exploration of the solution space and the final choice are left to the decision maker. The main advantage of such an approach is that decision makers do not have to specify their preferences completely in advance, but can choose from different options.[815]

In the following, the data composed for the illustrative example in section 5.4.5 is reused in order to demonstrate the approach. Here, it is assumed that the interdependencies in the illustrative example represent complementary benefit interdependencies. In contrast to section 5.4.5, the specific parameter values are of secondary importance in this section.

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[814] This issue could be partly addressed by calculating the "membership fraction" of each project, i.e. the share of scenarios in which the respective project is selected (cf. Abe et al., 2007, pp. 785, 792f.). Thereby, an indicator for the importance of each project can be provided. However, this approach is also unsatisfying in the current context as it only provides an indication of the performance of single candidate projects. A decision maker would be more interested in a selection of preferable portfolios.

[815] This approach falls into the category of approaches depicted at the right-hand side of Figure 15 in section 3.2.6. Instead of determining a single optimal portfolio, different alternative portfolios are identified and evaluated.

In section 5.6.1, the process of specifying the required input data is described. Following, in section 5.6.2, approaches for identifying efficient portfolios are briefly discussed and the developed software prototype is introduced. The visual presentation of the identified portfolios is portrayed in section 5.6.3. In section 5.6.4, the perspectives of local decision makers are compared with the perspective of a centralized decision maker based on displays provided by the software prototype. Finally, section 5.6.5 contains a brief conclusion and a discussion of the limitations of this visual approach.

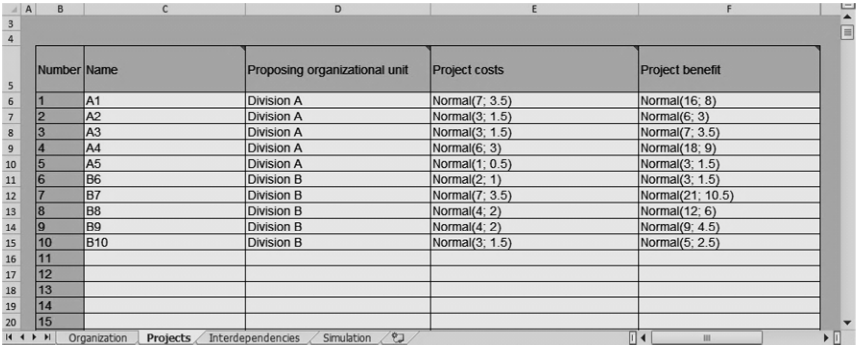
5.6.1 Data input and visualization

In general, the input parameters required for the software prototype correspond to the model parameters introduced in section 5.4.3. This input data can be specified in an Excel workbook composed of several spreadsheets. The spreadsheets are used to collect the input data concerning the organization under investigation, the candidate projects, the project interdependencies, and additional simulation settings like the number of scenarios to be created.

In contrast to the setting described in the illustrative example, the project costs and benefits can be specified in terms of probability distributions instead of crisp numbers, in order to take account of the uncertainty contained in these value estimates.[816] The formatting of the spreadsheets is designed in such a way that the specified data can later be automatically imported into the software prototype calculating and displaying the efficient frontiers. Figure 27 displays an excerpt of the workbook used for specifying the data of the illustrative example. In contrast to the original data contained in Figure 21, the crisp values are replaced by normal distributions.[817]

[816] In the current implementation, normal distributions, Poison distributions, uniform distributions and triangular distributions are supported. Additional distributions can be added quickly as the program is written in an extendable fashion.

[817] The chosen normal distributions only serve as examples. In practice, triangular distributions are often used in order to describe the worst, best, and average case.



Number	Name	Proposing organizational unit	Project costs	Project benefit
1	A1	Division A	Normal(7; 3.5)	Normal(16; 8)
2	A2	Division A	Normal(3; 1.5)	Normal(6; 3)
3	A3	Division A	Normal(3; 1.5)	Normal(7; 3.5)
4	A4	Division A	Normal(6; 3)	Normal(18; 9)
5	A5	Division A	Normal(1; 0.5)	Normal(3; 1.5)
6	B6	Division B	Normal(2; 1)	Normal(3; 1.5)
7	B7	Division B	Normal(7; 3.5)	Normal(21; 10.5)
8	B8	Division B	Normal(4; 2)	Normal(12; 6)
9	B9	Division B	Normal(4; 2)	Normal(9; 4.5)
10	B10	Division B	Normal(3; 1.5)	Normal(5; 2.5)
11				
12				
13				
14				
15				

Figure 27: Specification of input data

After having specified the input data, the program for determining the potential portfolios can be started. In the first step, a graph-based visualization of the specified project data is presented in order to recheck the data and to make refinements.[818] For example, interdependencies can be added or removed via this display. A node in the graph represents a project; vertices correspond to project interdependencies. The color and the position of a node indicate which organizational unit proposed the respective project. Figure 28 depicts the visualization of the illustrative example.

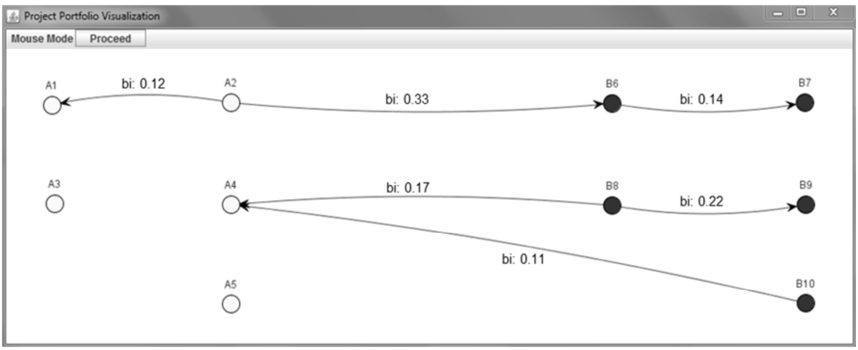


Figure 28: Visualization of the candidate project portfolio

[818] These visualizations are similar to the visual project maps proposed by Killen & Kjaer as a means to support strategic project portfolio decisions (cf. Killen & Kjaer, 2012, p. 559).

5.6.2 *Problem solving process*

After proceeding from the portfolio visualization, a dialog is displayed in order to specify the parameters required for the problem solving process (cf. Figure 29). More precisely, different meta-heuristics and different components for these meta-heuristics can be selected and the parameters required for the respective solution components can be specified.[819]

A brute-force approach in order to identify all efficient portfolios is to completely enumerate all combinations of the binary selection states for all projects and then to determine the portfolios not dominated by other portfolios.[820] This approach is feasible for small problem instances.[821] However, due to the many combinatorial options,[822] this approach quickly becomes infeasible for a large number of projects.[823] The problem becomes even more difficult to solve when interdependencies between the projects and uncertainty in the project parameters need to be considered.[824] For this reason, meta-heuristics are provided in order to determine good portfolios in feasible time-spans for large problem instances. In the software prototype presented in the following, a genetic algorithm and a tabu search heuristic are included in addition to the complete enumeration approach. As already noted, the preferred solution procedure can be specified via the graphical interface. For example, the selection- and mutation-procedures for the genetic algorithm and the size of the tabu list for tabu search can be selected.[825]

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[819] The software prototype described in the following has been developed in a joint effort as part of a student's thesis (Weimer, 2013).

[820] Cf. Doerner et al., 2006, p. 830. Note that branch & bound procedures can be employed in order to reduce the solution space.

[821] For the illustrative example, the potential portfolios have been completely enumerated as only ten projects are contained in the set of candidate projects. In this case, a complete enumeration of all potential portfolios can be conducted in a few minutes.

[822] If n denotes the number of candidate projects and all decision variables are binary, there are 2^n potential portfolios.

[823] Cf. Doerner et al., 2006, p. 830.

[824] Also compare Gutjahr & Reiter, 2010, p. 424.

[825] The interface and the underlying program code are designed in a modular way. Consequently, additional meta-heuristics can easily be added. For example, simulated annealing or ant colony algorithms (cf. Doerner et al., 2006) could easily be incorporated.

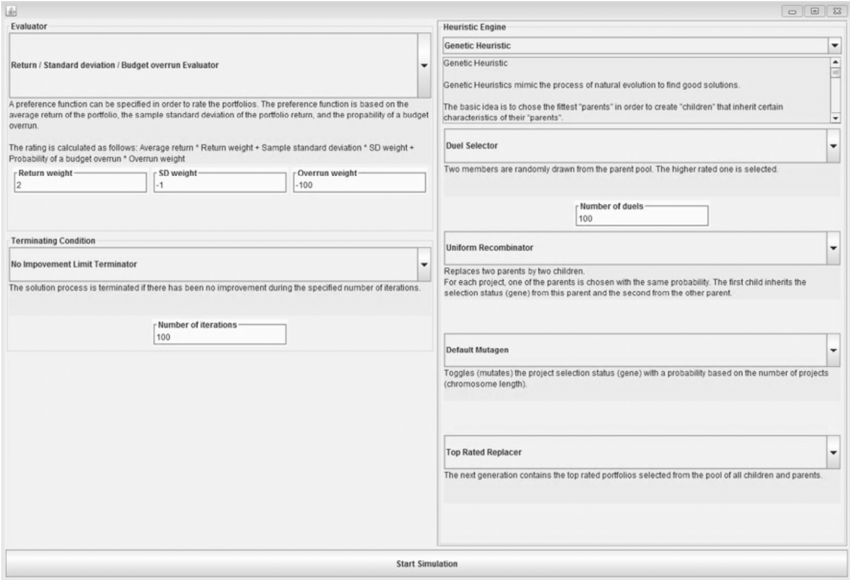


Figure 29: Graphical interface for specifying the problem solving process

For brevity, the two meta-heuristics implemented in the current version are not described in more detail here. For descriptions of genetic algorithms and tabu search, it is referred to the respective literature.[826] It should be highlighted that, due to the heuristic nature of these algorithms, there is no guarantee that all efficient portfolios are identified. Rather, only a selection of considerably good portfolios is obtained this way. The quality of the solution depends on the chosen heuristic, the chosen parameters, the specified preference function, and the termination criterion.

After the solution procedure has been selected, the respective algorithm is triggered. In several iterations, different portfolios are generated, rated, and compared. At the end of each iteration, typically only a subset of the generated portfolios is retained. High-rated portfolios are usually retained with a higher probability than low-rated portfolios. Thereby, better

[826] Different meta-heuristics, including evolutionary algorithms, are described inter alia by Dréo et al., 2006. Tabu search is described for example by Glover, 1989, 1990. An often-cited standard work on genetic algorithms has been written by Goldberg, 1989.

portfolios shall be identified over time.[827] The problem solving process terminates after a predefined number of iterations or if no better solution has been identified for a specified number of iterations.

In order to account for the risk inherent in the project parameters, a Monte Carlo simulation is conducted for every newly generated portfolio.[828] For this purpose, a pre-specified number of scenarios are created. For each scenario, a crisp value is drawn from the risk and return probability distributions of the projects contained in the portfolio. Thereby, the combined effect of the uncertainty inherent in the single project estimations is approximated at the portfolio level.[829]

For each scenario, the portfolio benefit $F_o(\boldsymbol{x})$ and the money spent $C_o(\boldsymbol{x})$ for a specific portfolio composed of candidate projects in the decision domain of organizational unit o ∈ O are calculated as follows:[830]

$$F_o(\boldsymbol{x}) = \sum_{i \in P_o} (b_i - c_i) \cdot x_i + \sum_{i \in P_o} \sum_{\substack{j \in P_o \\ i \neq j}} \big((v_{ij} \cdot b_i) - (r_{ij} \cdot c_i)\big) \cdot x_i \cdot x_j \quad (9)$$

$$C_o(\boldsymbol{x}) = \sum_{i \in P_o} c_i \cdot x_i + \sum_{i \in P_o} \sum_{\substack{j \in P_o \\ i \neq j}} r_{ij} \cdot c_i \cdot x_i \cdot x_j \quad (10)$$

$$x_i, x_j \in \{0,1\} \qquad \forall\, i, j \in P_o \quad (11)$$

In accordance with the conception introduced in section 5.4, the different organizational units independently search for a solution (i.e. a preferred portfolio) within their decision domain. In order to contrast the resulting perspectives of local decision-making units with a centralized perspective, an additional efficient frontier is always determined for the combined set of candidate projects.

[827] However, an important characteristic of these meta-heuristics is that they also explicitly allow for a temporary decline in the portfolio ratings in order to overcome local maxima.

[828] The results obtained for a newly generated portfolio are stored for the following iterations in order to avoid time-consuming recalculations.

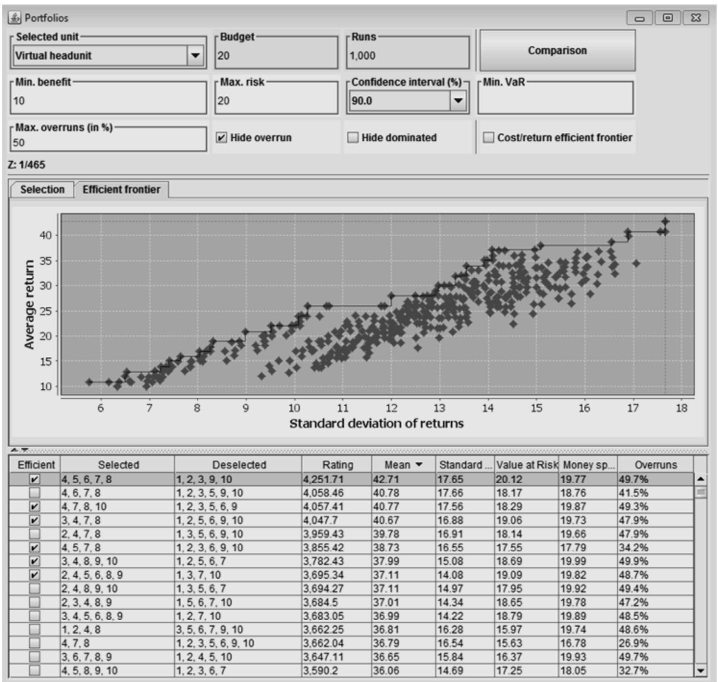
[829] Note that there is a significant difference between this approach and the risk estimation approach described in section 5.5. In section 5.5, different scenarios were generated and an optimal portfolio was chosen for each scenario. Here, several scenarios are created for each identified portfolio and the respective outcomes are compared. This approach is often recommended in order to consider the variance inherent in the project parameters (cf. Bardhan et al., 2006, p. 4; Burke & Shaw, 2008, p. 9; Costa et al., 2007, p. 23; Gabriel et al., 2006, p. 302).

[830] Note that, in contrast to the optimization model presented in section 5.4.4, formulas 9 and 10 simply represent calculations and not objective functions.

In line with the assumptions described in section 5.4.2, it is assumed, again, that cross-unit interdependencies are not taken into account by local decision makers. Analogous to the computational study described in section 5.5, the ignorance of cross-unit interdependencies of complementary nature directly affects the valuation of the alternative portfolios. Consequently, in the presence of a high number of complementary cross-unit interdependencies a centralized decision maker is likely to obtain a superior portfolio. The effect of ignoring competitive cross-unit interdependencies, in contrast, cannot be directly incorporated here as this effect depends on which portfolios will finally be chosen by the different decision makers. This limitation will be discussed in more detail in section 5.6.5.

5.6.3 *Presentation of results*

The problem solving process produces a set of high-rated portfolios for each decision-making unit. The results can be explored separately for each local unit and the (virtual) centralized unit. Figure 30 displays the centralized perspective on project portfolios composed of the candidate projects taken from the illustrative example.



Efficient	Selected	Deselected	Rating	Mean	Standard ...	Value at Risk	Money sp...	Overruns
✔	4, 5, 6, 7, 8	1, 2, 3, 9, 10	4,251.71	42.71	17.65	20.12	19.77	49.7%
☐	4, 6, 7, 8	1, 2, 3, 5, 9, 10	4,058.46	40.78	17.66	18.17	18.76	41.5%
✔	4, 7, 8, 10	1, 2, 3, 5, 6, 9	4,057.41	40.77	17.56	18.29	19.87	49.3%
✔	3, 4, 7, 8	1, 2, 5, 6, 9, 10	4,047.7	40.67	16.88	19.06	19.73	47.9%
☐	2, 4, 7, 8	1, 3, 5, 6, 9, 10	3,959.43	39.78	16.91	18.14	19.66	47.9%
✔	4, 5, 7, 8	1, 2, 3, 6, 9, 10	3,855.42	38.73	16.55	17.55	17.79	34.2%
✔	3, 4, 8, 9, 10	1, 2, 5, 6, 7	3,782.43	37.99	15.08	18.69	19.99	49.9%
✔	2, 4, 5, 6, 8, 9	1, 3, 7, 10	3,695.34	37.11	14.08	19.09	19.82	48.7%
☐	2, 4, 8, 9, 10	1, 3, 5, 6, 7	3,694.27	37.11	14.97	17.95	19.92	49.4%
☐	2, 3, 4, 8, 9	1, 5, 6, 7, 10	3,684.5	37.01	14.34	18.65	19.78	47.2%
☐	3, 4, 5, 6, 8, 9	1, 2, 7, 10	3,683.05	36.99	14.22	18.79	19.89	48.5%
☐	1, 2, 4, 8	3, 5, 6, 7, 9, 10	3,662.25	36.81	16.28	15.97	19.74	48.6%
☐	4, 7, 8	1, 2, 3, 5, 6, 9, 10	3,662.04	36.79	16.54	15.63	16.78	26.9%
☐	3, 6, 7, 8, 9	1, 2, 4, 5, 10	3,647.11	36.65	15.84	16.37	19.93	49.7%
☐	4, 5, 8, 9, 10	1, 2, 3, 6, 7	3,590.2	36.06	14.69	17.25	18.05	32.7%

Figure 30: Visualization of alternative portfolios from a centralized perspective

The portfolio characteristics are presented in tabular form as well as in an interactive visualization of the efficient frontier. Due to the binary decision variables, the efficient frontier has a stepwise form. A project can either be approved or rejected. Therefore, in contrast to the concept of efficient frontiers as described in investment theory, there are a discrete number of potential portfolios to choose from, instead of a continuum.

The axis of ordinates of the efficient frontier displays the expected return for the respective portfolios.[831] The axis of abscissae displays the sample standard deviation of the returns. Thereby, the variance inherent in the project return estimates is taken into account. The variance in the project costs, in contrast, is not directly considered in the efficient frontier. In general, stochastic cost parameters have to be treated as a special case. In the presence of stochastic cost parameters, the presentation of results becomes more complicated as the total costs of the portfolio become a stochastic output and, thus, it cannot be ascertained with certainty that the given budget-restriction is not violated.[832] Still, several metrics are provided in order to describe the probability and the impact of potential budget overruns.[833] For example, the simulation framework determines the sample mean value of the budget consumption for each portfolio. Moreover, the share of scenarios in which the given budget is violated, is provided as an indicator for the probability of a budget overrun.[834]

In general, different filters are provided in order to search for portfolios with specific characteristics and to limit the solution space. For example, portfolios leading to a budget overrun on average can be excluded by default. Moreover, limits can be specified for the minimal return, the maximal sample standard deviation, and/or the maximal probability of a budget overrun. The candidate portfolios are then limited to those that satisfy these conditions within a specified confidence interval. For example, the decision maker can specify that the

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[831] The expected return is measured as the sample mean value of the portfolio returns obtained in the different scenarios (in this case, 1,000 scenarios for each portfolio).

[832] In general, in situations where the budget is not strictly rationed, a cost/return efficient frontier can be an alternative to the risk/return efficient frontier. By replacing the risk dimension by the cost dimension, the tradeoff between higher spending and higher returns can be visualized. Such cost-oriented efficient frontiers are rather common in the project portfolio management domain and have been proposed by several authors (e.g. Cao et al., 2005, p. 370f.; Gruia, 2005, pp. 179–181; Montibeller et al., 2009, p. 851; Nicholas & Steyn, 2008, p. 619f.; Phillips & Bana e Costa, 2007, pp. 55–63). Such cost/return displays are also implemented in the software prototype. However, due to space restrictions, only risk/return efficient frontiers are displayed in this section.

[833] These metrics could also be incorporated directly into the visualization as additional dimensions. For example, the candidate portfolios can be displayed in different shapes or colors. However, with additional dimensions, the decision maker might be overburdened with too much information (cf. Stummer et al., 2009, p. 389).

[834] Similar indicators are described and used by Touran and Wang & Hwang (cf. Touran, 2010, p. 361f.; Wang & Hwang, 2007, p. 256).

portfolio returns of all candidate portfolios have to exceed 35 monetary units with a 99 percent probability.[835] Thereby, the displayed portfolios can be limited to those with preferable characteristics.

5.6.4 Comparison of centralized and decentralized perspectives

As noted at the beginning of this section the main purpose of the framework presented here is to contrast the perspectives of different decision makers. These different perspectives can be compared by contrasting the efficient frontiers calculated for all decision-making units. Figure 31 displays a combined view for the given example.

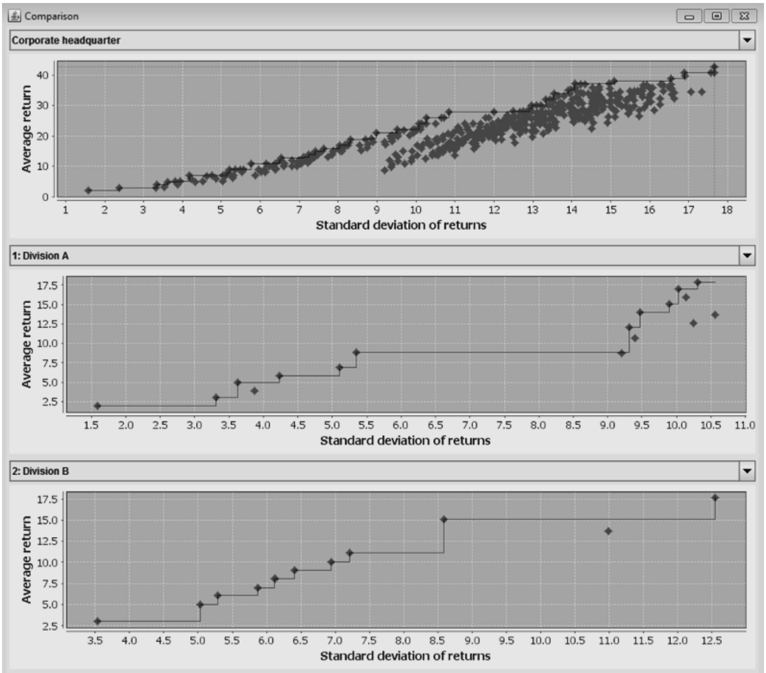

Figure 31: Comparison of the centralized and decentralized perspectives

[835] In this case, the lower partial moments are specified in order to identify the downside risk. Based on the specified probability, the Value at Risk is calculated. Similar filters can easily be added in order to provide additional risk measures like the Conditional Value at Risk. For a discussion of the advantages and disadvantages of different risk measures for evaluating uncertain alternatives, compare Graves & Ringuest, 2009 and Liesiö & Salo, 2012, p. 164. For an analysis of the appropriateness of the mean-variance criterion and alternative asymmetric risk measures, compare King, 1993.

A number of findings can be derived by comparing the different displays in Figure 31. In particular, the figure provides a good demonstration of the circumstance that the centralized decision maker can choose from a significantly larger variety of candidate portfolios than the decentralized decision makers can. Portfolios most likely resulting in a budget overrun are already filtered in this example. Still, a large number of candidate portfolios remain. This has two implications. On the one hand, the centralized decision maker can obtain a portfolio that well with the requirements of the company. On the other hand, the decision maker may more likely become overburdened by the amount of information to be taken into account, in particular if additional criteria have to be considered. Thus, it is understandable that decision-making competency for minor projects is often assigned to local units in order to reduce the amount of information to be handled at the corporate level. This is in line with the findings from the case study described in section 4.5.4.3 and may illustrate why the coordination mechanism described in section 5.4.1 is quite common in practice.

The example also demonstrates that the local decision makers are not fully aware of potential diversification effects due to their local perspectives. The data reveals that the sum of the sample standard deviations for two local portfolios for division A and B is typically significantly higher than the sample standard deviation determined for the combined portfolio. In addition, cross-unit interdependencies also influence the sample standard deviation as well as the financial return of the combined portfolio. Consequently, the centralized decision maker can better oversee the risk-related implications of project portfolio selection.

In order to demonstrate the different perspectives on a particular candidate portfolio, the portfolio chosen by the corporate headquarter in section 5.4.5 can be taken as an example. In the deterministic case, the portfolio composed of projects A4, A5, B6, B7, and B8 has been identified as the optimal solution (cf. Table 15). This portfolio is also contained in the efficient frontier for the corporate headquarter displayed in Figure 30. The portfolio is displayed in the upper right of the efficient frontier. It is the portfolio with the highest benefit but also the highest sample standard deviation. Table 21 describes the key characteristics of this portfolio in comparison to the characteristics of the sub-portfolios that are displayed to the local decision makers. It is obvious that the characteristics of the sub-portfolios largely diverge from the characteristics of the combined portfolio. While the candidate portfolio for the corporate headquarter and the sub-portfolio for division A are displayed as potential options by the prototype, the portfolio composed of projects B6, B7 and B8 is removed from the view for division B due to the very high probability of a budget overrun.

Table 21: Characteristics of a corporate-wide project portfolio and its local sub-portfolios

Decision-making unit	Portfolio	Mean return	Sample standard deviation	Sample probability of a budget overrun	Efficient?	Filtered?
Corporate headquarter	A4, A5, B6, B7, B8	42.71	17.65	49.7%	Yes	No
Division A	A4, A5	13.99	9.47	14.4%	Yes	No
Division B	B6, B7, B8	25.74	14.19	74.8%	Yes	Yes

The example also demonstrates the potential conflict between the divisions and the corporate headquarter. Even if decision makers in division B recognized the potential diversification effects, the risk inherent in the local portfolio would presumably be more relevant to them than the risk inherent in the corporate-wide portfolio. They would most likely avoid the high risk to overspend. This example illustrates the importance of taking account of the incentives of different stakeholders and of potential goal conflicts as discussed in section 4.5.6.4.

5.6.5 Discussion and limitations

In this section, it has been demonstrated, inter alia, that the general conception for comparing the outcomes of different decision-making designs introduced in section 5.4 is rather generic. The same comparison as demonstrated in Figure 31 could also be conducted based on different kinds of visualizations and different project portfolio selection approaches. A major advantage of the current approach is that the different options and incentives of different stakeholders are visualized in an intuitive way. As briefly demonstrated above, insights obtained from the comparison of different designs can well be compared with qualitative insights.

In contrast to the optimization-based approach employed in the computational study in section 5.5, the given prototype may also be of practical use if adapted to the specific situation and requirements of a given company. The use of efficient frontiers for project portfolio selection is proposed in several textbooks and visualizations of efficient frontiers are often included in commercial project portfolio management software.[836] Consequently, the situation modeled above might be comparable to the situation in a number of companies where efficient frontiers are employed for decision support.[837] The current approach also demonstrates that there is typically a range of choices different decision makers may select from. However, the downside of this approach is that the choices of decentralized and centralized decision makers

[836] Cf. Gruia, 2005; Nicholas & Steyn, 2008, p. 619f.

[837] In practice, different tools and techniques are often combined. Moreover, the information provided by these tools and techniques is not always taken into account and is used in different ways by different decision makers. Typically, uncertainty and subjective aspects also have a huge impact during the decision-making process (cf., e.g., Gruia, 2005, p. 180f.; Nicholas & Steyn, 2008, p. 620). Still, the concept of (cost/benefit) efficient frontiers is quite pervasive in project portfolio management theory and practice.

cannot be compared directly, but only by visually comparing the different efficient frontiers.[838] This leads us to the limitations of the approach presented in this section.

A main limitation is that only the effect of ignoring complementary cross-unit interdependencies is incorporated in the visual displays. The effect of ignoring competitive cross-unit interdependencies cannot be directly considered as this effect depends on the final choices taken by the local decision makers. This is a direct consequence of assumption A4 in section 5.4.2. In general, due to assumption A4, the effect of competitive cross-unit interdependencies can only be considered when definite portfolios are provided by the project portfolio selection procedure employed.

Another limitation to the approach is that, similar to the optimization problem introduced in section 5.4.4, it is in particular applicable to financial input data. Still, additional benefit dimensions like the strategic contribution of the portfolio can easily be incorporated into the visualization.[839] However, this would require additional input data and the visualization would become more complex. As the main purpose here is to demonstrate the different perspectives on the portfolio of candidate projects at different levels of an organization, comprehensibility has been preferred to completeness in this case.

As it is made use of efficient frontiers in this section, the general critique concerning the application of modern portfolio theory to the IT project portfolio management context also partly applies to the current approach (cf. section 3.2.2). However, in contrast to the original concept of efficient frontiers proposed by Markowitz, the current approach relies on binary decision variables and takes account of project interdependencies. Thereby, the approach is adapted to the selection of IT projects instead of financial securities.

Finally, the meta-heuristics implemented in the current framework could be improved in computational terms. Different meta-heuristics specifically adjusted to the project portfolio selection context have been presented in the literature. These algorithms are capable of identifying efficient portfolios for large problem instances in relatively short time. As computational aspects were not in the focus of the current study, the implemented algorithms have been kept comparably simple. Consequently, the framework would likely have to be

[838] A single portfolio could be determined if explicit preference functions of all decision makers were known. However, the underlying assumption of comparable approaches is that the decision makers are unable to state their preferences explicitly in full detail.

[839] Alternatively, scoring approaches could be employed in order to aggregate different benefit dimensions into a single benefit score for each portfolio, but these approaches are also criticized, as they tend to homogenize project evaluation and hide detailed information (cf. Zheng & Vaishnavi, 2009, p. 1f.).

adapted in order to compute large problem instances. To this end, the software has been designed in a modular way in order to be able to integrate additional meta-heuristics.

5.7 Final discussion

The approach presented in this chapter provides an empirically grounded framework for analyzing organizational behavior in the context of IT project portfolio management. This framework is intended as an analytical tool and therefore is primarily of theoretical contribution. The general conception allows for modeling and formally analyzing decision-making behavior in organizations, based on different project portfolio selection approaches. It has been demonstrated that the general approach can be employed in order to illustrate empirical findings based on formal analyses. Moreover, also new propositions for future empirical research could be derived based on this framework.

Although the general approach is primarily intended for theoretical purposes and not for decision support, practitioners might also benefit from this approach. For example, it may be used in adjusted forms in order to investigate potential impacts of changes to the current governance mode based on historical project data.

In practice, there is often considerable uncertainty of how well the existing arrangements for IT project portfolio management perform and if better outcomes could be achieved if a different (typically more formal) approach was employed. For example, in a company consulted during the conception phase for the computational study presented in section 5.5, the CIO was interested in an assessment of the performance of the current centralized but rather informal approach for IT project portfolio selection. For this reason, he had instructed a member of his staff to look for a more formal evaluation approach in order to be able to compare the results of the two approaches. In the second company consulted during the conception phase, different business units were currently negotiating a common corporate-wide approach for IT project portfolio selection. This search was triggered by a recent restructuring of the IT supply organization. The board of directors had decided that IT resources and services should be provided by a single unit in future. Formerly, IT services had been provided in a decentralized manner within each individual business unit. Due to the reorganization, a stronger need for coordination emerged. In such a situation, the evaluation of synergies between the IT projects in the different portfolios and a quantitative analysis of the existing IT portfolio data can be of high value in order to provide an objective basis for future discussions.

These two examples demonstrate that the analysis of historical data in order to understand the nature of the project portfolios in different business units can be of high value. In general, changes in the design of governance arrangements for IT project portfolio selection were rather frequent in the companies investigated during the case study research.[840] Consequently, an approach for evaluating potential impacts of different governance arrangements before these arrangements are actually implemented can also be of high relevance in practice. The conception and the models described in this chapter give an impetus to address this requirement.

Of course, this research is not without limitations. In the following, the major limitations and areas of improvement are briefly discussed.

A major limitation to the current research is that factors speaking in favor of federal and decentralized arrangements are not considered in the model. Thus, a gap rather than a tradeoff between different governance designs has been portrayed in the first instance. Of course, decentralized and federal arrangements also provide a number of advantages. For example, a high degree of autonomy and entrepreneurship in the business units is fostered by decentralized arrangements.[841] However, such advantages are of more qualitative nature and a separate qualitative assessment of these advantages seems to be more appropriate than the incorporation into a quantitative model. For this reason, advantages of decentralized and federal arrangements have not been modeled. Analogously, not all contingency factors identified in section 4.5.6 have been modeled. Primarily the impacts of the organizational structure and synergy potentials in the project landscape have been considered. Of course, in order to conduct a complete assessment of the appropriateness of a particular governance arrangement in a given context, also other contingency factors would have to be regarded. Due to these limitations, the outcomes of the comparisons conducted based on the current approach should not be misinterpreted as final recommendations for or against a certain governance design. Still, the identification of the potential gap between the outcomes in different arrangements provides an indication of the value proposition of central coordination. As the introduction of centralized governance arrangements may cause significant costs,[842] the approach can reveal, for example, that a high degree of central coordination is not worthwhile in a given setting. In this context, the gap provides kind of an estimate of how much money may be invested at the utmost in order to establish central coordination.

A limitation of the studies presented in section 5.5 and 5.6 is the implicit assumption that the same approach for IT project portfolio selection is used by the different decision-making authorities. In practice, it is likely that different organizational units use different project

[840] Cf. chapter 4.
[841] Cf. Weill & Ross, 2004, p. 8. Also see the comparison of different arrangements in section 4.5.4 and 4.5.5.
[842] For example, the institution of a centralized portfolio management office may cause significant tangible and intangible costs (cf. Pellegrinelli & Garagna, 2009, p. 652).

valuation and selection techniques, although the organizational culture may foster a certain kind of valuation. In principle, the given conception does not prohibit the modeling of different decision-making approaches for different authorities. However, this would complicate a clear comparison of the results. In order to foster such a comparison of centralized and decentralized decision-making, this aspect has been left unaccounted for in both studies.

A major challenge to the current approach is that project interdependencies are difficult to estimate in practice. Although there are a number of examples in the literature where estimates for IT project interdependencies have been provided by practitioners, this seems to be more of an academic endeavor than a common practice. In the two companies consulted for the quantitative study, for example, the IT project portfolio managers were not able to provide value estimates for project interdependencies, although one of these companies had a quite professional approach to IT project portfolio management. Although project interdependencies definitely have a strong impact in the IT project portfolio management context, they do not necessarily have to be addressed explicitly by centralized project portfolio selection, but can also be considered more implicitly by using different coordination mechanisms.

Despite the above limitations, the approach discussed in this chapter contributes to theory and practice by fostering a systematic investigation of synergy exploitation in different governance arrangements. In existing contributions, interdependencies have all too often only been considered at a composed level between different departments.[843] The current approach, in contrast, uses a fine-grained way of modeling synergy potentials in the IT project portfolio management context and is capable of explicitly retracing the impact of different kinds of interdependencies on IT synergy exploitation in different organizational settings. In this chapter, particularly centralized and decentralized governance arrangements have been investigated. However, the generic way of modeling the empirically derived coordination mechanism offers an opportunity to investigate the impact of a continuum of different governance arrangements in the presence of different IT project portfolio selection and resource allocation conceptions. Other researchers are particularly invited to further investigate the impact of the encountered practice of distributing decision-making rights for different kinds of projects to largely independent decision makers and committees.

[843] Cf. Malone et al., 1999, p. 432.

6 Practical implications

The practical implications of the research described in the foregoing chapters will be briefly discussed here. In the foregoing chapters it has been demonstrated that the given organizational environment as well as cultural and political factors exert a strong influence on IT project portfolio management. While early approaches towards project portfolio management were primarily concerned with procedural aspects and "good practices",[844] recent contributions have outlined that the complex interplay between the stakeholders involved in project portfolio management as well as different environmental factors need to be taken into account when adopting new IT governance arrangements and new project portfolio management practices.[845]

For practitioners responsible for the design of IT governance arrangements, the current research implies that it is vital to conduct a thorough analysis of the given organizational environment, the roles and perception of the stakeholders involved, as well as the characteristics of the IT project landscape before introducing new IT project portfolio management practices. If governance mechanisms for IT project portfolio management are implemented without taking note of such contingency factors, the respective change initiative is likely to fail.[846]

In order to support practitioners in analyzing the adoption of IT project portfolio management practices from a high-level perspective, a general approach is outlined in the following. This approach incorporates the contingency factors identified in chapter 4 and the conception described in chapter 5. The following steps are proposed when assessing the appropriateness of new governance arrangements for IT project portfolio management:

1. Assess if in principle a high degree of coordination is advantageous in the given organization, independently of cultural and political factors that potentially may complicate coordination. In particular, assess if high synergy potentials can be exploited. For this purpose, historical data and the approach presented in chapter 5 may be of help.

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[844] Cf. Martinsuo & Lehtonen, 2007, p. 56.
[845] Cf., e.g., Beringer et al., 2012; Canonico & Söderlund, 2010; El Arbi et al., 2012; Killen et al., 2012; Petit, 2012; Teller et al., 2012; Unger, Gemünden, et al., 2012; Xue et al., 2008.
[846] Also compare Cameron, 2005, p. 398; Hobbs & Aubry, 2007, p. 85; Pellegrinelli & Garagna, 2009, p. 652.

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2. If a high degree of coordination appears to be advantageous in general, assess other important antecedents for the design of IT governance arrangements in the current organization, based on the contingency model presented in section 4.5.6.
3. If a rather centralized governance arrangement for IT project portfolio selection is not appropriate – for example because it would not yield significant synergies or strong resistance is expected – opt for a decentralized or federal arrangement, depending on the degree of autonomy required by local units.
4. If a federal arrangement is chosen, critically assess the appropriateness of budget assignments and the criteria employed for routing projects to different decision-making authorities (e.g. cost thresholds, treatment of mandatory and corporate-wide projects, etc.). Again, historical data can be used in combination with the general approach described in chapter 5 in order to analyze potential outcomes of different governance designs.
5. If a rather decentralized or a federal arrangement is chosen, consider to install additional coordination mechanisms such as the following:
    - Use liaison roles in the demand management field of activity in order to identify interdependencies and redundancies and to keep different decision-making authorities informed about synergy potentials and potential conflicts.
    - In a federal arrangement, interlink decision-making committees at different organizational levels. This can be achieved, for example, by appointing members of parent committees as chairpersons in subordinate committees.
    - Foster unit-spanning relationship networks in order to enable informal information exchange.
    - Install program management practices in order to manage groups of projects with significant cross-unit interdependencies effectively.
6. Align the governance mechanisms employed in the four fields of activities outlined in section 4.5.1 and constantly adjust the governance mechanisms if unfavorable outcomes occur. In particular, closely monitor the use of IT resources. If resources are used over capacity or are primarily assigned to small initiatives with low benefit, reassess the governance arrangements in the four fields of activities. Again, the approach outlined in chapter 5 can be used in order to simulate the impact of alternative budget assignments based on historical data.

In general, it should be noted that completely decentralized arrangements, where business units act entirely independently of each other, are quite rare in practice. Usually, even in organizations with a strong culture of autonomy, some coordination mechanisms exist in order to foster synergy exploitation. As indicated in chapter 4, coordinated decision-making between different independent units can be achieved in several ways in the context of IT project portfolio management. For example, coordination can be fostered by "portfolio process formalization".[847] Alternatively, a centralized project portfolio management office can be established.[848] Coordination can also be achieved by setting up IT duopolies in combination with relationship managers.[849] In addition, program management practices can be introduced in order to account for project interdependencies within a group of projects.[850]

In hierarchically organized companies, it is vital that existing interdependencies are recognized at lower organizational levels and communicated to superior decision-making authorities in order to be able to exploit synergies. For this purpose, decision-making committees composed of representatives of several business units are often installed in practice. As multiple stakeholders are involved in IT project portfolio management, finding a design that suits all interests is virtually impossible. On the other hand, stakeholders who are dissatisfied with a particular design may resist or impede implementation. Consequently, an appropriate governance design has to keep stakeholder satisfaction at an acceptable level while enabling the selection and implementation of an IT project portfolio that reflects the strategic needs of the company and makes use of the available synergy potentials.

In competitive environments, functional and social mechanisms are required in addition to structural devices in order to develop adequate coordination capabilities.[851] As highlighted by Peterson, "[...] in competitive environments, effective IT governance is more likely to resemble a network of relationships rather than classical hierarchical structures."[852] Informal networks can improve coordination and alignment while maintaining the autonomy of the decentralized units. Consequently, companies for which centralized decision-making arrangements and structural coordination mechanisms like unit-spanning committees are not an option should make use of relational mechanisms like expert groups and informal networks.

Due to the strong impact of political factors in the IT project portfolio management context, governance experts are well advised to thoroughly evaluate the positions and interests of all stakeholders and groups involved in IT project portfolio management before trying to establish new governance mechanisms. In this context, top management involvement can play an important role as a clear top management mandate can reduce political behavior. However,

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847 Cf. Teller et al., 2012, p. 599.
848 Cf. Unger, Gemünden, et al., 2012, p. 610f.
849 Cf. Weill & Ross, 2004, p. 62f.
850 Cf. Blomquist & Müller, 2006, p. 55.
851 Cf. Peterson et al., 2000, p. 445.
852 Peterson et al., 2000, p. 445.

in order to gain top management buy-in, it is vital to thoroughly assess and anticipate the advantages and disadvantages of alternative governance designs. This fosters a clear and retraceable argumentation, which is required to convince skeptical stakeholders. By clearly demonstrating the benefits of a superior governance design in terms of portfolio management effectiveness and corporate-wide synergy exploitation, top management buy-in can be secured. However, this can constitute a significant effort. The experiences reported during the case studies described in chapter 4 suggest that the implementation of formal governance mechanisms for IT project portfolio management is often strongly exacerbated if a first attempt had failed. Thus, a trial and error approach should be avoided. Again, this supports a claim for a thorough and systematic evaluation of the current situation and the resulting governance requirements.

In this dissertation, governance arrangements for IT project portfolio management have purposefully been addressed from a quite abstract perspective in order to keep the focus on the major contingencies. Therefore, the foregoing discussion covers the general approach towards changing the design of governance arrangements for IT project portfolio management but not the practical implementation of specific governance mechanisms. Of course, not only the choice of an appropriate governance design but also the proficient implementation of the respective governance mechanisms is vital for a successful change initiative. This requires a deep knowledge of relevant terms, mechanisms, methodologies, and conceptions in the (IT) project portfolio management context. These are thoroughly addressed in frameworks of reference like the PMI standard for portfolio management as well as in a wide range of textbooks oriented towards practitioners.[853] These books also cover a wide range of examples and practical experiences.

[853] E.g. Artto et al., 2001; Bonham, 2005; Dye & Pennypacker, 1999; Kendall & Rollins, 2003; Maizlish & Handler, 2005; Meredith & Mantel, 2006 (chapters 1–6); PMI, 2013.

7 Summary and outlook

This dissertation has been motivated by the continued increase of the number of IT projects in contemporary companies and by the need to manage these projects effectively as a portfolio. In order to implement IT project portfolio management practices in a given organization, appropriate governance arrangements are required. The current work has set out to investigate governance arrangements for IT project portfolio management in sufficient detail and in different contexts. Based on an empirical study and a quantitative modeling approach, the advantages and disadvantages of different governance arrangements have been illustrated and the impacts of different design choices on the exploitation of synergy potentials have been demonstrated.

Concretely, the following objectives have been addressed in the previous chapters:

- Structured analysis and systematization of the current state of the art concerning IT project portfolio management and identification of future research opportunities
- Empirical investigation of current governance practices for IT project portfolio management
- Conception and quantitative modeling of organizational decision-making in the context of IT project portfolio selection
- Simulation of the impact of different governance arrangements on the outcomes of project portfolio selection contingent upon different influencing factors

The structured literature review described in chapter 3 revealed that the IT project portfolio management discipline historically has emerged from two different streams of research. The first stream covers quantitative modeling approaches supporting IT project portfolio selection and resource allocation. The second stream primarily consists of empirical studies of IT project portfolio management practices, success factors, and problem areas. Both streams of research have evolved over time and have made significant methodical, theoretical, and practical progress in recent years. Today, design science provides an important methodical paradigm for research on decision support systems. Moreover, while research in the project management discipline has been criticized for of a lack of theoretical foundations in the past, general theoretical concepts have been adapted to the realm of IT project portfolio management in recent empirical contributions. The two streams of research outlined in chapter 3 are currently beginning to converge. Empirical findings are increasingly taken into account in modern quantitative approaches for decision support. Empirical research on the other hand increasingly takes note of the impact of decision-making tools and methods. Based on recent developments, a further convergence of the two streams of literature is expected.

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Still, there are also a number of emerging issues. In particular, it has recently been emphasized that the design and performance of governance arrangements for IT project portfolio management depend on several contingency factors. This issue has been addressed in detail in this dissertation. The structured literature review presented in chapter 3 contributes to the field of research by integrating existing work, illustrating recent developments and outlining emerging issues. In particular, relevant attributes of modern decision support systems have been described and the need to take a contingent view on governance arrangements has been reemphasized. Thereby, practical requirements for decision support systems are outlined and an impetus for future empirical investigations is given.

Substantive detail on how companies govern project portfolio management in practice and why they choose different governance arrangements for IT project portfolio management has been provided in chapter 4, based on a qualitative empirical study. In this context, four different fields of activities for IT project portfolio management have been identified and illustrated from a governance perspective: IT budget allocation, IT demand management, IT project portfolio selection, and IT resource management. Governance mechanisms employed by the investigated companies in these fields of activities have been presented and compared. It has also been demonstrated how these fields of activities are interlinked. For example, coordination mechanisms established in the context of demand management may facilitate the identification of project interdependencies and, thereby, foster the exploitation of synergy potentials during IT project portfolio selection. Seven major contingency factors concerning the design of governance arrangements for IT project portfolio management have been identified and the outcomes resulting from the use of different governance arrangements have been discussed based on four different outcome categories. In particular, it has been demonstrated that centralized arrangements usually facilitate the selection of significantly larger projects of more strategic nature compared to decentralized arrangements. It has also been argued that more synergy potentials can be exploited if decisions are taken at a corporate-wide level. The results have been integrated with the existing literature in order to develop a comprehensive contingency framework concerning the design of governance arrangements for IT project portfolio management. This framework may help practitioners to assess the suitability of a specific governance arrangement in a given context. Moreover, from a theoretical point of view, it provides an opportunity for further empirical testing, but also for quantitative modeling, as demonstrated in chapter 5 of this dissertation.

In chapter 5, first, a general coordination mechanism for IT project portfolio management has been identified, based on the case study research described in chapter 4. During the empirical study, it became apparent that in many companies decision-making competencies for IT project portfolio selection are distributed to authorities at different organizational levels based on different budget assignments and cost thresholds. This way, the size of the projects in the local portfolios and the total volume of these portfolios are controlled. As this coordination mechanism is generic, it lends itself to a formal way of modeling. Consequently, in a second step, the coordination mechanism has been embedded into a simulation framework. This framework can be used in order to simulate the impact of different characteristics of a portfolio of candidate IT projects on the outcomes of project portfolio selection. In the current dissertation, particularly the impact of different kinds of project interdependencies on outcomes obtained in centralized and decentralized governance arrangements has been investigated. In this context, the process of project portfolio selection has been modeled in two alternative ways – via a quantitative optimization model and via a decision-support framework based on efficient frontiers. It has been demonstrated that different kinds of interdependencies have different effects on aspects like the obtained benefit, the portfolio risk, and the level of budget spending. These effects inter alia depend on the governance arrangements used for IT project portfolio selection.

In general, the generic nature of the chosen modeling approach allows for a rich variety of extensions and, thereby, provides the grounds for further quantitative studies. The overall objective is to foster a detailed understanding of the impact of different governance mechanisms in the context of IT project portfolio management. An assessment of the advantages and disadvantages of these mechanisms in different contexts provides a foundation for more rational decision-making and a deeper theoretical understanding of organizational decision-making. In this thesis, it has been demonstrated how the effects identified in simulation models can be compared to findings obtained in empirical studies. Based on the quantitative modeling approach, effects identified in quantitative empirical studies can be assessed in a more detailed contextual environment, and on the other hand, findings obtained in qualitative empirical studies can be investigated at a more analytical level. In this context, the current research also represents a departure to bridge the gap between the two streams of research identified during the structured literature review.

With respect to future research, a number of opportunities remain. For example, many roles and committees involved in (IT) project portfolio management have been described in the existing literature (top management, project managers, program managers, resource managers, portfolio managers, steering committees, portfolio committee, PMO, etc.), but the variety of interactions between different roles and different governance mechanisms still has not been fully addressed. Understanding these interactions is crucial for assessing the suitability of different governance arrangements. For example, the qualitative study in chapter 4 demonstrates that a number of disadvantages of decentralized governance arrangements for IT project portfolio selection can be cushioned by installing coordination roles in the demand management field of activity. A number of such interactions have already been addressed in this dissertation, but others may exist and may require deeper investigations. In particular, research on the role of demand management in the context of project portfolio management is still in its infancy. Due to its obvious relevance, research in this area should be significantly intensified in the future.

With respect to the quantitative modeling of governance arrangements and coordination mechanisms in the IT project portfolio management context, it has turned out that a small but fertile set of approaches already exists. Analogous to the approach presented in chapter 5, these former contributions address the phenomenon of decentralized planning in multidivisional companies. However, previous approaches particularly cover cooperative scenarios with a high degree of coordination. Based on the qualitative empirical research described in chapter 4, it has been demonstrated that a number of companies employ governance arrangements that allow for quite autonomous decisions with very little coordination and cooperation. Hence, the approach presented in this dissertation is complementary to existing approaches concerned with the modeling of organizational behavior. In this context, further research on decision-making arrangements and coordination mechanisms used in practice is desirable. For an accurate modeling of these arrangements and mechanisms, detailed empirical data is required. In addition, more disaggregated data on project characteristics (in particular project benefits) and project interdependencies would be of high value. During the study presented in chapter 5, only a limited number of effects could be simulated due to the limited availability of data. With more data available, the generic approach presented in this dissertation would allow for a large variety of investigations. In particular, an investigation of the effect of predetermining different cost thresholds for different decision-making units would be of practical relevance due to the high prevalence of federal governance arrangements for IT project portfolio selection.

Throughout this dissertation, it has been focused on IT project portfolios. The focus has been limited to this context, as IT projects have a number of specifics that require special attention.[854] However, many findings in this dissertation do not only apply to IT projects but might be transferable to other project portfolio management contexts.[855] Thus, the current research might also motivate future investigations in related contexts like new product portfolio management.

[854] Particularly the interplay between different business units and the IS function constitutes a specific context (cf. section 3.2.3).

[855] For example, project interdependencies also exist in other kinds of project portfolios, like R&D project portfolios and new product development project portfolios. Consequently, the exploitation of synergy potentials is also a relevant topic in other project portfolio management disciplines.

The importance of project-based work is constantly increasing. At the same time, many companies are still struggling with effectively and efficiently managing their project landscapes. Consequently, it appears to be likely that research on appropriate governance mechanisms for project portfolio management will continue to be of high relevance in the foreseeable future. Recently, a considerable number of empirical contributions have been published and the field of research has made significant progress. However, there is still much to do in order to support experts in choosing governance mechanisms that are suitable for the given context.

Appendices

Appendix A – Contributions identified based on the structured literature search[856]

Identified contributions (ordered by year from left to right):					
Ward, 1990	Schniederjans & Santhanam, 1993	Platje et al., 1994	Santhanam & Kyparisis, 1995	Santhanam & Kyparisis, 1996	Shoval & Giladi, 1996
Archer & Ghasemzadeh, 1999	Farbey et al., 1999	Jiang & Klein, 1999a	Jiang & Klein, 1999b	Ghasemzadeh & Archer, 2000	Lee & Kim, 2000
Lee & Kim, 2001	Oral et al., 2001	Irani et al., 2002	Kenneally & Lichtenstein, 2002	Klapka & Pinos, 2002	Verhoef, 2002
Elonen & Artto, 2003	Engwall & Jerbrant, 2003	Stummer & Vetschera, 2003	Bardhan et al., 2004	Jeffery & Leliveld, 2004	De Reyck et al., 2005
Bardhan et al., 2006	Benaroch et al., 2006	Blomquist & Müller, 2006	Chou et al., 2006	Drake & Byrd, 2006	Eilat et al. 2006
Martinsuo & Lehtonen, 2007	Phillips & Bana e Costa, 2007	Thomas et al., 2007	Angelou & Economides, 2008	Blichfeldt & Eskerod, 2008	Burke & Shaw, 2008
Lanzinner et al., 2008	Müller et al., 2008	Peters & Verhoef, 2008	Stewart, 2008	Ahlemann, 2009	Ajjan, 2009
Chen & Cheng, 2009	Cho & Shaw, 2009	Diepold et al., 2009	Patanakul & Milosevic, 2009	Stummer et al., 2009	Canonico & Söderlund, 2010
Gutjahr et al., 2010	Gutjahr & Reiter, 2010	Heimerl & Kolisch, 2010	Jonas, 2010	Meskendahl, 2010	Prifling, 2010a
Urli & Terrien, 2010	Frey & Buxmann, 2011	Hsu et al., 2011	Kundisch & Meier, 2011a	Kundisch & Meier, 2011b	Zheng & Vaishnavi, 2011

856 Adopted from Frey & Buxmann, 2012, p. 13.

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Appendix B – Concept matrix for mathematical approaches[857]

Reference (ordered by year)	Characterization of the approach	Main focus	Objectives	Non-financial resource constraints	Risk at the portfolio level	Strategic directions	Intratemporal interdependencies	Group decision-making	Mandatory projects	Interactive approach	Visual representations	Dynamics	Intertemporal interdependencies
Schniederjans & Santhanam, 1993	Linear 0-1 goal programming	Multi-objective, resource constrained project selection	Multi-objective model (aggregated objective function)	X		X			X				
Santhanam & Kyparisis, 1995	Nonlinear 0-1 goal programming	Incorporation of benefit, resource and technical interdependencies into a multi-objective project selection model	Multi-objective model (aggregated objective function)	X			X		X				
Santhanam & Kyparisis, 1996	Nonlinear 0-1 programming	Incorporation of benefit, resource and technical interdependencies into a single-objective project selection model	Single-objective model	X			X		X				
Ghasemzadeh & Archer, 2000	Different approaches - e.g. AHP and 0-1 integer programming	Decision support for several steps of the framework proposed by Archer & Ghasemzadeh, 1999	Multi-objective model (aggregated objective function)	X	(X)			X	X	X	X	(X)	
Lee & Kim, 2000	Combination of ANP and 0-1 goal programming	Designed for multi-criteria group decisions; interdependencies are taken into account	Multi-objective model (aggregated objective function)	X			X	X	X				
Lee & Kim, 2001	Combination of ANP, Delphi method and 0-1 goal programming	Multi-criteria group decisions; interdependencies are regarded	Multi-objective model (aggregated objective function)	X			X	X	X				
Oral et al., 2001	Mixed-integer programming problem	Reaching consensus between several decentralized decision authorities	Multi-criteria disaggregated approach					X					

[857] Adopted from Frey & Buxmann, 2012, pp. 15–19.

Reference (ordered by year)	Characterization of the approach	Main focus	Objectives	Non-financial resource constraints	Risk at the portfolio level	Strategic directions	Intratemporal interdependencies	Group decision-making	Mandatory projects	Interactive approach	Visual representations	Dynamics	Intertemporal interdependencies
Klapka & Pinos, 2002	Nonlinear 0-1 goal programming	Decision support system considering synergistic effects of second- and third-orders and hierarchical interdependencies between projects	Multi-objective model (aggregated objective function)	X			X		X	X	(X)	(X)	(X)
Stummer & Vetschera, 2003	Goal programming	Group decision-making with multiple criteria in decentralized settings / allocation of shared resources	Multi-objective model (aggregated objective function)	X		(X)		X		X		(X)	
Bardhan et al., 2004	Real options portfolio optimization algorithm	Focus on intertemporal interdependencies	Single-objective model (discounted cash flow plus real options)		(X)								X
Bardhan et al., 2006	Real options portfolio optimization algorithm	Focus on intertemporal interdependencies	Single-objective model (discounted cash flow plus real options)		X								X
Chou et al., 2006	Fuzzy multi-criteria decision model	Evaluation criteria for IT/IS investments; inclusion of different stakeholders into the evaluation process	Multi-objective model (aggregated objective function)		(X)	(X)		X				(X)	
Eilat et al., 2006	Data envelopment analysis (DEA), balanced scorecard	Multi-criteria group decisions; interdependencies are taken into account.	Multi-objective model (aggregated objective function)	(X)	X	X	X	X					
Angelou & Economides, 2008	Combination of real options and the analytic hierarchy process (AHP)	Focus on intertemporal interdependencies (via real options) in a multi-criteria decision-making setting integrating qualitative and quantitative criteria	Multi-objective model (aggregated objective function)		(X)	X							X

Reference (ordered by year)	Characterization of the approach	Main focus	Objectives	Non-financial resource constraints	Risk at the portfolio level	Strategic directions	Intratemporal interdependencies	Group decision-making	Mandatory projects	Interactive approach	Visual representations	Dynamics	Intertemporal interdependencies
Chen & Cheng, 2009	Group multi-criteria decision-making method based on fuzzy logic (the projects are divided into five different evaluation classes)	Support of group decision-making in a fuzzy environment	Multi-objective model (aggregated objective function)		X	X		X				(X)	
Cho & Shaw, 2009	Calculation of the efficient frontier (for budget allocation)	Synergies between different IT investment units; allocation of budgets to different units; risk-return perspective	Proportion of investment for different IT investment units		X	(X)	X				(X)		
Stummer et al., 2009	Interactive approach based on the determination of Pareto-efficient portfolios	Decision support combining project portfolio selection, staff assignment and scheduling of project proposals; competence development is also taken into account	Multi-criteria disaggregated approach	X		(X)				X	X		
Gutjahr et al., 2010	Multi-objective programming model for determining Pareto-efficient portfolios (solved with a meta-heuristic)	An approach combining project portfolio selection, staff assignment and scheduling of project proposals; competence development is also taken into account	Multi-criteria disaggregated approach	X		(X)		X					
Gutjahr & Reiter, 2010	Bi-objective stochastic optimization problem for determining Pareto-efficient portfolios (combination of Monte-Carlo simulation and optimization)	An approach combining project portfolio selection, staff assignment and scheduling of project proposals; competence development is also taken into account; uncertainty and interdependencies between projects are considered	Multi-criteria disaggregated approach	X	X	X	X						

Reference (ordered by year)	Characterization of the approach	Main focus	Objectives	Non-financial resource constraints	Risk at the portfolio level	Strategic directions	Intratemporal interdependencies	Group decision-making	Mandatory projects	Interactive approach	Visual representations	Dynamics	Intertemporal interdependencies
Heimerl & Kolisch, 2010	Mixed-integer linear program	Efficient scheduling of human resources with different skills and efficiencies in a multi-project environment	Minimize labor cost	X									
Urli & Terrien, 2010	Multi-objective non-linear integer program (solved with a meta-heuristic)	Identification of efficient portfolios in order to support group decision-making (a two-stage approach is presented)	Multiple objectives (aggregated objective function)	X	X		X	X		(X)	(X)		
Kundisch & Meier, 2011a	Tailored mathematical decision model	Identification of resource interactions (allocation, performance and sourcing interactions); presentation of a project selection model that takes account of these interactions	Single deterministic benefit value	X			X		X				
Zheng & Vaishnavi, 2011	Visual exploration approach based on the concept of multidimensional perceptual maps	Interactive portfolio selection approach based on visual representations	Multi-criteria disaggregated approach	(X)	X	(X)				X	X	(X)	

Legend:
X: The particular requirement is considered
(X): The particular requirement is partly considered

Appendix C – Success factor descriptions[858]

Success factor	Description
Strategic fit / Strategic alignment	IT projects have to comply with the IT strategy and, therefore, also need to be evaluated with regard to the IT strategy (cf. Jiang & Klein, 1999b, p. 171). Thomas et al. state the following: "If projects are not aligned to strategy, decision making is not tied to the direction of the company, and resources may not be used effectively." (Thomas et al., 2007, p. 10) In this context, business representatives and IT representatives should frequently discuss alignment between IT strategy and business strategy (cf. Jeffery & Leliveld, 2004, p. 43).
Consideration of project inter-dependencies	Different kinds of interdependencies between projects within the portfolio have to be taken into account in order to exploit synergy potentials (cf. Meskendahl, 2010, p. 809).
Centralized view	To gain a complete overview of the IT project portfolio, all projects have to be in one database and all IT spending has to be tracked centrally (cf. De Reyck et al., 2005, p. 526; Jeffery & Leliveld, 2004, p. 43).
Financial analysis	Companies with a high level of IT project portfolio management maturity constantly evaluate projects with financial tools like ROI, Payback Period, NPV etc. (cf. De Reyck et al., 2005, p. 530; Jeffery & Leliveld, 2004, p. 43).
Top management commitment	Top management commitment is vital for effective evaluation practices (cf. Thomas et al., 2007, p. 9f.). Furthermore, top management commitment usually has a positive effect on project portfolio success, though it can also have a negative effect if the project portfolio management process is impeded by top management intervention (cf. Jonas, 2010, p. 825)
Accountability for results	Effective IT evaluation practices require that business managers are held accountable for project results (cf. De Reyck et al., 2005, p. 532; Thomas et al., 2007, p. 8).
Portfolio segmented by asset classes	In order to maintain a balance between different classes of projects (for example infrastructure projects and strategic projects), it is important to divide projects into different categories (cf. De Reyck et al., 2005, p. 529; Jeffery & Leliveld, 2004, p. 43).
Portfolio balance / Risk analysis	A particular important factor to consider when balancing a project portfolio is the risk level of the projects included (cf. Meskendahl, 2010, p. 809). Therefore, a thorough analysis of risks at the single project level as well as at the portfolio level is required (cf. De Reyck et al., 2005, p. 526).
Measurement of costs and benefits	The ability to measure costs and benefits is of vital importance as it is a prerequisite inter alia for consistent decision-making and corporate learning (cf. Thomas et al., 2007, p. 11). However, the ability to measure project benefits is a challenge that requires sufficient training (cf. De Reyck et al., 2005, p. 532).
Consideration of multiple constraints (budget capacity, staff capabilities, etc.)	The main reason for taking a portfolio perspective on projects is that project resources are limited. While the financial capacity usually is closely monitored, other resources like the available staff and the associated capabilities are often not sufficiently considered. However, shortage of these resources can impose significant restrictions on portfolios and the projects contained therein (cf. De Reyck et al., 2005, p. 530). Consequently, multiple constraints need to be considered.

[858] Adopted from Frey & Buxmann, 2012, p. 14.

Appendix D – Propositions for future research[859]

Contribution	Proposition for future work
Santhanam & Kyparisis, 1996	Santhanam & Kyparisis propose "[…] the development of a DSS that can help managers analyze the IS project selection problem and make an appropriate decision." (p. 394)
Archer & Ghasemzadeh, 1999	Archer & Ghasemzadeh demand for further research into "[…] the generic requirements for decision support in project portfolio selection […]" (p. 215). They propose to focus on the requirements of decision makers and the available data (cf. p. 215).
Jiang & Klein, 1999a	Jiang & Klein recommend to conduct "Longitudinal studies that examine dynamics in IS planning activities [...]" (p. 176).
Ghasemzadeh & Archer, 2000	Ghasemzadeh & Archer propose additional research in order to "[...] find suitable methods for evaluating project risks and their impact on portfolio selection." (p. 86) Furthermore, they want to adapt their approach to "[...] a group support system environment." (p. 87)
Oral et al., 2001	Oral et al. name several extensions to their model, inter alia incorporating interactions, multi-period cases, and contingency requirements between the projects (cf. p. 345).
Irani et al., 2002	Irani et al. recommend further application of fuzzy logic for IT/IS evaluation (cf. p. 208f.).
Kenneally & Lichtenstein, 2002	Kenneally & Lichtenstein propose empirical studies of the interaction between projects and remark that a definition of interacting options is required (cf. p. 250).
Engwall & Jerbrant, 2003	Engwall & Jerbrant conclude as follows: "[…] research on multi-project management has to go beyond resource allocation and start addressing incentive structures, accounting systems, and other deeply embedded features of the organization." (p. 408)
Stummer & Vetschera, 2003	Stummer & Vetschera inter alia suggest adapting the presented models to a federal decision-making setting with an additional decision maker on an upper level (cf. p. 275f.).
Bardhan et al., 2006	Bardhan et al. propose Monte-Carlo simulations in order to conduct "[...] sensitivity analysis of the impact of the volatility of estimated project benefits on the portfolio optimization results." (p. 4) Furthermore, they also name "[...] developing actionable policies to guide managers in making better resource allocation decisions [...]" as an area for future research (p. 4f.).
Blomquist & Müller, 2006	Blomquist & Müller recommend further (empirical) investigations with special focus on "[...] geographical and industry particularities [...]" (p. 64). They conclude that their study "[...] opens the discussion of whether portfolio management could, in fact, be studied in isolation or only in combination with other line management tasks." (p. 64)
Eilat et al., 2006	Eilat et al. note that the adaption of their selection model to a dynamic environment would be a possible extension of their work (cf. p. 1025).

[859] Adopted from Frey & Buxmann, 2012, pp. 20–22. As the appendix is ordered chronologically, the evolution over time can be retraced to a certain extent.

Martinsuo & Lehtonen, 2007	Martinsuo & Lehtonen propose further studies on contingency factors relevant to portfolio management efficiency (cf. p. 62). They also propose large-scale studies on the contingency factors covered in their literature review (cf. p. 62f.).
Blichfeldt & Eskerod, 2008	Blichfeldt & Eskerod make a claim for a normative theory focusing on "[...] how companies can improve their PPM." (p. 365)
Lanzinner et al., 2008	Lanzinner et al. announce to test their concept and their approach based on an "[...] expert survey or interviews with IT and business managers [...]." (p. 9)
Müller et al., 2008	Müller et al. conclude that the results of their study [...] support a contingency perspective toward portfolio management." (p. 39). They recommend further studies "[...] addressing the contextuality of portfolio management." (p. 39)
Ajjan, 2009	Ajjan proposes to investigate differences in opinions of senior business and IT managers concerning project goals (cf. p. 7).
Chen & Cheng, 2009	Chen & Cheng recommend "[...] developing a decision support system in a fuzzy environment [...]" (p. 398), "[...] in order to improve the solving of multicriteria decision-making problems [...]" (p. 398).
Cho & Shaw, 2009	Cho & Shaw suggest further analytical analyses "[...] to identify the conditions where IT synergy enhancement helps firms find a better IT portfolio." (p. 14)
Diepold et al., 2009	Diepold et al. recommend further research on the consideration of "[...] intratemporal interdependencies among projects" and of "multiple real options within an IT project and their impact on its risk and return." (p. 12) In this context, they in particular highlight compound options, deferral options and abandonment options (cf. p. 12).
Patanakul & Milosevic, 2009	Patanakul & Milosevic offer the framework derived in this contribution as a foundation for a large sample study. In this context, they state: "All propositions are testable and can be deployed to research hypotheses for the future empirical research." (p. 230)
Stummer et al., 2009	Stummer et al. identify "robust portfolio modeling" and "contingent portfolio programming" as future directions to cope with low-quality data (p. 398). Furthermore, they recommend adapting the decision-support model presented in the paper to "group decision-making" and "negotiation analysis" (p. 398).
Canonico & Söderlund, 2010	Canonico & Söderlund propose additional case study research on contingency factors concerning organizational structures and management control mechanisms in multi-project organizations (cf. p. 805).
Gutjahr et al., 2010	Six topics for future research are identified: Developing tools for collecting data, incorporating precedence relations between tasks or projects, accounting for uncertainty (stochastic extension), accounting for a long term planning horizon (strategic planning), developing a dynamic optimization model, employing exact methods to solve the model described in the paper (cf. p. 678).
Gutjahr & Reiter, 2010	Gutjahr & Reiter recommend to enhance their current model by incorporating a dynamic way of assigning personnel to tasks and to account for fluctuations in staff (cf. p. 439f.).
Jonas, 2010	Jonas suggests conducting a longitudinal study focusing on the impact of management involvement on project portfolio management performance (cf. p. 828).

Meskendahl, 2010	Meskendahl recommends empirical validation and enhancement of his conceptual model (cf. p. 815).
Prifling, 2010a	Prifling notes that: "[…] research on organizational culture and/or the organizational context in which IT projects are carried out is still scarce." (p. 4) He proposes to conduct quantitative studies in order to show that his findings concerning the influence of organizational culture are universally valid (cf. p. 8).
Urli & Terrien, 2010	Urli & Terrien suggest expanding their model by incorporating project portfolio dynamics (cf. p. 821).
Hsu et al., 2011	Hsu et al. ask for further studies taking account of the user and organizational perspective (cf. p. 523).
Kundisch & Meier, 2011a	In this contribution, Kundisch & Meier inter alia recommend to evaluate the identification process presented in their study by conducting design science research (cf. p. 10).
Kundisch & Meier, 2011b	Kundisch & Meier propose the following enhancements to their framework: Inclusion of scheduling constraints, development of a classification scheme for resources and outputs, consideration of uncertainty and the risk diversification, intertemporal interactions (cf. pp. 484, 486). Furthermore, they propose to investigate the impact of different types of project interactions on project portfolio selection outcomes empirically (cf. p. 486).

Appendix E – Interview guideline

1. Organizational structure / Structure and role of the IS function

1.1. Role and responsibilities of the interviewee

- Formal position
- Typical tasks
- Years of experience (within the company)

1.2. Organizational structure of the company

- Regions
- Sites
- Subsidiaries
- Divisions
- Departments

1.3. Organizational integration of the IS function

- Degree of centralization
- Alignment of the IS function to the organizational structure of the company
- To what extent is IT staff integrated into business units?

1.4. Internal structure and characteristics of the IS function

- Entities / groups
- Number of employees
- Profit center / Service center / Cost center
- Major systems and services

1.5. Has the IS function recently been restructured? If yes, how did the former structure look like and what has triggered the changes?

1.6. Are there any ongoing changes to the IS function?

1.7. Does the company strongly rely on external IT services and external employees? Which relationships exist between the company and external IT providers?

2. Governance arrangements for IT project portfolio management

2.1. What is the understanding of an IT project in the company? What are typical examples of IT projects?

2.2. Where do IT project proposals primarily originate?

2.3. Which departments / committees / persons are involved in IT project portfolio management and how are they involved?

- Roles
- Responsibilities
- Competencies
- Interactions

2.4. How are candidate projects evaluated?

2.5. Where, by whom, and in which way are candidate projects approved?

2.6. How are IT investment budgets allocated within the company?

- Size of the total IT budget
- Relation of operative and strategic expenditures
- Share of investment budget allocated to different units
- Budgeting process

2.7. How are IT projects staffed? Who is typically involved in IT projects, and who provides the required resources?

2.8. Which tasks and activities exist in the context of IT project portfolio management?

2.9. Which factors have influenced the current governance design for IT project portfolio management?

2.10. What is the role of IT and what is the role of the business side in IT project portfolio management?

2.11. Are there significant interdependencies between projects proposed by different business units?

3. Organizational impact

3.1. Which experiences have been made with the current governance arrangement for IT project portfolio management?

3.2. Which experiences have been made with different decision-making arrangements for IT project portfolio management in the past?

3.3. Which advantages and disadvantages are attributed to different kinds of governance arrangements?

3.4. Are there any conflicts between stakeholders at different organizational levels?

3.5. Are there any conflicts or differences between the IT side and the business side?

3.6. Are there any planned changes with regard to the existing governance arrangements for IT project portfolio management? If yes, what has triggered these changes?

Appendix F – Case descriptions

	Organizational design and IT structure	IT budget allocation	IT demand management	IT project portfolio selection	IT resource management
C1	The organizational design of the company had been altered to a large degree four years ago. Before the reorganization, the company was structured into independently operating divisions. The divisions had own business processes and the company was organized similar to a holding with only loose central control. The responsibility for IT infrastructure and IT projects was mainly located at the different divisions (decentralized IT governance). Since the reorganization, the company is structured into different business segments. In this context, centralized IT structures were established (together with other central functions like sales, legal, etc.). Triggered by the new organizational design, the IT governance design has been completely revised. Two different IT units were established. The first unit, the corporate IT governance department, is led by the corporate CIO. This unit in particular defines and implements rules and standards for IT budget allocation, IT demand management, and IT project portfolio selection. The second unit, the business segment IT services, provides services to the company as well as to external customers. The IT governance department operates as an interface between the company as a whole and the IT services segment.	Budgets are planned by the business units and are discussed in yearly planning cycles with the IT governance department.	The demand from the business side is articulated to the IT governance department and discussed with the CIO. If a project is selected, the order is passed to the IT services segment by the IT governance department. The IT services segment represents the supply side. The IT governance department represents the interface between the business units and the IT services segment.	All IT projects, except for strategic projects with uncertain benefits, have to be approved by the CIO. Strategic projects are approved by the board. Projects have to pass several stage gates after approval.	Project resources are provided by the IT services segment. This segment is separate from the IT governance unit and offers services to external customers. IT projects are typically staffed from the IT services segment. In rare cases, projects are outsourced to external providers.

	Organizational design and IT structure	IT budget allocation	IT demand management	IT project portfolio selection	IT resource management
C2	The company is the holding of a corporate group. It represents a distinct strategic segment. As the company is managed independently of other strategic segments in the group, the IT governance arrangements within this company are the primary unit of analysis. The company operates globally. It is organized into three major regions. The headquarters of the company are located in Germany. The IS function is organized into three service centers located in the three major regions. The IT headquarters are located at the German site. Furthermore, a number of competence centers exist at the three different sites. These competence centers serve as corporate-wide contact for all three regions. The IT headquarters supervise the IT project portfolio management processes. The current organizational design has been established four years ago. Before, the IT service centers in the three different regions operated more independently of each other. The current central headquarters did not yet exist at that time. There was less coordination between the different regions and no formal processes for IT project portfolio management. Accordingly, there was no central IT project portfolio. Today, the IT project budget is administered centrally and a centralized project portfolio is composed each year.	Budgets for operations and maintenance are assigned to the different regions. The IT project budget, in contrast, is administered centrally by the IT headquarters. There are no decentralized IT project budgets for the different regions.	IT project proposals are raised and prepared locally in consultation with the local IT service centers. The IT service centers are the main contact for the business functions in the regions. The IT headquarters standardize and enforce a common centralized process for project elevation and provide templates. The local IT service centers communicate the demand to the IT headquarters. There are usually several communication loops between the IT service centers and the IT headquarters.	The IT project portfolio is planned by the IT headquarters on a yearly basis. Before IT project proposals are sent to IT headquarters the regions already conduct an internal prioritization. The IT headquarters compose a central IT project portfolio based on KPIs. The corporate controlling department supports and monitors the evaluation process. The resulting portfolio is communicated to and discussed with the heads of the IT service centers in the regions, who serve as contacts to the business functions.	The internal IT staff is in particular engaged in demand management and provider management. Resources for IT projects are typically provided by an outsourcing partner belonging to the same corporate group.

	Organizational design and IT structure	IT budget allocation	IT demand management	IT project portfolio selection	IT resource management
C3	The company as a whole consists of three major divisions, separated into several different business segments. Each business segment is supported by an own IT organization. Since several years, the IT organization is rather decentralized and oriented towards the business segments (vertical structure). Before, the organization was more centralized. Currently, there is a trend towards centralization. Parts of the IT organization were transferred into horizontal structures. The interviewee describes these organizational changes as a reaction to changes in the economic environment. While the application portfolio is controlled by the IT organization, IT project portfolio management in particular falls into the responsibility of the business segments and is strongly driven by the front office. IT budgeting and IT project portfolio management are procedurally implemented via an IT investment governance process. This process is driven top-down by strategic considerations. The IT organization primarily has a consulting function.	The investment budget is allocated top-down via an investment governance process. Budget allocation takes place in a yearly planning cycle. IT investment budgets are allocated to each business segment based on last year's budget, the economic development, and the outlook for the segment. Consequently, the budget proportions between the different segments can change. IT budgets are initially proposed by the IS function and then negotiated between the board and the heads of the business segments. Budgets are adjusted to the prospect of the different segments, based on a quarterly rolling wave planning process.	A central IT unit collects the project proposals for the respective business segment. This unit also moderates the process and discusses the initiatives with the business from a strategic perspective. The unit also serves as a central interface between the business segment and the IS function.	An IT investment governance process is conducted on a regular basis. As part of this process, fields of actions are derived from the business strategy. The initiatives are prioritized based on business cases. Only a small number of major initiatives are discussed at the board level. The projects are primarily independently selected by the business segments. The IS function accompanies the project portfolio selection process and – in case of conflicts – escalates these conflicts to the IT representative at the board level.	Most of the internal IT employees work in projects. Moreover, a significant number of external project resources are involved in IT projects. Internal IT employees are organized in a matrix organization. In the past, IT employees were primarily organized based on the different applications. Nowadays, resources are primarily organized according to roles and skills. However, the organization has become rather complex and, therefore, is subjected to further adjustments. IT project managers are organized in a separate unit and are managed like in a consultancy firm.

	Organizational design and IT structure	IT budget allocation	IT demand management	IT project portfolio selection	IT resource management
C4	The company is structured into different globally operating segments. Apart from the customer and demand management function, the structure of the IT organization largely differs from the organizational structure of the company. The IS function is strongly centralized. It is internally structured into six different units. Two units are engaged in demand management. The development and project management capacities are organized in a different unit. Two other units are responsible for architecture management and for infrastructure and application operations. Finally, there is a unit for IT governance and other cross-sectional tasks. The structure of the IS function has recently undergone significant changes. The structure has been reshaped from a decentralized structure to a largely centralized structure. In particular, IT resources have been reorganized into resource pools. Formerly, IT resources were organized in decentralized product-based teams. IT demand management has also been restructured in order to provide a single point of contact to the customer. In consequence of the structural changes, the operational structure of the IS function has been transformed into a completely process-based model.	Each business segment controls a separate investment budget. Each year, the business segments have to present their business strategy and important business initiatives to the board. Based on this information, the board derives general target directions for the business segments. The IT capacity planning is informed by these decisions. However, the IS function is not directly involved in the budget planning process. After budgets have been assigned to the business segments, the segments in principle have these budgets at their own disposal and can set their own priorities independently of each other.	Two centralized IT units are responsible for IT demand management. These two units inter alia conduct business impact and requirements analyses. They transform the demand of the internal customers into projects. The demand management units are aligned to the segment structure of the company. They provide a single point of contact between the associated segment and the IS function.	In the past, the IS function had introduced a corporate-wide IT project portfolio management approach, based on strategic fields of actions. However, this approach has not been accepted. The business segments have reverted to managing their own budgets. Currently, the IS function is mainly planning and managing the portfolio of running projects for the different segments. The IS function is involved in the project approval process via an IT committee. Projects are preliminarily approved by this committee with a focus on resource restrictions and architecture issues. The final project approval is reserved to a committee composed of representatives of the different segments. This committee also controls for unappreciated cross-segmental interdependencies.	The IS function plans capacities based on volume estimates and tries to provide sufficient resources to conduct the projects requested by the business segments. The budget is actively monitored in order to ensure that the required capacity is provided. Project resources are organized in resource pools and can be requested based on skill profiles. A significant number of external resources are typically involved. In this company, particularly project managers are a limiting factor because only a limited number of project managers are recruited from external providers. If a particular segment exceeds its capacity limit, the segment is forced to reprioritize.

	Organizational design and IT structure	IT budget allocation	IT demand management	IT project portfolio selection	IT resource management
C5	The company has a strong regional focus, but operates globally. From an organizational point of view, the company is in particular divided into three different groups of business units. In addition, there is a corporate center primarily engaged in controlling and administration. The IS function is organized as one of several business units. A major focus of the IS function lies on application development. About half of the IT employees work in this area. In the application development area, the IS function is strongly aligned to the corporate structure. Application development is organizationally divided into three different units corresponding to the three groups of business units. There are also a number of overarching departments within the IS function. These are inter alia concerned with IT governance, IT security, IT engineering methods, as well as service and partner management. A further unit within the IS function is responsible for organizational development and process optimization. The current organizational structure of the IS function exists since about three years. Before, the application development area was also subdivided into different units, but the units were not consequently aligned to the business units. The IT governance unit is in particular responsible for IT strategy, IT controlling, risk management and skill management. The service and partner management unit is responsible for the steering and control of external resources and services. Infrastructure services are mainly provided by an external partner and a significant fraction of project resources are provided externally.	A budget frame for IT investments is defined in a top-down manner by the board of directors. However, de facto, the investment volume results from a bottom-up process, as the budget limit is not consequently enforced. This is perceived as a major issue. Consequently, it is planned to introduce a more structured project portfolio management process. Currently, the board of directors is involved in the project portfolio management process for the first time. It will decide which projects have to be omitted or postponed. This reduction will not be conducted at a single-project level but at a compound level.	Between two and three client managers are assigned to each group of business units. The client managers belong to the corresponding application development units. During the investment governance process, the requirements of the business units are communicated to the client managers. In a two-week interval all client managers take part in a common meeting (client manager board) in order to discuss the current requirements and to identify inter-dependencies and redundancies. Corresponding to the client managers, the business units employ IT coordinators. Thereby, a single point of entry is implemented at both sides.	IT projects below a given cost threshold can be initiated by the business units out of their dedicated IT contingent. All other project proposals have to be handed in via a corporate-wide investment governance process. The controlling department governs this process in coordination with the IS function. The corporate controlling department is entitled to approve or reject projects, but this has to happen in a dialogue with the business units. There is no clear rule for how to proceed if the combined project costs exceed the budget limit. There are also no formal criteria for project prioritization. Two attempts to implement a formal process for IT project portfolio selection have failed.	Project resources are organized into three separate application development departments. The employees within these departments in general work for a defined set of business units. However, the IS function has recently introduced the role of a skill manager within the IT governance department as an attempt to reach a higher degree of flexibility in resource management. This skill manager shall coordinate resource requirements and balance the workload across all three application development departments. If there is a resource shortage in one of the three areas, resources can be borrowed from the other units. Thereby, internal resources shall be utilized to the full capacity.

	Organizational design and IT structure	IT budget allocation	IT demand management	IT project portfolio selection	IT resource management
C6	The company is organized as a holding. It consists of a number of legal entities operating predominately in the German market. The holding structure is a consequence of legislative requirements. From an organizational point of view, the company is divided into several functional departments. The department directors are members of the board of directors. The company has a rather centralized structure. Planning and controlling activities are concentrated at the corporate headquarters. The IS function is organized as an independent department. It provides IT services to the entire holding. The structure of the IS function is aligned along plan, build, and run activities. The run area is responsible for infrastructure and application management. Resource management, project management, architecture management and security management are organized into the build area. The plan area inter alia consists of a unit engaged in internal client management and a unit engaged in IT governance. The client management unit is subdivided according to the corporate structure. The build and run activities, in contrast, are organized centrally, independently of the corporate structure. The current structure already exists since several years. Before, the IS function was decentralized to a large degree. In particular, the IS function was organized according to the department structure. IT-related changes were implemented in a rather informal way, based on direct contact between employees from the different business departments and the IS function. In the current investment governance process, in contrast, a federal investment commission coordinates the major project-related decisions.	A corporate-wide IT budget for change activities is determined based on a planning approach covering a timespan of three years. The budget is expressed in terms of person-days. About 25% of the person-days are dedicated to the business departments. This budget is divided between the different departments and is used for department-specific projects falling below a specified cost threshold. About 20% of the corporate-wide IT budget are reserved for application-specific optimizations and related IT activities. The major part of the budget (55%) is dedicated to large, strategic projects. This budget is managed by a federal investment commission.	The plan area of the IS function includes a relatively large unit engaged in client management. Each business department is attended by a client manager. This client manager is a dedicated IT contact person for the respective business department. The client manager also discusses service level agreements, prices, and other issues with the department. In respect to change-related initiatives, the client manager passes the demand to the IS function. The client manager also coordinates the project planning activities and acts as a consultant. He attends to the project steering committees and the quality gates. Moreover, the client manager also communicates new IT-related standards and requirements to the business department.	The business departments are allowed to independently initiate IT projects below half a million Euro out of their dedicated IT investment budget. Projects above this cost threshold have to be approved by an investment commission composed of high-ranking representatives of the IS function and the business departments. The investment commission prioritizes, approves or rejects proposals and decides about the project implementation order. Very large projects with a volume of several million Euro have to be approved by the board of directors.	Project resources are requested based on skill-profiles. Resource availability has to be ensured before a project can be approved. Project resources are in particular pooled in the change area of the IS function. Employees from the application management unit also partly work in projects. External resources are called in by the IS function on demand. Project managers are pooled in an independent unit within the change area.

	Organizational design and IT structure	IT budget allocation	IT demand management	IT project portfolio selection	IT resource management
C7	The company has a matrix structure with different regions and different business units. The organizational structure has recently been changed. In particular, the former divisional structure has been replaced by a business unit structure. The business units operate quite independently of each other. The corporate center covers boundary-spanning functions and sets strategic directions. The board of directors is primarily engaged in defining the corporate strategy. The business unit heads are not part of the board. A major impetus for the recent reorganization was to improve activities like project management, portfolio management and resource management. Moreover, the company has undergone and is still undergoing a number of strategic changes that are reflected in mergers, de-mergers, and acquisitions. The structure of the IS function was formerly strongly aligned to countries. Currently, it is transferred into a more centralized structure. In a first step, the IS function has been reorganized towards a regional orientation. Each region is composed of several countries. Finally, the IS function will become a global organization. IT resources will still be dispersed to the different regions but will be steered centrally.	The company has recently switched from a bottom-up budget planning approach to a top-down approach. The former very detailed planning approach has been abandoned. The business units are now predominantly steered by financial targets. The actuals of the different cost units are mapped against these targets. Within the boundaries of the predefined targets, the units have significant decision autonomy.	IT demand management has traditionally been oriented towards the different countries. However, it has recently been bundled at a regional level and will finally be transferred to a global demand management function. In addition, there will be dedicated regional demand officers (formerly regional CIOs) as contact persons for the different regions. The demand organization will be transferred to a strongly centralized structure, with global top-down control. The demand of the business units will be discussed and managed globally.	All investments (except of completely IT-focused projects) are approved by business committees. There is a staged decision-making structure ranging from countries to regions to the board of directors to the supervisory board. Depending on the project costs, investment decisions are taken at the different levels. The criteria and procedural mechanisms are the same on all levels. The IS function is usually not formally involved in investment decision-making but is consulted during the project proposal stage.	IT resources are physically dispersed throughout the different regions but have recently been organized into a global IT supply organization. The company has been consolidated in recent years. In consequence, IT resources have been pooled in global shared service centers. Regional CIOs currently still are disciplinary supervisors but the IT resources are managed globally.

	Organizational design and IT structure	IT budget allocation	IT demand management	IT project portfolio selection	IT resource management
C8	The company is organized as a corporate group with three legal entities. The company as a whole has undergone significant changes in recent years. The corporate group was formerly organized into 14 business units and a corporate center. These business units have recently been merged. Thereby, the number of business units has been reduced to eight. The IT organization has also undergone significant changes. A large number of IT employees have formerly worked in the decentralized business units. These employees have been transferred to a large degree to a centralized service provider within the corporate group. Besides, there is a centralized IT unit responsible for IT-related decisions in the entire group. This unit is supervised by the corporate CIO. The CIO reports to the board. The IS function is subdivided into four departments. Three departments are responsible for controlling and strategic sourcing, architecture and landscape, as well as security and compliance. Moreover, there is a fourth department responsible for business relations.	Project funds are provided by the decentralized business units. There is no centralized IT project budget. Only small pilot projects can be funded centrally by the IS function.	The IT demand of the business units is discussed in a hierarchy of corporate-wide committees composed of decision makers from business and IT. Moreover, each business unit is advised by an information officer directly reporting to the CIO.	Different project proposals are approved by distinct committees at different hierarchical levels. This level depends on the project volume and the relevance of the project. At the lowest level there are round tables composed of business and IT representatives. These round tables are installed by a steering group. At least one member of a round table is also a member of a steering group. The IT steering committee is the parent body of the steering groups. This committee is the highest IT-related decision-making body below the board. It is composed of the heads of the IT steering groups and senior representatives of the IT service center. The IT steering committee is led by the CIO. Projects with strategic relevance, compliance relevance or particularly cost relevance are discussed in the IT steering committee.	IT employees have formerly been located at the business units but have recently been transferred to an IT service center. The IT service center serves as an internal IT provider for all units in the group. IT employees organized in the service center now work for all business units and not only the business unit they have previously been assigned to.

	Organizational design and IT structure	IT budget allocation	IT demand management	IT project portfolio selection	IT resource management
C9	The company operates globally from three main locations. The corporate headquarters are located in Germany. IT is increasingly centralized at the German location, which is becoming the IT hub. The company as a whole is separated in two major businesses. The two businesses also have own separate boards. Both businesses are – to a large degree – independent of each other, but share a number of IT systems. Triggered by a major acquisition, the IS function has recently been restructured. In this context, major parts of the IT supply organization have been reorganized according to processes and services instead of components. Moreover, IT infrastructure has been centralized to a large degree. Currently the demand management organization is also reorganized in order to fit to the new structure. A corporate IT unit directly supervised by the corporate CIO is responsible for IT planning and IT governance. This unit is inter alia responsible for compliance, IT finance, and IT portfolio management.	There are separate IT budgets for the two businesses but also a central IT budget for the entire company. The businesses independently determine a cap for their IT spending and communicate this cap to the IS function. The IS function uses this information in order to provide the required resources. If the costs of the proposed projects exceed the budget announced by the respective business, projects have to be taken out of the portfolio by the IS function. After bad experiences with a bottom-up budgeting process, which resulted in a very large number of project proposals, recently a new process for IT budget allocation has been installed. This process is in general designed as a top-down process but has also a bottom-up component.	The IS function is represented by a board member in each of the two businesses. Moreover, a demand management organization is installed. This organization is currently repositioned due to the reorganization of the supply unit. A corporate-wide process has been installed in order to collect project requests. The process is supported by an information system and accompanied by the IS function. All project proposals – local as well as corporate-wide projects – are entered into the same system. During the demand management process, it is also specified if a given project proposals only affects a single business or the company as a whole.	Project proposals are approved by different committees at different hierarchical levels. The decision-making level for a given project proposal is primarily determined based on the project costs. The two businesses can independently approve projects with relatively high costs. However, projects that are relevant for both businesses have to be approved by a business/IT council if they fall within a certain cost range. Projects with a very high financial volume have to be approved by the executive board. Independently of where a project is approved, it is tracked centrally.	Project resources are managed in a virtual corporate-wide organization. Projects are staffed on demand with employees working in the IT supply organization. Employees who are assigned to a project work full-time for the project. Employees who do not work on a project are organized in a matrix structure (with products and processes as the primary dimensions) and usually conduct run and maintenance activities. Project managers are organized in a separate unit.

	Organizational design and IT structure	IT budget allocation	IT demand management	IT project portfolio selection	IT resource management
C10	The company has a matrix-like structural organization with a functional and regional dimension. The regions are the main dimension. The regional organizations operate independently to a large degree. This regional focus is mainly due to the recent history of the company, which has been influenced by a number of mergers and acquisitions. Moreover, the regional focus is also effectuated by different national legislations for the pharmaceutical industry. The corporate headquarters focus on providing a strategic orientation for the company as a whole. The IS function is also strongly decentralized into regions and countries. Independent IT departments support regions and/or countries where the company is strongly engaged. The local IT departments are headed by regional CIOs and have individual governance arrangements. IT resources are organized in these local IT departments. Corporate wide coordination is fostered via an IT leadership committee headed by the corporate CIO. The committee consists of regional CIOs as well as functional CIOs. The latter in particular have a strategic focus. In the committee meetings, the group-wide IT strategy and common issues are discussed and group-wide directives and standards are adopted. The leadership committee shall in particular facilitate an exchange of experiences. The strategies of the regional IS functions should not contradict the group-wide strategy but are in general independent of each other.	Budgets are coordinated globally as well as in the different regions and countries. Different approaches are used by different countries. In the investigated country organization, bottom-up as well as top-down planning approaches were tested. Currently, a top-down approach is applied. Individual budgets are assigned to the functional units within the region. The projects proposed by the respective units are prioritized according to these budgets.	IT demand management is organized locally at a regional or country level. In the investigated country organization, the demand management process is very informal. Typically, demand is communicated to the regional CIO at an early stage of the project evaluation phase. IT demand is also discussed in a customer advisory board composed of business and IT representatives. There is a close informal relationship between the business units and the IT department. The IT department usually has a consulting role during the preparation phase.	IT project portfolio selection is conducted at a regional or country level. The process in the given country organization is supported by a governance expert within the IT department. A project portfolio management tool has been implemented in the respective country organization in order to support the process. The process is constantly redesigned. Currently, projects are discussed and prioritized in the customer advisory board composed of business and IT representatives. In this committee, project proposals are mapped against the functional as well as the regional strategy in order to prioritize the projects against the given budget.	IT employees are managed locally in the different regions and countries. Infrastructure and applications are also managed locally. In general, IT resource management is decentralized to a very large degree.

Appendix G – Impacts of contingency factors on governance arrangements

Contingency factor	Characteristics	Impacts on IT governance arrangements for IT PPM			
		IT budget allocation	IT demand management	IT project portfolio selection	IT resource management
Organizational structure	Centralized	Top-down approach / Allocation based on the corporate strategy and business unit performance	Formalized demand management processes	Corporate-wide portfolio / Strong top management and IT involvement	Centralized resource pools / Service orientation / Skill-based or process-based resource assignments
	Decentralized	Bottom-up approach / Budget not fixed in advance but dependent on the projects and initiatives accruing in the respective business unit	Different IT demand managers assigned to different business units. Close informal contact between IT demand managers and business units	Local portfolios / Projects predominantly selected by business units / Coordination via committees, informal networks and liaison roles	Functional specialization / Product-based resource assignment
Firm size	Large firm size	Divisional budgets / Probably individual planning processes per business unit / Budget approved by business unit heads	Large number of IT demand managers / Several demand managers responsible for one business unit	Several IT project portfolios / different decision-making committees in different units and at different hierarchy levels	Subdivision of project resources / Matrix arrangements
	Small firm size	Corporate-wide budget / Budget potentially negotiated between the board and the IS function (CIO)	Small number of IT demand managers / One demand manager responsible for several business units	One corporate-wide IT project portfolio / Few decision makers and committees / Informal arrangements	Single resource pool / Low functional specialization / Flexible resource assignments
External environment	Static (steady-state)	Yearly planning cycles / Fixed budget	Focus on procedural mechanisms / Regular institutionalized meetings	Yearly planning cycles / Stage-gate approval / Relatively strong involvement of IT representatives	Permanent procedural arrangements / Centralized resource planning
	Dynamic	Rolling wave planning / Frequent adjustments	Strong relational mechanisms / Close contacts / Frequent meetings	Rolling wave planning / Session-based approval / Relatively strong involvement of business unit managers	Flexible resource assignments / Ad-hoc planning
Corporate strategy and IT strategy	Efficiency	Strong involvement of the IS function / Large fraction of the budget assigned to IT architecture and infrastructure initiatives	Demand managers act as controllers / Strong focus on costs and architectural aspects	Focus on cost savings and process improvements / Use of financial figures / Mix of short-term and long-term initiatives	IT resources are organized according to processes / IT projects are predominantly staffed with IT resources
	Innovation	Budget primarily controlled by business units (Strategic fields of activities)	Demand managers act as consultants / Strong focus on business value of IT	Focus on strategic benefits / Project evaluation based on business cases / Strong involvement of business unit representatives	Projects are conducted by interdisciplinary teams (Collaboration between IT and business staff)
Organizational culture and politics	Culture based on formal authority and hierarchy	Budgets assigned based on performance metrics / Top-down approach	Strong procedural mechanisms / Predefined criteria	Strong procedural mechanisms / Focus on financial figures and strategic relevance	Formal resource owners / Projects staffed according to formal priorities and the power of the project sponsor
	Consensus-oriented culture	Budget negotiated in meetings and committees based on last year's values	Strong relational mechanisms / Informal contacts between business and IT / Flexible use of criteria	Consensus-based evaluation approaches / Group decisions / Some “pet projects” are likely	Bargaining process / Market-based mechanisms

Role of the IS function	Business enabler	Budget negotiated between the board, the IS function and the business units	Joint search for new opportunities / Demand managers primarily act as consultants.	IS function governs the IT project portfolio management process / Strong involvement of the IS function	Functional specialization of resources / Product-based resource assignments / Strong dependence on IT resources with expert skills
	Support unit	Budget negotiated directly between the board and the business units	IS function is kept informed by the business units via demand management / Demand managers primarily exert control tasks	IT projects are selected by the business units / Low involvement of the IS function	IT resources are managed in a shared service center / Low functional specialization / Flexible resource assignments to projects
Top management involvement	High involvement	Budget negotiated between business units and the board	Top management may intervene during demand management / Risk of premature decisions	Focus on large, strategic projects / Potential impediment of other projects	Acceleration of strategic projects / Potential impediment of smaller projects without top management attention
	Low involvement	Bilateral negotiations between business units and the IS function or the controlling department	Demand managers mediate between the business units and the IS function	Focus on smaller unit-specific initiatives / Risk of too many projects in the portfolio / Lack of focus	Bargaining process / Market-based mechanisms / Risk of delays in the entire portfolio and fire-fighting
Project interdependencies and synergy potentials	High synergy potentials	Budget predominantly managed centrally and reserved for large strategic initiatives and programs	Strong coordination between IT demand managers / Regular demand management meetings	Comprehensive project portfolio selection approaches / Strong coordination	Focus on resource interdependencies / Close monitoring of resource assignments / Use of program management practices
	Low synergy potentials	Budget independently managed by business units	Demand managers focus on project proposals of assigned business unit	Selection based on hurdle rates / Isolated decisions	Focus on timely provisioning of resources

Appendix H – Theoretical integration of the identified contingency factors

Contingency factor	Corresponding theories and concepts	Objects of study	References
Organizational structure and firm size	• Organizational theory • Organizational fit concept • Strategic-choice perspective	• Unit grouping / Unit size • Centralization / Decentralization • Standardization of work processes, outputs and skills • Total revenue • Number of employees	• Child, 1972 • Mintzberg, 1980 • R. E. Miles et al., 1978 • Ein-Dor & Segev, 1982 • Allen & Boynton, 1991 • Hodgkinson, 1996 • A. E. Brown & Grant, 2005 • Martinsuo & Lehtonen, 2007
External environment	• Organizational theory • Dynamic capabilities theory	• Competitive pressures • Environmental variability • Environmental complexity • Organizational adaption • Speed of response	• Ansoff & Brandenburg, 1971 • Child, 1972 • R. E. Miles et al., 1978 • Peterson, 2004 • Xue et al., 2008
Corporate strategy and IT strategy	• Management theory • Organizational theory	• Organizational adaption • Strategic typologies • Strategic alignment • Strategic planning process	• R. E. Miles et al., 1978; R. E. Miles & Snow, 1978 • Tavakolian, 1989 • Henderson & Venkatraman, 1993 • C. V. Brown & Magill, 1994 • Peterson et al., 2000 • Meskendahl, 2010
Organizational culture and politics	• Agency theory	• Incentive structures • Goal conflicts • Outcome uncertainty • Information asymmetry • Routines • Risk preferences • Attitude towards change	• Eisenhardt, 1989b • Weill & Olson, 1989a • Allen & Boynton, 1991 • Peterson, 2004 • Teece, 2007 • Prifling, 2010a, 2010b • El Arbi et al., 2012
Role of the IS function	• Institutional theory • Absorptive capacity	• IT function power • Line IT knowledge • IT business knowledge	• Xue et al., 2008 • Winkler et al., 2011 • C. V. Brown & Magill, 1994
Top management involvement	• Upper echelons theory	• Managerial discretion • Encouragement • Empowerment • Intervention	• Hambrick & Mason, 1984; Hambrick, 2007 • Doll, 1985 • Thomas et al., 2007 • Jonas, 2010 • Unger, Kock, et al., 2012
Project interdependencies and synergy potentials	• Economic theory of complementarities	• Interdependencies • Cross-unit synergy	• Milgrom & Roberts, 1995 • Allen & Boynton, 1991 • Hodgkinson, 1996 • C. V. Brown & Magill, 1998 • Ross & Weill, 2002 • Tanriverdi & Venkatraman, 2005; Tanriverdi, 2006 • Cho & Shaw, 2009a

Appendix I – Theoretical integration of the identified outcome categories

Outcome category	Corresponding theories	Objects of study	References
Project portfolio configuration	• Modern portfolio theory	• Portfolio balance • Portfolio return • Portfolio risk • Project type • Project size • Project fit to strategy	• Markowitz, 1952 • R. G. Cooper et al., 1999, 2000, 2001 • McFarlan, 1981 • Meskendahl, 2010
Speed of decision-making and implementation	• Organizational theory	• Operating responsiveness • Structural responsiveness • Efficient use of resources	• Ansoff & Brandenburg, 1971 • Allen & Boynton, 1991, p. 438 • R. G. Cooper et al., 1999, 2000 • Thomas et al., 2007 • Barnett, 2008
Stakeholder satisfaction	• Agency theory • Stakeholder theory • Theory of procedural justice	• Conflicts • Political behavior • Agency costs	• Jensen & Meckling, 1976 • Peterson et al., 2000 • Thomas et al., 2007 • El Arbi et al., 2012
Use of synergies	• Economic theory of complementarities	• Complementarities • Interdependencies • Redundancies	• Milgrom & Roberts, 1995 • Tanriverdi, 2006 • Cho & Shaw, 2009a • Meskendahl, 2010 • Teller et al., 2012 • Voss & Kock, 2012

Appendix J – Simulation statistics

Main effects:

	Factor 1 – Budget in relation to total costs	Factor 2 – Number of interdependencies	Factor 3 – Interdependency weight
Complementary benefit interdependencies	0.0144	0.0376	0.0976
Competitive benefit interdependencies	0.0099	0.0278	0.0680
Complementary cost interdependencies	-0.0237	0.0585	0.1362
Competitive cost interdependencies	-0.0025	-0.0047	-0.0032

Two-factor interactions:

Complementary benefit interdependencies	Factor 1 – Budget in relation to total costs	Factor 2 – Number of interdependencies	Factor 3 – Interdependency weight
Factor 1 – budget in relation to total costs	-	0.0040	0.0078
Factor 2 – number of interdependencies	-	-	0.0206
Factor 3 – interdependency weight	-	-	-

Competitive benefit interdependencies	Factor 1 – Budget in relation to total costs	Factor 2 – Number of interdependencies	Factor 3 – Interdependency weight
Factor 1 – budget in relation to total costs	-	0.0049	0.0115
Factor 2 – number of interdependencies	-	-	0.0252
Factor 3 – interdependency weight	-	-	-

Complementary cost interdependencies	Factor 1 – Budget in relation to total costs	Factor 2 – Number of interdependencies	Factor 3 – Interdependency weight
Factor 1 – budget in relation to total costs	-	-0.0174	-0.0260
Factor 2 – number of interdependencies	-	-	0.0457
Factor 3 – interdependency weight	-	-	-

Competitive cost interdependencies	Factor 1 – Budget in relation to total costs	Factor 2 – Number of interdependencies	Factor 3 – Interdependency weight
Factor 1 – budget in relation to total costs	-	0.0003	0.0005
Factor 2 – number of interdependencies	-	-	-0.0003
Factor 3 – interdependency weight	-	-	-

Three-factor interactions:

	Effect between all three factors
Complementary benefit interdependencies	0.0013
Competitive benefit interdependencies	0.0049
Complementary cost interdependencies	-0.0190
Competitive cost interdependencies	0.0006

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