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VALUE CREATION BY IT ARCHITECTS AND THEIR ROLES IN IT PLANNING

PhD dissertation

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"The firm that does not have an IT architecture does not have a real IT strategy."

(Peter G. W. Keen, 1991)

"Indeed, the word *architecture* may replace *plans* or *strategies*."

(Michael J. Earl, 1996)

ABSTRAKT

Der er stærke aftaler mellem forskere om, at informationsteknologi (IT) er en kilde til værdiskabelse og konkurrencefordel. Der er også bred enighed om, at it-planlægning og it-arkitektur er væsentlige faktorer for at nå strategiske forretningsmæssige mål gennem it. Selvom der er foretaget intensiv undersøgelse af alle disse emner i flere årtier, er der stadig lidt forståelse for deres tilknytning - både i teori og praksis. Denne afhandling undersøgte værdiskabelsen af IT-arkitekter og deres roller i IT-planlægningsstrukturer; det uddybet it-værdi, konkurrencefordel og i henhold til strategiteorier. Denne doktorafhandling er præsenteret som en samling af seks artikler og en overordnet introduktions- og diskussionsdel, der gennemgik den relevante litteratur grundigt. Fire store forskningsproblemer blev belyst i den overordnede del ved at overveje resultaterne fra artiklene.

Specialet omfatter intensive teoretiske diskussioner for at forstå begrebet it-værdi, som er obligatorisk for strategisk analyse. Tre problemer blev afsløret i litteraturen og er derfor blevet afklaret. For det første er værdien fra it-investeringer uklar. For det andet kræver forholdet mellem it-værdi og konkurrencefordel større klarhed. For det tredje er den dominerende ressourcebaserede opfattelse (RBV) utilstrækkelig til at forklare konkurrencefordel fra IT. Således er en mere integrerende teori nødvendig.

IT-værdi består af to komplementære facetter: kundeværdier, der påvirker en virksomheds ydeevne og organisatoriske værdier som forudsætninger for kundens værdi. Kundeværdidisciplinerne "operationel ekspertise", "produktledelse" og "kundeintimitet" blev påvist gennem indholdsanalyse på årsrapporter fra IT-leverandører og sammenlignet med IT-værdiedefinitioner fra tidligere publikationer. Fire kategorier af organisatoriske værdier blev induceret fra litteraturen.

RBV mangler perspektiver på det ydre miljø og kundeverdien. Det blev vist, at RBV og erhvervssyn komplementerer hinanden med hensyn til strategisk formulering af konkurrencefordel - forretning generelt og IT i særdeleshed. Kundeværdighedsvisningen blev drøftet med disse grundlæggende teoretiske synspunkter. Det er vigtigt at medtage kundeværdisyn i en passende ramme for strategisk forretningsanalyse. Forbindelserne mellem RBV, industrivisningen og kundeværdighedsvisningen er illustreret i den integrerede model til konkurrence / komparativ fordel. Denne model er nyttig til IT-forretningsanalyse og til strategisk tilpasning. Denne model er svaret på det første forskningsspørgsmål: "Hvilket strategisk syns er passende til analyser af IT-værdi og konkurrencefordel?"

Betydningen af IT-arkitektur for konkurrencefordel anerkendes i den eksisterende litteratur, men der er ingen generelt accepteret definition for IT-arkitektur. IT-arkitektenes rolle er uklar i både akademia og det virkelige liv. For en bedre forståelse af IT-arkitekter stilles det andet forskningsspørgsmål om de krævede opgaver og færdigheder hos IT-arkitekter. Den første indholdsanalyse af jobannoncer for IT-arkitekter leverede 37 opgavekategorier og 49 færdighedskategorier, der blev sammenlignet med andre forskningsresultater fra interviews, undersøgelser og fokusgrupper. Indholdsanalysen i denne afhandling gav større detaljer og var mere objektiv end ved tidligere forskning. Derudover blev der identificeret tre typer it-arkitekter, som hver adskiller sig med hensyn til deres strategiske og taktiske opgaver og deres forretnings- og teknologikompetence. Resultaterne fra indholdsanalysen af jobannoncer blev kontrasteret med praktiserende rammer og indflydelsesrige artikler om IT-arkitektur og IT-planlægning.

Det tredje forskningsspørgsmål vedrørte værdien genereret af IT-arkitekter. Fra den eksisterende litteratur er det konkluderet, at it-arkitekter forbedrer alle typer kundeværdi. IT-arkitekter skaber desuden organisatoriske værdier: strategisk planlægning, beslutningstagning,

forbedrede færdigheder / evner og fleksibilitet / smidighed - det vil sige dynamiske evner. Denne analyse er karakteristisk, da den var baseret på rige data (IT-arkitekts opgaver fra indholdsanalyse) og en grundig omdefinering af IT-værdi. Udover virksomhedsarkitekter omfattede undersøgelserne og diskussionerne løsningsarkitekter og software arkitekter.

Det er vist, at it-arkitekter opnår konkurrencefordel ved at planlægge unikke (IT) evner med overlegne eller tilpassede funktioner; en komparativ fordel kan opnås ved standardisering. Bæredygtighed af disse fordele kræver ledelsesfærdigheder hos it-arkitekter og sofistikerede it-arkitekturer, der er vanskelige at duplikere.

IT-planlægning kan defineres som evnen til at designe IT til fremtidige behov ved at kombinere IT-ressourcer i muligheder for kundeværdi og strategisk differentiering. Sådan planlægning inkluderer IT-forretningsretning og IT-arkitektur. Der er dog ingen klarhed omkring it-planlægningsprocesser, strukturer og de involverede roller. Litteraturen er kontroversiel med hensyn til de væsentlige roller, der kræves for IT-forretningstilpasning. Det kan være opfyldt af senior (IT) ledere eller IT arkitekter. Det fjerde forskningsspørgsmål vedrørte de forskellige roller i IT-planlægning, der er forbundet med IT-arkitekter. Resultaterne blev syntetiseret ud fra data, eksisterende litteratur og branche-publikationer.

Data fra litteratur og jobannoncer viser, at it-arkitekter udfører på to sammenkoblede niveauer: virksomhedsarkitekter på strategisk niveau og løsning / software arkitekter på taktisk / projektniveau. Opgaverne i jobannoncer afspejler, at virksomhedsarkitekter tilpasser IT til virksomheden og definerer IT-strategien. Virksomhedsarkitekter opretter forbindelse til senior forretningsførere, senior IT-ledere og udvalg. De vælger, prioriterer og planlægger projekter sammen med projektporteføljeadministratorer. Derudover guider de og styrer løsningsarkitekter, der opretter forbindelse til projektledere til kravanalyse og løsningsdesign. IT-leverandører påvirker en virksomheds IT-strategi og skifter omkostninger; forholdet mellem it-arkitekter og it-leverandører er centralt.

Denne afhandling identificerede IT-arkitektur som kernefunktionen i IT-planlægning og justering. IT-arkitekter skal arbejde tæt sammen med projektporteføljeadministratorer for IT-projektjustering, projektledere, løsningsdesign og forretningsførere. Tre logiske modeller viser de vigtigste fund, som kan inspirere til nye forskningsretninger. Desuden afslørede denne afhandling midler og strukturer, der kan anvendes i virkelige virksomheder; det foreslår en ramme for IT-værdeplanlægning.

ABSTRACT

There are strong agreements among scientists that information technology (IT) is a source of value creation and competitive advantage. There is also broad consensus that IT planning and IT architecture are essential factors for achieving strategic business goals through IT. Although intensive research on all these topics has been conducted for several decades, there is still little understanding on their relatedness—in both theory and practice. This dissertation examined the value creation by IT architects and their roles in IT planning structures; it elaborated on IT value, competitive advantage, and according strategy theories. This doctoral thesis is presented as a collection of six articles and an overarching introduction and discussion part, which reviewed the relevant literature in depth. Four major research problems were elucidated in the overarching part by considering the findings from the articles.

The thesis comprises intensive theoretical discussions to comprehend the notion of IT value, which is mandatory for strategic analysis. Three problems were unveiled in the literature and have consequently been clarified. First, the value from IT investments is nebulous. Second, the relation between IT value and competitive advantage requires greater clarity. Third, the dominant resource-based view (RBV) is insufficient for explaining competitive advantage from IT. Thus, a more integrative theory is necessary.

IT value consists of two complementary facets: customer values that impact a firm's performance and organizational values as preconditions to customer value. The customer value disciplines "operational excellence," "product leadership," and "customer intimacy" were proved through content analysis on annual reports from IT vendors and compared to IT value definitions from previous publications. Four categories of organizational values were induced from the literature.

The RBV lacks perspectives on the external environment and on customer value. It was shown that the RBV and the industry view complement each other in terms of strategic formulation of competitive advantage—business in general and IT in particular. The customer-value view was discussed with these foundational theoretical views. It is essential to include customer-value view in an appropriate framework for strategic business analysis. The links among the RBV, the industry view, and the customer-value view have been illustrated in the integrated model for competitive/comparative advantage. This model is useful for IT-business analysis and for strategic alignment. This model is the answer to the first research question: "What strategic view is appropriate for the analyses of IT value and competitive advantage?"

The significance of IT architecture for competitive advantage is acknowledged in the extant literature, but there is no generally accepted definition for IT architecture. The role of the IT architects is unclear in both academia and real life. For a better understanding of IT architects, the second research question asked about the required tasks and skills of IT architects. The first content analysis on job advertisements for IT architects provided 37 task categories and 49 skill categories that were compared to other research findings from interviews, surveys, and focus groups. The content analysis in this thesis provided greater details and was more objective than that in prior research. Moreover, three types of IT architects were identified, each of which differ in terms of their strategic and tactical tasks and their business and technology proficiencies. The results from the job ads content analysis were contrasted with practitioner frameworks and influential articles on IT architecture and IT planning.

The third research question addressed the value generated by IT architects. From the existing literature it has been concluded that IT architects enhance all types of customer value. Further, IT architects create organizational values: strategic planning, decision-making, enhanced skills/capabilities, and flexibility/agility—that is, dynamic capabilities. This analysis is

distinctive as it was founded on rich data (tasks of IT architects from content analysis) and a thorough redefinition of IT value. Beyond enterprise architects, the examinations and discussions included solution architects and software architects.

It has been shown that IT architects achieve competitive advantage by planning unique (IT) capabilities with superior or customized features; comparative advantage may be achieved by standardization. Sustainability of these advantages calls for managerial skills of IT architects and sophisticated IT architectures that are difficult to duplicate.

IT planning can be defined as the capability of designing IT for future needs by combining IT resources into capabilities for customer value and strategic differentiation. Such planning includes IT-business alignment and IT architecture. However, there is no clarity on IT planning processes, structures, and the roles involved. The literature is controversial with regard to the essential roles required for IT-business alignment. It may be fulfilled by senior (IT) managers or IT architects. The fourth research question concerned the various roles in IT planning that are connected to IT architects. The outcomes were synthesized from data, existing literature, and industry publications.

The literature and job ads data show that IT architects perform at two interlinked levels: enterprise architects at the strategic level and solution/software architects at the tactical/project level. The tasks in job ads reflect that enterprise architects align IT to the business and define the IT strategy. Enterprise architects connect to senior business managers, senior IT managers, and committees for IT-business alignment. They select, prioritize, and schedule projects jointly with project portfolio managers. In addition, they guide and govern solution architects that connect to project managers for requirement analysis and solution design. Further, IT vendors impact a firm's IT strategy and switching costs; the relationship between IT architects and IT vendors is pivotal.

This dissertation identified IT architecture as the core function in IT planning and alignment. IT architects must closely collaborate with project portfolio managers for IT-project alignment, project managers, solution design, and business managers. Three logical models display the main findings, which may inspire new research directions. Further, this dissertation revealed means and structures that can be applied in real businesses; it proposes a frame for IT-value planning.

PREFACE

This dissertation is a collection of six published articles that examined IT value, the roles of IT architects, and their connections in IT planning.

All articles are my own research and are original. I did not receive any funds from a public, commercial, or nonprofit organization.

Christof Gellweiler

March 12, 2020

Munich

CONTENTS

ARTICLES PART II

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LIST OF ARTICLES

All articles of this dissertation were written by Christof Gellweiler as sole author. All articles were blindly reviewed by at least two reviewers. Information in *italics* denotes the most important scientific databases of the journals.

Article 1: Bridging IT Requirements to Competitive Advantage: The Concept of IT Value Planning

Published: 2017. Procedia Computer Science, 121, 145–151.

https://www.sciencedirect.com/science/article/pii/S1877050917322111

Scopus, Clarivate WoS CPCI

Article 2: Cohesion of RBV and Industry View for Competitive Positioning

Published: 2018. International Journal of Strategic Management and Decision Support Systems in Strategic Management, 23(2), 3–12.

http://www.ef.uns.ac.rs/sm/archive/SM2018_2.pdf

Clarivate WoS ESCI

Article 3: Operational Excellence as the Main Customer Value: Information Technology Vendors' Perspective

Published: 2019. Business Systems Research Journal, 10(1), 13–30.

https://content.sciendo.com/view/journals/bsrj/10/1/article-p13.xml?lang=en

Scopus, Clarivate WoS ESCI

Article 4: Types of IT Architects: A Content Analysis on Tasks and Skills

Published: 2020. Journal of Theoretical and Applied Electronic Commerce Research, 15(2), 15–37.

http://www.jtaer.com

Scopus, Clarivate WoS SSCI

Article 5: Connecting Enterprise Architecture and Project Portfolio Management: A Review and a Model for IT Project Alignment

Published: 2020. International Journal of Information Technology Project Management, 11(1), 99–114.

https://www.igi-global.com/article/connecting-enterprise-architecture-and-project-portfolio-management/236575

Scopus, Clarivate WoS ESCI

Article 6: Collaboration of Solution Architects and Project Managers

Published: 2019. International Journal of Human Capital and Information Technology Professionals, 10(4), 1–15.

https://www.igi-global.com/article/collaboration-solution-architects-project-managers/234713

Scopus, Clarivate WoS ESCI

The articles presented in this dissertation include changes and additions based on the comments from the preliminary assessment. Therefore, the dissertation articles deviate from the versions that are published in the above-mentioned journals.

Published article that is not part of this dissertation:

Gellweiler, C., & Krishnamurthi, L. (2020). Editorial: How Digital Innovators Achieve Customer Value, Journal of Theoretical and Applied Electronic Commerce Research, 15(1), I – VIII.

http://www.jtaer.com

Scopus, Clarivate WoS SSCI

The research results were presented at the following scientific conferences:

Enterprise Research Innovation Conference (Entrenova), Rovinj, Croatia, 13.09.2019: *Aligning IT Projects to Business Strategy*

Conference on Enterprise Information Systems (Centeris), Barcelona, Spain, 09.11.2017: *The Concept of IT Value Planning*

Project Management Development – Practice and Perspectives, Riga, Latvia, 28.04.2017: *Bridging IT Requirements to Competitive Advantage*

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OVERARCHING INTRODUCTION AND DISCUSSION

1 General overview

1.1 Research context

Information technology (IT) is central to a firm's competitive strategy (Clemons & Row, 1991) and a capability for value creation (Peppard & Ward, 2004). IT is an instrument for sustainable competitive advantage (Mentzas, 1997, p. 85) that can be used to empower business strategy (Luftman, 2003, p. 15). Strategic IT planning helps achieve the business goals of an organization (Lederer & Salmela, 1996) and relates to the alignment of the IT and business strategies to create competitive advantage (Chen, 2010). The alignment of IT with business strategy has been intensively discussed (El-Mekawy, Rusu, & Perjons, 2015; Luftman, 2003; Marrone & Kolbe, 2011). Although strategic IT planning has been significant since the late 1970s (Robson, 1997, pp. 100–101), the term "IT strategy" remains only partially understood (Chen, 2010). The value from IT is recognized in the literature, but there is a lack of a common understanding of the strategic value of IT (Oh & Pinsonneault, 2007; Oz, 2005; Schryen, 2013). Moreover, the processes and responsibilities for the creation of value from IT investments are poorly defined (Peppard & Ward, 2004; Schryen, 2013).

IT architecture is a source of differentiation and can translate into competitive advantage for a firm (Earl, 1990, p. 27; Feeny & Ives, 1990, p. 37). IT architecture is an element of the strategic alignment process along with IT strategy, business strategy, and the organization (Baets, 1992). IT architecture relates to IT planning (Earl, 1989, p. 62) and is integral to an organization's IT (e.g., Venkatraman, Henderson, & Oldach, 1993). However, there is no universally agreed upon definition for IT architecture (Earl, 1989, p. 97; Ross, 2003, p. 32). In practice, the term "architecture" is poorly understood outside the civil engineering field (Josyula, Orr, & Page, 2012, p. 35). The role of the IT architect remains vague in the literature and in practice (Ameller et al., 2012, p. 11; Olsen, 2017, p. 641; Thönssen & von Dewitz, 2018, p. 409).

Thus, IT architecture is an unclear function in an immature IT planning process that is vital to a firm. There is a strong need to elaborate on the role of IT architects and learn about their value-creating function as well as their integration in IT planning.

1.2 Research aims

The aspects of IT value, competitive advantage, business strategy, IT strategy, IT planning, IT business-alignment, and IT architecture are intertwined. Because these notions still lack clarity, their interrelationships cannot be fully understood. This dissertation strives to find a structured means in which IT architects help align the IT strategy to the business for value creation. Accordingly, the first research question (RQ1) is "What strategic view is appropriate for the analyses of IT value and competitive advantage?"

The dissertation also explores the roles of IT architects by proposing the following research question (RQ2): "What are the required tasks and skills of IT architects?" The outcomes are required to answer the third research question (RQ3)— "What types of values result from IT architects?" The identification of the tasks of IT architects enables the analysis of their value contributions. Since the term IT value is fuzzy, precise IT value types must be drawn up that can be compared to the tasks of IT architects.

Clarity on the tasks of IT architects provide insights into IT planning structures by providing clues on related roles that they interact with. Planning is a social process and IT architects do not work in isolation—they are connected to people in other roles, who they collaborate with in IT planning. In turn, these infer implications regarding IT planning structures. Thus, another main question (RQ4) that is addressed in this thesis is “How are IT architects linked to other roles in IT planning?”

1.3 Research design

Comprehensive literature reviews were conducted in order to build a theoretical model for strategic business analysis, define IT value, and work on the relationship between IT value and competitive advantage.

Content analysis is a recognized scientific method to infer meaning from codes in documents (e.g., Krippendorff, 2004). Although it is widely applied in various scientific disciplines, it has barely been used in IT-business research (Surakka, 2005, Todd, McKeen, & Gallupe, 1995). This research searched for codes for IT values in annual reports from IT vendors in order to examine customer value from IT investments.

Only a few studies have been carried out on the tasks and skills of IT architects. These studies employed classic techniques such as interviews (Casas, Sánchez, & Villalobos, 2017; Figueiredo et al., 2012, 2014), surveys (Casas, Sánchez, & Villalobos, 2017), and focus groups (Akenine, 2008). This dissertation includes the first paper that reveals the required tasks and skills of IT architects from content analysis on job advertisements; it provides richer data and is more objective.

These outcomes were compared to IT value types, induced from the literature, to identify organizational values from IT architects. The tasks and skills found in the jobs ads also provide directions to related functions in IT planning, particularly project management and IT vendors. The literature and practitioner publications (e.g., global standards, bodies of knowledge, and industrial articles) were reviewed in order to understand the strategic connections between enterprise architecture and project portfolio management as well as the tactical relations between solution architecture and project management. Through conceptual synthesis, ideas were integrated and new logical relationships are suggested from these.

1.4 Main findings

This dissertation integrated previous classifications of IT value into a new definition that consists of customer values that directly impact firm performance and non-monetary organizational values, which are preconditions to the creation of customer value.

The resource-based view (RBV) (e.g., Penrose, 1959) and the industry view (Porter, 1980) are incomplete for both business analysis and strategic IT planning, if considered in isolation. Both perspectives complement each other in the formulation of strategies for competitive advantage. Based on theoretical arguments, a model was created in which the customer-value view was linked with the RBV and the industry view.

The customer value disciplines from Treacy and Wiersema (1993, 1995) build the foundation of the customer-value view and are appropriate for describing customer value created by IT. Codes for these were found in 84% of the annual reports sample from IT vendors. These codes correlate positively with codes for competitiveness.

Further, 37 task categories and 49 skill categories were obtained from job ads for IT architects. Three types of architects were identified that function on two levels. IT architects provide managerial IT skills for sustainable competitive advantage; they can create (IT) capabilities that are distinctive and difficult to duplicate.

IT architects provide organizational value in terms of strategic planning, decision-making, and skill/capability enhancement. Standardization and integration provide flexibility for dynamic (IT) capabilities. Further, standardization, customization, and innovation by IT architects offer ways to create customer value.

Enterprise architects connect strategically to business managers/committees for IT-business alignment and to project portfolio management for IT project alignment (i.e., selection, prioritization, and scheduling of IT projects). In addition, enterprise architects guide solution architects, who collaborate with project managers in tactical ways to actualize architectural plans.

IT vendors strongly influence a firm's IT architecture and its value creation from IT investments. Further, switching costs depend on architectural decisions regarding products from IT vendors. Yet, in practice, the relationship between IT vendors and IT architects is neglected.

1.5 Dissertation structure

This doctoral thesis is a collection of six interrelated papers and an overarching introduction/discussion that focuses on the integration of these papers and their joint research contributions. The dissertation is organized into the following four parts:

- Overarching introduction and discussion (overarching literature review, motivation, methods, article summaries, overarching discussion, and conclusions)
- Articles part I (IT value planning, literature review on theories, and content analysis for customer value)
- Articles part II (tasks, skills, and types of IT architects from content analysis; connections to project (portfolio) management)
- Appendices (e.g., list of acronyms, sample data)

The overarching literature review (chapter 2) consists of four sections: IT value and competitive advantage (section 2.1), the RBV on IT (section 2.2), IT planning and IT architecture (section 2.3), and the essential roles in IT planning (section 2.4). Each of these sections concludes with a dedicated summary that highlights the key aspects.

Based on the identified deficiencies and gaps in the literature, the motivation of this dissertation is elucidated, and the overall research questions are formulated. The overarching introduction also describes the selected research methods and condenses the highlights from the articles. The articles are briefly summarized in terms of purpose, content, outcomes, and suggestions.

The overarching discussion section elaborates on the main findings and propositions in relation to the overall research questions. The section also summarizes the theoretical and practical contributions as well as limitations of this dissertation. The discussion section also indicates directions for future research, recapitulates the outcomes, and draws conclusions.

The articles are divided into two parts, each consisting of three papers. Part I deals with strategic values from IT planning and strategic capabilities. It explores IT planning capabilities between strategy formulation and value delivery. Part II concentrates on IT architecture and its relationship with project management. The results from Parts I and II support the proposition of the integrated model for IT value planning.

The first article in Part I (Bridging IT Requirements to Competitive Advantage: The Concept of IT Value Planning) presents the idea of IT value planning in a nascent state. It derives the

IT planning sequence from logical dependencies and reveals the roles involved. This paper indicates IT planning coherence from strategy to value realization. The chain for IT value planning (Article 1, Figure 3) is an early version of a process model for IT planning and provides ideas for the succeeding papers. The second article (Cohesion of RBV and Industry View for Competitive Positioning and for Strategic IT Planning) concentrates on competitive strategies are necessary for IT-business alignment. The third paper (Operational Excellence as the Main Customer Value: Information Technology Vendors' Perspective) reflects the customer value that originates from products of IT planning.

The articles in Part II refer to managerial key roles and functions in IT planning. Part II begins with Article 4 (Types of IT Architects: A Content Analysis on Tasks and Skills); it provides data for the discussion regarding the relationship of IT architects with project management. The subsequent Article 5 (Alignment of Enterprise Architecture and Project Portfolio Management: A Review and a Model for IT-Project Alignment) focuses on strategic relationships and the ways for alignment. The last paper considers the tactical level for detailed planning and implementation (Collaboration of Solution Architects and Project Managers). Finally, the appendices contain a list of acronyms and data from content analyses.

The parts of this dissertation are sub-structured into chapters, sections, subsections, and topics. Table 1 displays the structural elements and the formats of their headlines.

Each article has its own numbering for tables and figures. The overarching introduction and discussion occasionally refers to tables and figures from the articles; the corresponding article number is provided in parentheses.

Structural element	**Headline examples**	**Letters/Numbering**
Part	OVERARCHING INTRODUCTION AND DISCUSSION ARTICLES PART I	Capitalized letters/No numbers
Chapter	**1 General overview** **2 Overarching literature review** **Article 1**	Bold letters/Numbers without sub-numbers
Section	**2.3 IT planning** **5.3 The strategic level: business alignment**	Bold letters/Numbers with sub-numbers
Subsection	***2.2.1 IT resources*** ***4.6.2 Types of IT architects***	Bold letters, italics/Numbers with two sub-numbers
Topic	*The role of the project portfolio manager*	Italics, no numbers

Table 1: Structural elements of the dissertation

Notes

The IT literature provides numerous terms with similar meanings that often become confusing. This dissertation uses IT (information technology) and IS (information systems) synonymously for ease of readability (e.g., to avoid slashes like “IT/IS”). IT can be considered as assets and IS may be understood as a capability from the use of IT (Wade & Hulland, 2004, p. 132); in this doctoral thesis, IT implies both aspects. Moreover, the terms enterprise, firm, and organization express the same sense. Further, the phrases IT vendors, IT product vendors, and IT suppliers are used synonymously here.

In this thesis, “Project (portfolio) management” implies both “project portfolio management” and “project management.” IT architecture is a collective term for all categories (enterprise architecture, solution architecture, etc.) and is used for general descriptions.

2 Overarching literature review

2.1 IT value and competitive advantage

2.1.1 The notion of IT value

Since the 1990s, it has commonly been acknowledged that value can be created by IT, for example, by increasing the productivity of a firm or by providing advantages to customers (Hitt & Brynjolfsson, 1996, p. 137; Mata, Fuerst, & Barney, 1995). Although the notion of IT value is frequently used and has been under discussion for a few decades in the IT strategy literature (Hitt, Brynjolfsson, & Walsham, 1994, p. 263), it remains necessary to clarify exactly what it means and how it is generated (Lieberman, Balasubramanian, & Garcia-Castro, 2018). Even substantial research has not resulted in an established understanding of the strategic value of IT (Oh & Pinsonneault, 2007, p. 239). Numerous studies in the IT management and IT strategy arenas have attempted to obtain knowledge on the value created for businesses as a result of investments in IT (Drnevich & Croson, 2013, p. 486). Even influential and comprehensive review articles from the 2000s (Kohli & Devaraj, 2003; Melville, Kraemer, & Gurbaxani, 2004; Piccoli & Ives, 2005) could not sufficiently contribute to a generally accepted concept of IT value (e.g., Oz, 2005). Approximately 15 years later, scholars still lack an understanding of the concept of IT value, while numerous contemporary studies concentrate on the measurement of value from IT investments (Gandelman, Cappelli, & Santoro, 2017). After having studied almost 300 papers on IT value, Schryen (2013) concluded that there were no theories on IT (business) value. Thus, there is a further need to illuminate the notion of IT value and to suggest new definitions for wider acceptance and for consistency in research, not only for measurement purposes but also for theoretical IT value discussions, such as on planning processes for IT value.

The words "value" and "benefits" have been occasionally synonymously used in the literature (Laursen & Svejvig, 2016, p. 736). For example, Chan (2000, p. 228) signified IT value as benefits from IT investments. A few authors have applied the term "benefits" (e.g., Mirani & Lederer, 1998; Ross, 2006; Shang & Seddon, 2002), while other IT strategy scientists have used IT value (Chan, 2000; Davern & Kauffman, 2000; Hitt, Brynjolfsson, & Walsham, 1994) or IT business value (e.g., Armstron & Sambamurthy, 1996; Sambamurthy & Zmud; 1994; Tallon, Kraemer, & Gurbaxani, 2000), or, similarly, business value of IT (e.g., Hitt, Brynjolfsson, & Walsham, 1994, Nevo & Wade, 2010); a few authors used both the terms benefits and value concurrently throughout a paper (e.g., Jurison, 1996) or merged them in to the phrase "IT business value benefits" (e.g., Daulatkar & Sangle, 2016). This dissertation uses these terms interchangeably.

2.1.2 Categories of IT value

IT value manifests itself in numerous ways: profitability, productivity, process improvements, and more (Kohli & Grover, 2008, p. 26). Not surprisingly, IT value has been classified very differently, for example, in strategic dimensions (Oh & Pinsonneault, 2007, pp. 244-245) as value drivers (Jarvenpaa, 2002), business functions (Tallon, Kraemer, & Gurbaxani, 2000), flow directions of products/services (Lankhorst et al., 2013, 114), or other categories (Chan, 2000; Gammelgård, 2007). Chan (2000, p. 245) reviewed IT value articles in prestigious journals between 1993 and 1998 and found five main aspects in terms of which IT value was discussed: environment, strategy, objectives, structure, and culture. In contrast, Oh and Pinsonneault's (2007, pp. 244–245) strategic dimensions comprised three different aspects: cost reduction, revenue growth, and quality improvement. Two dimensions were linked to performance (lower costs, higher revenues), while quality addressed external market aspects (e.g., value perception and differentiation from competitors). The "drivers" for IT value that

Jarvenpaa (2002) indicated include efficiency increase, resource and capability enhancements, buyer-supplier relationships, and transaction mechanisms and structures. One or more value driver must be strengthened to achieve value in the e-/mobile-business. In summary, this subsection showed that classifications of IT values are inconsistent and incomplete in the literature. Apart from the need for a new definition of IT value, a categorization of IT values would be beneficial for future research.

2.1.3 Firm performance

Firm performance (synonyms: performance, organizational performance) is a term that has frequently been used in the context of IT value, particularly when measurements of IT values are presented. Nevo and Wade (2010) and Melville, Kraemer, and Gurbaxani (2004, p. 287) regarded IT value as an impact of IT on organizational performance; it includes process efficiency, the entire organization, and competitive effects. There are various IT value objectives that can be achieved in distinctive ways. However, overall, IT investments strive to improve a firm's performance (Kohli & Devaraj, 2004, p. 58).

A firm's performance may be measured in financial terms, such sales growths and profitability (Croteau & Bergeron, 2001, 14) or averages over periods of years of returns on sales, return on investments, and profits (Hazen, Bradley, Bell, In, & Byrd, 2017). Zhu (2004) explored the links between e-commerce and performance, considering inventory turnover in addition to return on assets, reduction of costs, and increase in revenues. Schryen (2013) also considered stock market performance for IT valuation. IT valuation can also apply financial measures such as net present value, payback period, or discounted cash flow analysis (Bardhan, Bagchi, & Sougstad, 2004). Thus, performance refers to manifold numeric indicators of IT value, but there is no consensus among scientists regarding what kind of computation reflects IT value in the best manner. Research on IT value measurement becomes problematic if the concept of IT value is disputed (Brynjolfsson, & Yang, 1996). The conceptual inconsistencies of IT value explain the divergent means employed to evaluate the economic outcomes of IT investments (Schryen, 2013, p. 140).

A few researchers have noted that numeric performance data (as presented in the previous paragraph) do not mirror all values that IT may provide. For example, process improvements or supplier-relationships are IT values that are distributed over organizations (Chan, 2000, p. 235). The value of information, knowledge, and usage rights are other examples of non-monetary values that are also not reflected in performance data (Lankhorst et al., 2013, p. 89). In contrast, revenues directly affect performance data. They result from the monetary value in terms of the price paid by the customer. However, Bowman and Ambrosini (2000) remarked that revenues from customers do not fully reflect the value that customers perceive.

From this discussion on previous literature, a distinction may be suggested between types of IT value that directly impact a firm's performance and other types of IT value that do not immediately, but indirectly, affect monetary outcomes.

2.1.4 Organizational and customer values from IT

Organizational values from IT

Aral and Weill (2007, p. 776) found that powerful organizational IT capabilities leverage firm performance. For example, governance—that is, structures and mechanisms for decision-making—can influence performance. Increase in profitability from IT investments may be delayed due to the dependence of decision-making on IT infrastructure and IT applications. Thus, governance is an organizational value that has an indirect effect on performance.

IT infrastructure was denoted as an organizational capability to create value (Bhatt & Grover, 2005, p. 258). IT infrastructures constitute shared resources that function as bases for IT applications (Duncan, 1995, p. 41; Zhu, 2004, p. 180). Sharing of resources across an organization provides synergies (Bharadwaj, 2000, p. 176). These synergies provide cost advantages to an organization and can, therefore, be regarded as organizational value. IT infrastructures are also viewed as flexible platforms for organization-wide future initiatives (Weill & Aral, 2004, p. 2). Flexible IT infrastructures also enable cost efficiencies by introducing new products/services (Bharadwaj, 2000, p. 176). IT enables flexible structures between and within organizations (suppliers, human resources) that potentially speed up product/service delivery and improve performance (Sambamurthy & Zmud, 1994, p. 8). Flexibility and synergies are highly valued organizational features, although they do not directly generate cash inflows. Cash flows originate from customers, as they value the products/services and pay for them.

Other examples for non-cash-generating but valuable organizational conditions and attributes are intellectual capital and knowledge, which are immanent to an organization's human resources and processes, policies, and databases (Bharadwaj, 2000, p. 175). Organizational values in context with digitalization can be customer information or partner business models (Bharadwaj, El Sawy, Pavlou, & Venkatraman, 2013; Gellweiler & Krishnamurthi, 2020).

Organizational values are essential but do not have direct effects on an organization's performance, since profits depend on revenues that are realized values from customers in terms of money. Following the idea from Woodruff (1997), organizational values are distinguished from customer values; they quantify a firm's values to owners in contrast to value of products/services that buyers perceive.

Customer value from IT

The relevance of customer value from IT has been indicated by Hitt and Brynjolfsson (1996). In an empirical study on 370 firms from 1988 to 1992 based on databases and surveys, the authors found that IT investments generated extensive customer value. They also took into consideration the consumer "surplus"—that is, the part of the customer value that is created but not captured by the organization—which was considerably growing over time.

Customer value from IT can be achieved by organizations with different strategic directions. Firms with strong market orientation utilize IT to provide greater value to their customers, whereas firms that focus on operations pursue IT goals for operational effectiveness (Avison, Jones, Powell, & Wilson, 2004; Tallon, 2007). Increase in productivity from IT efficiency also increases customer value (Baldwin & Curley, 2007, p. 28). Thus, both market- and operations-focused organizations provide IT value to customers.

The organizational value view complements the customer-value view

The organizational IT value does not compete or intersect with the customer value view, but both complement each other: the first considers the internal values of the organization, while the latter addresses the external value for customers. Clemons (1986) discussed IT applications and competitive advantage and distinguished them in terms of their internal or external focus. Externally focused IT applications provide customer value and increase profits and market share, while internally focused IT applications provide value to the firm by reducing costs and improving quality without a connection to customers. Value from internal IT applications is found in scale advantages, experiences, skills, infrastructure, etc. Values from internal and external IT applications must fit with the firm's strategy (Clemons, 1986, p. 134). Both types of IT applications—one with an internal focus and the other with an external focus—are needed because both create value. External customer value from IT can be converted into monetary value reflected in the organizations' performance; in contrast, internal IT value improves organizational capabilities to achieve higher customer value. In the next section, an integrative definition for IT value—encompassing organizational and customer values—is derived from value categories and value items from the literature.

2.1.5 An integrated definition for IT value

In order to formulate a broader definition for IT value, scientific articles that display value categories and detailed value items were searched. Table 2 displays the collection of value activities/indicators from the following authors in chronological order:

- Mirani and Lederer, (1998, p. 815): three value categories comprising 25 value indicators (items) hypothesized for a study of 178 IT projects.
- Gregor, Martin, Fernandez, Stern, and Vitale (2006, p. 255): five transformational benefits that complement the value indicators from Mirani and Lederer (1998) for a survey with 1050 organizations and 50 interviews.
- Tallon, Kraemer, and Gurbaxani (2000, p. 32): six dimensions of business value covering 12 value indicators based on a literature review for questionnaire design of a survey with 304 managers.
- Shang and Seddon (2002, p. 277): five benefits dimensions containing 21 sub-dimensions based on system features, literature review, vendor publications and 34 interviews.
- Gammelgård (2007, p. 82): twenty-five value categories from a literature review.

As a next step, the listed items were examined in terms of meaning and relatedness to customer value. Treacy and Wiersema (1993, 1995) suggested a general, not IT-specific, typology for customer values that has gained recognition in marketing theory (Day, 1994, p. 48) and in the IT strategy literature (e.g., Peppard & Ward, 2016, pp. 78–79; Ross, Weill, & Robertson, 2006, p. 100; Tamm, Seddon, Shanks, & Reynolds, 2011); this typology has been fruitfully applied in a survey on IT value with 241 executives by Tallon (2007). These customer value disciplines from Treacy and Wiersema (1993, 1995) describe different means to offering exceptional value to customers: product leadership (PL), operational excellence (OE), and customer intimacy (CI). Product leaders deliver new products with outstanding features, functions, design, innovation, etc. Operational excellence focuses on providing cost advantages through process efficiency, economies of scale, etc. Organizations may also concentrate on customer-relationships by solving complex client problems or by being highly responsive to customer requests (customer intimacy).

			Customer value			Organizational value				
Author	**Category**	**IT value activity/indicator**	PL	OE	CI	SP/DM	FX/A	SA/R	ESC	Other
Mirani & Lederer (1998)	Strategic benefits	Enhance competitiveness or create strategic advantage								x
		Enable the organization to catch up with competitors								x
		Align well with stated organizational goals				x				
		Help establish useful linkages with other organizations						x		
		Enable the organization to respond more quickly to changes					x			
		Improve customer relations			x					
		Provide new products or services to customers	x							
		Provide better products or services to customers	x							
	Informational benefits	Enable faster retrieval or delivery of information or reports				x				
		Enable easier access to information				x				
		Improve management information for strategic planning				x				
		Improve the accuracy or reliability of information				x				
		Improve information for operational control				x				
		Present information in a more concise manner or better format				x				
		Increase the flexibility of information requests					x			
	Transactional benefits	Save money by reducing travel costs		x						
		Save money by reducing communication costs		x						
		Save money by reducing system modification or enhancement costs		x						
		Allow other applications to be developed faster	x							
		Allow previously infeasible applications to be implemented	x							
		Provide the ability to perform maintenance faster		x						
		Save money by avoiding the need to increase the work force		x						
		Speed up transactions or shorten product cycles	x							
		Increase return on financial assets								x
		Enhance employee productivity or business efficiency		x						
Gregor et al. (2006)	Transformational benefits (in addition to the benefits from Mirani & Lederer, 1998)	An improved skill level for employees							x	
		Developing new business plans				x				
		Expanding organizational capabilities							x	
		Improving business models				x				
		Improving organizational structure/processes		x						
Tallon, Kraemer, & Gurbaxani (2000)	Process planning and support	IT improves planning and decision-making by improving organizational communication and coordination and by enhancing organizational flexibility				x	(x)			
	Supplier relations	Utilize IT to coordinate supplier linkages and reduce search costs						x		
		IT can improve communication, quality control, and delivery techniques, leading to competitive advantage						x		
	Production and operations	Utilize IT to deliver enhanced manufacturing techniques through computer-aided design		x						
		Improvements in the production process can lead to economies of scale in the delivery of products and services		x						
		Incorporating IT into the end product, and the use of advanced manufacturing processes can enable a greater range of products and services	x							
	Product and service enhancement	IT can be used in the development of new products and services	x							
		IT can enable products and services to be uniquely differentiated in a variety of ways	x							
	Sales and marketing support	The development of new products and services can enable an organization to identify and serve new market segments				x				
		IT can be used to track market trends and responses to marketing programs				x				
	Customer relations	IT can be used to establish, sustain, and improve relationships with customers			x					
		Improving customer relations can result in improved market share			x					

			Customer value			Organizational value				
Author	**Category**	**IT value activity/indicator**	PL	OE	CI	SP/DM	FX/A	SA/R	ESC	Other
Shang & Seddon (2002)	Operational benefits dimension	Cost reduction		x						
		Cycle time reduction		x						
		Productivity improvement		x						
		Quality improvement	x							
		Customer service improvement			x					
	Managerial benefits dimension	Better resource management		x						
		Improved decision-making and planning				x				
		Performance improvement								x
	Strategic benefits dimension	Support for business growth				x				
		Support for business alliance						x		
		Building business innovations	x							
		Building cost leadership		x						
		Generating product differentiation	x							
		Building external linkages						x		
	IT infrastructure benefits dimension	Building business flexibility for current and future changes					x			
		IT cost reduction		x						
		Increased IT infrastructure capability					x			
	Organizational benefits dimension	Changing work patterns					x			
		Facilitating organizational learning							x	
		Empowerment							x	
		Building common vision				x				
Gammelgård (2007)	Business value categories	Change management				x				
		Third party relations						x		
		Technology/tools							x	
		Supplier relations						x		
		Strategy formulation and planning				x				
		Quality of products/services	x							
		Productivity		x						
		Organizational culture							x	
		New products/services	x							
		Lock-in effect/switching costs								x
		Learning and knowledge							x	
		Integration and coordination					x			
		Information				x				
		Inbound logistics						x		
		Flow of products/services		x						
		Flexibility					x			
		Efficiency		x						
		Differentiations in products/services	x							
		Deliveries	x							
		Decision-making				x				
		Customer relations			x					
		Cost reductions		x						
		Control and follow up				x				
		Competitor relations						x		
		Communication		x						

Legend

PL: Product leadership
OE: Operational excellence
CI: Customer intimacy

SP/DM: Strategic planning/informed decision-making
FX/A: Flexibility, agility
SA/R: Strategic alliances / supplier relationships
ESC: Enhanced skills and capabilities

Table 2: Mapping of IT value activities to customer values and organizational values (Source: author).

These customer value disciplines from Treacy and Wiersema (1993, 1995) were mapped to each value activity/indicator (Table 2). For those IT value activities/indicators that were not attributable to customer value, four logical groups of organizational values were created to which these activities/indicators were allocated. The following groups of organizational value were induced (the acronyms in brackets refer to Table 2)

- strategic planning/decision-making processes (SP/DM)

- flexibility/agility (FA)
- strategic alliances/supplier-relationships (SA/SR)
- enhanced skills and capabilities (ESC)

As presented above, 82 out of 88 IT value activities/indicators were exclusively allocated to one category. Just one item matched two organizational aspects, one for planning/decision and another for flexibility. Further, 5 out of 88 items from the IT value activities/indicators collection could neither be allocated to a customer value type nor to an organizational value type. The items "Enhance competitiveness or create strategic advantage" and "Enable the organization to catch up with competitors" were not applicable—they refer to competitiveness but not to value. The transactional benefit from Mirani and Lederer (1998) "Increase return on financial assets" represents a performance indicator, which is not a value, but a result of value creation. "Performance improvement" remained unallocated for the same reason. Lastly, "Lock-in effect/switching costs" was not attributable to any value type; however, switching costs are a source of competitive advantage for vendors (Mata, Fuerst, & Barney, 1995). From a customer's viewpoint, vendor lock-ins do not create value; on the contrary, they may generate extra costs when switching to another vendor's products due to long-binding contracts, license costs, or proprietary technology. However, the means to lock-in a customer may be interchanged with the value discipline "customer intimacy." For example, the lock-ins displayed from Amit and Zott (2001, p. 507) clearly indicate relationship attributes of "customer intimacy": customers gain value from a vaster customer network or from trust and customization.

Based on the literature review, the collection of IT value activities/indicators and their transparent mapping to three customer value and four organizational values categories, the following definition for IT value is suggested:

IT value results from IT investments in capabilities that provide benefits either to customers or to the organization (i.e., firm or enterprise). Categories for customer values from IT refer to three strategic disciplines (Treacy & Wiersema, 1993, 1995).

- product leadership provides functional benefits characterized by "best" products/ services, high quality, newness, innovation, and short time-to-market.
- operational excellence provides economic benefits characterized by lowest costs, process efficiency, organizational effectiveness, and high productivity.
- customer intimacy provides benefits from relationships characterized by specific solutions to customer problems, responsiveness to customers, and brand image.

Organizational values are

- strategic planning and decision-making processes: data and process flows for strategic planning and informed decisions-making, including business development (i.e., growth opportunities).
- flexibility/agility: ability to quickly adapt resources and capabilities to change the product /service offering (e.g., as a response to changes in the environment; flexibility) and/or the competitive position (agility).
- strategic alliances/supplier relationships: business linkages to other firms that are part of the value chain (inbound and outbound).
- enhanced skills and capabilities: increased skills of human resources or improvement of organizational capabilities.

Organizational values are prerequisites to generate customer values. Core processes are required to provide customer value (Tallon, 2007, p. 285). For example, established supplier-relationships and lean production processes affect operational costs that, in turn, impact customer value discipline operational excellence. IT can support the automation of the production process and improve the electronic data interface to the supplier.

Money from customers flows in exchange to the perceived customer values. Thus, performance measured in terms of profitability, sales growths, or return on assets is a consequence of customer value. In other words, performance is not an IT value in itself but an impact from organizational values and customer value delivery. However, increases in organizational value may not immediately be reflected in a firm's performance. For example, certain investments in IT infrastructure (e.g., server hardware) may not enrich customer value because they provide necessary technical preconditions for new functions that will be subsequently delivered with a software application (Aral & Weill, 2007, p. 776).

2.1.6 Customer value and competitive advantage

The role of IT in value creation and its relation to competitive advantage has a long research history (Piccoli & Ives, 2005, p. 747). Scientists have agreed that IT capabilities can be built for value delivery and competitive advantage (Clemons & Row, 1991; Drnevich & Croson, 2013; McAfee & Brynjolfsson, 2008; Venkatraman, Henderson, & Oldach, 1993). However, value from IT is not equal to gaining or sustaining competitive advantage (Kohli & Grover, 2008, p. 26; Peppard & Ward, 2004, p. 169), even if it increases a firm's performance by lowering costs and/or revenue growth (Mata, Fuerst, & Barney, 1995, p. 488). The performance impacts from IT and competitive advantage depend on the higher values that customers perceive from a firm's products/services relative to the competitors' products.

IT has direct or indirect effects on performance (Rivard, Sraymond, & Verreault, 2006): direct effects result from product/services that create customer value, while indirect effects result from organizational values that are needed for production—that is, producing products or delivering services. Another necessary condition for a positive impact of IT on a firm's performance is its alignment to the business strategy (Rivard, Sraymond, & Verreault, 2006).

Value creation is the key to profitability and competitiveness (Dranove & Marciano, 2005). The achievement of value is a necessary but not sufficient condition for competitive advantage (Bhatt & Grover, 2005, p. 258). Another necessary factor is the number of available products from other firms that provide the same kind and extent of value to customers. Both the rareness of competing offerings and high customer value are central conditions for increasing a firm's performance. Both conditions impact prices, demands, and revenues.

Researchers who have studied the RBV use the adjectives "valuable" and "rare" for competitive advantage from firm-internal resources or capabilities (Barney, 1991, p. 106); these are necessary but insufficient (Priem & Butler, 2001, p. 25). Here, the adjectives valuable and rare are transferred to a firm's products in the context of external forces—namely, customers and competitors. In order to achieve competitive advantage, the product/service offering must be valuable and rare. In case of competitive advantage, a firm's offering is highly valued by customers; no or only few competitors provide comparable products. The more competitors offer the same or similar product/service characteristics on the market, the higher are the pressures on prices, according to the rules of supply and demand. As the willingness of customers to pay premiums shrinks, the customer value decreases. Consequently, the competitive advantage of a product leader disappears.

Product rareness comes from differentiation strategies as defined by Porter (1980). The corresponding customer value disciplines from Treacy and Wiersema (1993, 1995) are product leadership and customer intimacy. If there are numerous comparable products from competitors on the market, then there is a high competition on prices. In this situation, cost pressures on firms are high and customers receive economic advantages that stem from low prices. Operational excellence is required to compete and survive on the market. Successful firms must pursue a cost leadership strategy and produce at lowest costs; business process flows must be highly efficient.

Ives and Learmonth (1984, pp. 1193–1194) stated that the strategic use of IT can provide competitive advantage by dedicated support of each of the generic strategies from Porter (1980). The generic strategies from Porter (1980) and the customer value disciplines from Treacy and Wiersema (1993, 1995) were mapped by Tallon (2007, p. 285), as displayed in the upper portion of Table 3:

Mapping from Tallon (2007)

Generic strategies Porter (1980)	**Customer value disciplines** Treacy & Wiersema (1993, 1995)
Differentiation	Product leadership
Niche	Customer intimacy
Low-cost leadership	Operational excellence

Mapping from author

<table>
<tr><th colspan="2">Generic strategies
Porter (1980)</th><th>Customer value disciplines
Treacy & Wiersema (1993, 1995)</th></tr>
<tr><td rowspan="3">Industry-wide</td><td rowspan="2">Differentiation</td><td>Product leadership</td></tr>
<tr><td>Customer intimacy</td></tr>
<tr><td>Overall cost leadership</td><td>Operational excellence</td></tr>
<tr><td rowspan="3">Focus (particular market segment)</td><td rowspan="2">Differentiation</td><td>Product leadership</td></tr>
<tr><td>Customer intimacy</td></tr>
<tr><td>Overall cost leadership</td><td>Operational excellence</td></tr>
</table>

Table 3: Mapping of generic strategies to customer value disciplines (Source: author and according to Tallon, 2007, p. 285).

Three modifications to the mapping from Tallon (2007, p. 285) are proposed here. First, take-over of the original terms from Porter (1980): “focus” instead of “niche,” “overall cost leadership” instead of “low-cost leadership.” Second, “focus” strategies distinguish from other generic strategies by addressing a specific market segment instead of an entire industry (Porter, 1980, pp. 38–41). Differentiation and cost leadership strategies can be applied to a particular target segment or to the entire industry. Third, the value discipline “customer intimacy” is not bound to a niche segment of a market: it can be fulfilled industry-wide. The resulting mapping is presented in the lower portion of Table 3.

Comparative advantage over competitors (Bakos and Treacy, 1986) results from cost leadership (Porter, 1980) and customer advantage stems from paying a lower price. The corresponding customer value discipline is termed operational excellence (Treacy and

Wiersema, 1993, 1995). Bakos and Treacy (1986) described comparative advantage as comparative efficiency—that is, organizations possess capabilities to offer a product at a lower price compared to competing products that customers perceive as equivalent. Johnston and Vitale (1988, p. 157) enumerated a series of activities for comparative efficiency. In the literature, comparative advantage (Bakos & Treacy, 1986) is frequently referred to as competitive advantage that stems from low costs.

Here, it is necessary to clarify exactly what competitive advantage implies. It is a state of superior performance in which a firm creates more customer value than competitors. It requires exceptional resources, capabilities, and assets that are difficult to duplicate (Mohr, Sengupta, & Slater, 2005, p. 51, p. 77). Competitive advantage is achieved by creating customer value from differentiation strategies if equivalent products/services from competitors are rare. The corresponding customer value disciplines are product leadership and customer intimacy. Comparative advantage is achieved by offering lowest prices to customers in markets with numerous equivalent products/services. Both competitive and comparative advantage yield performance data above the industry average.

The equivalence of products/services depends on customer perception of benefits from superior features or functions from product/services or from customer relationships. The customer value/product rareness matrix (Figure 1) can be applied to an entire industry or to a specific market segment. Competitors' products and customer value are two dimensions that must be concurrently considered for analyzing competitive advantage.

The customer value/product rareness matrix (Figure 1) integrates several theoretical concepts: customer value disciplines (Treacy & Wiersema, 1993, 1995), competitive advantage (e.g., Barney, 1991, Porter, 1985), comparative advantage (Bakos and Treacy, 1986), generic strategies (Porter, 1980), and the rules of supply and demand.

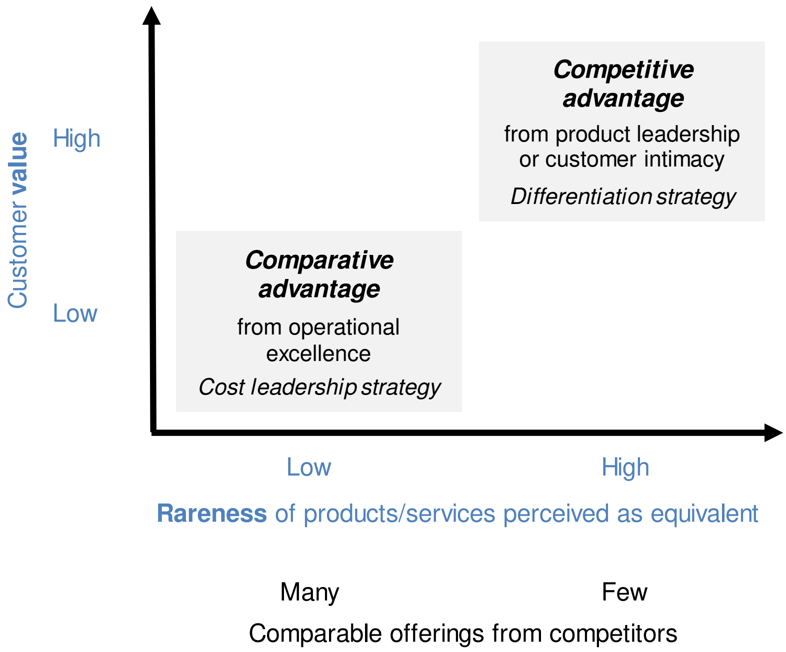

Figure 1: Customer value/product rareness matrix (Source: author)

2.1.7 *Summary: IT value and competitive advantage*

The studies on IT value and competitive advantage presented thus far are summarized below:

1. IT value has been studied for several decades but its implications are broadly interpreted and numerous synonyms are used. Moreover, the number and the definitions of IT value categories vary.
2. A firm's performance is given by financial indicators that reflect value from IT investments. There are numerous indicators that can be computed but there is no agreement on what is the best-suited one for IT value. However, there is no doubt that revenue is a key determinant for performance, and revenues come from customers.
3. Monetary performance indicators do not encompass all values that IT can deliver. IT can also provide values that indirectly impact performance outcomes. Moreover, performance also depends on non-monetary values (e.g., governance, flexible IT infrastructures, and intellectual assets) that provide foundations for cash inflows from customers.
4. IT value consists of two complementing types, customer value and organizational value. Customer value results in revenues and directly impacts a firm's performance. Organizational values provide prerequisites for creating customer value and have an indirect effect on performance.
5. The customer value disciplines operational excellence, product leadership, and customer intimacy given by Treacy and Wiersema (1993, 1995) and the organizational values strategic planning/decision-making, flexibility/agility, strategic alliances/supplier relationships, and enhanced skills/capabilities are suggested after comparison and coding IT value categories/activities from five previous publications.
6. The customer value disciplines Treacy and Wiersema (1993, 1995) correspond to Porter's (1980) generic strategies (industry view). The mappings of these, as proposed by Tallon (2007), have been refined.
7. Competitive advantage needs both high customer value and high rareness of competing products/services with equal value (differentiation strategy by product leadership or customer intimacy). If such rareness is low, firms must compete on low costs for comparative advantage (cost leadership strategy by operational excellence).

2.2 The RBV on IT

The RBV is a suited paradigm for examining IT in organizations (Daniel & Wilson, 2003, p. 283) and provides a useful and established theoretical framework for analyzing and discussing competitive advantage arising from the use of IT (Kohli & Devaraj, 2004, p. 58; Melville, Kraemer, & Gurbaxani, 2004, p. 289). The RBV claims that a firm owns and uses resources and capabilities for achieving competitive advantage (Kohli & Devaraj, 2004, p. 58; Wade & Hulland, 2004, p. 108). IT resources may improve competitive positioning (Parsons, 1984, p. 51), and IT capabilities are central differentiators (Bharadwaj, 2000, p. 169). The RBV is also used to explain IT performance (Hazen et al., 2017).

As such, IT resources do not perceptively improve a firm's performance (Oh & Pinsonneault, 2007, p. 240; Powell & Dent–Micallef, 1997, p. 375). IT resources, such as hardware or standard software, in isolated operation provide little or no value (Kohli & Grover, 2008, p. 26) and barely affect competitive advantage (Powell & Dent–Micallef, 1997; Rivard, Sraymond, & Verreault, 2006, p. 33; Wade & Hulland, 2004, p. 109). In order to contribute to competitive advantage, IT resources must complement the business, humans, or specific resources (Clemons & Row, 1991, p. 276, Rivard, Sraymond, & Verreault, 2006, p. 33); these resources must be part of a value-generating business process combined with other resources, capabilities, and assets (Kohli & Grover, 2008, p. 26; Wade & Hulland, 2004, p. 109).

Although the RBV is widely used to explain competitive advantage from IT, there is no agreement on basic definitions. Difficulties associated with the RBV are terminological ambiguity and variance in definitions (Priem & Butler, 2001). This problem is strikingly visible in the IT field. Terms that certain authors use synonymously are explained by other authors as distinctive notions (Doherty & Terry, 2009, p. 5). The following paragraphs reveal how differently the foundational RBV terms, resources, capabilities, assets, and skills, have been defined and interpreted in the IT literature.

2.2.1 IT resources

The term "resource" has already been used in a jumbled manner among RBV scientists outside the IT arena. A firm's resources were differently denoted as skill, competency, assets, or stocks (Wade & Hulland, 2004, p. 108). The confusion increases in the IT literature, as it is demonstrated below.

IT resources are used to create products/services by employing assets and bonding mechanisms, such as incentive systems or trust; they are owned or controlled by a firm (Drnevich & Croson, 2013, p. 485). Ravichandran and Lertwongsatien (2005, p. 246) considered IT resources as raw materials to develop capabilities. IT resources comprise hardware, software, support staff, and various forms of information (e.g., text, voice, pictures) (Boynton & Zmud, 1987, p. 59). Information or data must be viewed as "other" resources (Lederer & Mendelow, 1987, p. 390).

IT resources have been categorized in different ways: Powell and Dent–Micallef (1997, p. 384) divided IT resources into three broadly defined categories:

- human resources (including communication, organization, and IT strategy integration),
- business resources (e.g., supplier relationship, IT planning, IT trainings, teams), and
- technology resources (hardware, software, and related functions, such as communication or IT management).

Melville, Kraemer, and Gurbaxani (2004, p. 295) distinguished IT resources among

- technological resources (i.e., shared IT infrastructure or business applications),
- human IT resources, and
- human skills that are technical (e.g., programming, systems integration) or managerial (e.g., project planning).

Drnevich and Croson (2013, p. 285) used tangibility to categorize IT resources in the following manner:

- technical and managerial skilled human resources,
- tangible components (i.e., physical IT infrastructure), and
- intangible resources such as knowledge or social relationships (Ross, Beath, & Goodhue, 1996).

Nevo and Wade (2010, pp. 164–165) used intangibility to define IT resources in contrast to IT assets that are tangible in nature. According to them, examples of IT resources are relationships, and partnerships, IT management processes, or IT planning. Such IT resources cannot be acquired in markets; they must be developed over time.

Many authors consider IT resources as a composition of other RBV components. Traditionally, IT resources comprise both IT assets and IT capabilities (Piccoli & Ives, 2005,

p. 752). Aral and Weill (2007, p. 765) agreed with this composition and considered IT skills (including IT management) as a subset of IT capabilities. Peppard and Ward (2004, p. 175) described IT resources as the firm's IT infrastructure and skills/knowledge from employees and engaged IT vendors.

2.2.2 IT capabilities

Capabilities are constructs of skills/knowledge that are applied to organizational processes that employ assets; they enable business activities such as product/service development or delivery (Day, 1994, p. 38). Skills can be technical or managerial, and processes may include system integration (Wade & Hulland, 2004, p. 109). IT capabilities are information-based, firm-specific, and developed over time (Drnevich & Croson, 2013, p. 485). IT planning, IT systems development, IT support, and IT operations denote core IT capabilities (Ravichandran & Lertwongsatien, 2005, p. 244). The performance impacts from IT capabilities appear on income statements but not on balance sheets (Drnevich & Croson, 2013, p. 485), which distinguishes them from (IT) assets that must be valued in the balance sheet. IT capabilities enable value creation for all types of resources and capabilities—that is, both IT and non-IT (Drnevich & Croson, 2013, p. 485).

From a literature review on IT-dependent competitive advantage, Piccoli and Ives (2005, p. 753) identified three categories for IT capabilities: IT management skills, technical skills, and relationship assets. Bhatt and Grover (2005) investigated the impact of IT capabilities on competitive advantage and utilized three categories: IT infrastructure, IT business experience (business knowledge of IT groups), and relationships between IT group and line management for strategic alignment. Not in line with previous definitions, Bharadwaj, Sambamurthy, and Zmud (1999, p. 379) displayed 30 capabilities that were categorized into six groups: IT business partnerships, external IT linkages, business IT strategic thinking, IT business process integration, IT management, and IT infrastructure.

2.2.3 IT assets

IT assets are inputs or outputs of processes to design, produce, or market products/services; they can be tangible (e.g., IT infrastructure) or intangible (e.g., software application, vendor relationships) (Wade & Hulland, 2004, p. 109). The values of IT assets are included in balance sheets (Drnevich & Croson, 2013, p. 485). IT assets may encompass hardware and platforms (networks), software applications, and databases (Piccoli & Ives, 2005, p. 753).

Piccoli and Ives (2005, p. 753) suggested two main types of IT assets: IT infrastructure and information repositories. Weill and Ross (2004, pp. 6–7) designated six strategic key assets for value creation:

- human assets (skilled people),
- financial assets as presented on balance sheets,
- physical assets (property, plant, equipment),
- protected intellectual properties,
- information (e.g., stored in databases),
- relationships with customers, suppliers, or other organizations external to the firm.

The descriptions and categories for IT assets do not fully match. For example, information stored in databases, human assets, and relationships do not appear on balance sheets, as suggested by Drnevich and Croson (2013). Even more critical than the inconsistencies of IT asset definitions are the following conceptual overlaps among the terms resources, capabilities, and assets:

- Relationships were viewed as resources, capabilities, or assets.

- Skills were viewed as resources, capabilities, or assets.
- People were viewed as (human) resources or (human) assets.
- Infrastructure and hardware were viewed as resources or assets.

2.2.4 Redefining RBV terms for IT

The RBV is widely used—within and outside the IT field—to understand a firm's internal drivers and relationships for competitive advantage. Since the definitions and categories of resources, assets, and capabilities are confused in the literature, this dissertation defines these terms for IT in the following manner.

IT resources are items controlled by the firm and inputs to develop and support capabilities (IT and non-IT). IT resources comprise

- human resources with managerial and technical skills (in various combinations),
- tangible IT assets (hardware, embedded software, packaged software off-the-shelf, operating systems), and
- tangible assets used to produce (property, plant, equipment).

IT capabilities result from combining and integrating IT resources and intangible assets to value-generating activities, processes, or (IT) products/services. Combination and integration are implemented by skilled human resources. Capabilities are unique to a firm; they are not transferable and are, therefore, a source of sustainable competitive advantage. The following are examples of IT capabilities:

- IT processes (e.g., architecture, solution design, planning, implementation, operation)
- IT applications that support business processes (e.g., enterprise resource planning, computer aided design)
- IT applications for standard user services (help desk, user portals, file services, email, collaboration, workplaces)
- IT applications for customer services (e.g., web portals, apps on smartphones)
- underlying IT infrastructure (e.g., networks, server, storage, security systems).

Suppliers and channel partners involved in the value generation are part of IT capabilities. IT assets are inputs or outputs of IT capabilities; they can be tangible (see IT resources) or intangible (e.g., intellectual properties, policies, guidelines, standards). Values of tangible IT assets (e.g., server hardware, notebooks, and routers) and for intellectual properties (e.g., patents, self-developed software) are entered on balance sheets (Drnevich & Croson, 2013, p. 485).

2.2.5 Human IT skills

Regardless of whether skills are classified as resources, capabilities, or assets, their importance to firm performance and competitive advantage has been emphasized in the RBV literature. Mata, Fuerst, and Barney (1995, pp. 500–501) concluded that technical IT skills and managerial IT skills are sources of competitive advantage—the latter even in a sustained manner. Managerial IT skills complement technical IT skills in terms of leadership, business orientation, and involvement of suppliers, customers, and functional managers (e.g., joint analysis of current and future requirements for business and IT as well as coordination and cooperation in IT application development) (Mata, Fuerst, & Barney, 1995, p. 498). Technical IT skills comprise knowledge to implement and run IT products/services from available technologies (e.g., programming, operating systems, network protocols, IT products). In contrast to IT capabilities and managerial IT skills, technical IT skills are not sources of sustainable competitive advantage. Technical IT skills are not unique to a firm; they are mobile and not rare because they are widely available on human resource markets (Mata, Fuerst, & Barney, 1995; Ray, Muhanna, & Barney, 2005, p. 628).

Bharadwaj (2000, p. 173) suggested the same skill categories as Mata, Fuerst, and Barney. (1995): technical IT skills for system analysis, system design, new technologies, etc.; managerial IT skills for leadership, management efficiency, stakeholder coordination and collaboration, and project management. These skills help in integrating IT and business planning, developing IT applications, communicating and cooperating with business units, and innovating new products/services.

Similar to previous skill typologies, Melville, Kraemer, and Gurbaxani (2004, pp. 294, 295) included technical and managerial skills. The technical skill type refers to integration and maintenance of systems, development of applications or databases, programming, etc., whereas managerial skills include resource management, internal/external stakeholder collaboration, project identification, and project management.

The distinction between technical and managerial IT skills is useful to understand IT skills at a very high level, but it is insufficient to discuss skill requirements for job roles in the IT field. More detailed breakdowns of IT skills were presented by Wilkerson (2012) and Todd, McKeen, and Gallupe (1995).

Wilkerson (2012) presented six job skill categories derived from 19 prior studies on IT management. His technical IT skills had two categories: one focusing on planning and design ("core technical") and the other on implementation and operation ("technical"). Managerial IT skills from Mata, Fuerst, and Barney (1995) were allocated to three categories: core managerial, organizational, and interpersonal. The latter contained all skills that are needed to interact and collaborate with others. Finally, the personal skill group incorporates work characteristics of individuals, not specific to IT. Wilkerson's (2012) six job skill categories are provided below:

- core technical (e.g., requirement analysis, development, design, architecture, modeling, documentation)
- technical (e.g., programming, languages, diagramming, tools, techniques)
- core managerial (e.g., business, general management, project management, IT-business dependency)
- organizational (e.g., business administration, industry, organization)
- interpersonal (e.g., social skills, leadership, communication, stakeholder management)
- personal (e.g., personal work behaviors, motivation, attitudes)

From a longitudinal analysis of job advertisements between 1970 and 1990, Todd, McKeen, and Gallupe (1995, p. 6) decomposed IT skills into three main categories and two or three subcategories. The main categories are similar to those of human assets given by Ross, Beath, and Goodhue (1996 p. 33): technical skills, business understanding, and understanding of problem-solving. The sub-categories are listed below:

- technical skills
  - hardware (e.g., workplaces, servers, storage, networks)
  - software (e.g., applications, packaged software, operating systems, languages)
- business skills
  - business (e.g., business administration, industry)
  - management (e.g., leadership, project management, planning, controlling)
  - social (e.g., communication, collaboration)
- systems knowledge

- problem-solving (e.g., modeling, solution creation, innovation)
- development methods (e.g., system development, analysis/design techniques)

As defined by Todd, McKeen, and Gallupe (1995), systems knowledge is a result of planning, deploying, managing, and using technical skills related to hardware and software (Wade & Hulland, 2004, p. 114). Research on IT skills has been scarce. There is no agreement on the categories of IT skills, except at the highest level (i.e., technical vs. managerial). The IT literature does not provide a generic frame to assess IT skills for job roles.

Again, care must be taken with regard to terminology. A few researchers defined skills as capabilities (Piccoli & Ives, 2005). For example, Bharadwaj (2000, p. 175) claimed that skills are not only inherent in humans but also in processes, policies, and databases. In this dissertation, skills relate to human resources and never capabilities or assets.

2.2.6 The RBV and competitive advantage from IT

As held by renowned researchers, the RBV is suited to explain the essence and aspects of competitive advantage in the IT context (e.g., Peppard, Galliers, & Thorogood, 2014, p. 5; Rivard, Sraymond, & Verreault, 2006). Heterogeneity and sustainability are two central RBV terms that deal with competitive advantage: the first addresses the uniqueness of services (Penrose, 1959, p. 67) to differentiate from competitors, and the second is related to maintaining competitive advantage that depends on the risks of competitive duplication or substitution (Barney, 1991).

Competitive advantage is founded on the unique attributes of a firm—that is, the heterogeneity of available productive services from its resources (Penrose, 1959, p. 67). Productive IT services are a result of the conversion of IT components (e.g., hardware, software) by knowledgeable human resources and capabilities such as policies, planning, architecture, design, or operations (Broadbent, Weill, & Neo, 1999, p. 160). The uniqueness of IT services depends on *how* a firm leverages its IT investments (Bharadwaj, 2000, p. 170), thereby implying the effectiveness of combining acquired IT components for the creation of valuable IT services. In other words, IT planning/IT management processes and skilled human resources planning these IT services are sources of competitive advantage. IT planning/IT management processes are organizational capabilities that control the delivery and use of IT products/services and are, therefore, a matter of strategic advantage (Earl, 1989, p. 62).

Strategic IT planning/IT management implies an effective orchestration of all IT resources to achieve competitive advantage; this includes frameworks as well as creative and flexible processes (Gluck, Kaufmann, & Walleck, 1980, p. 157). It is a managerial ability to create processes, procedures, and structures and leverage the IT planning/IT management capability of a firm; in this manner, IT managers impact the business value more than IT components (Brynjolfsson & Hitt, 2000, p. 24).

Further, the uniqueness of IT products/services is variable. In case of no/low uniqueness, IT products/services are standardized with no or few requirements for integration and customization. With high uniqueness of IT products/services, the needs for integration and customization are high. There is a continuum in between (Piccoli & Ives, 2005, p. 761). Because uniqueness is a criteria for competitive advantage (Penrose, 1959), standardized IT products/service cannot generate competitive advantage; rather, they can compete on low costs for comparative advantage.

The high uniqueness of IT product/services—that is, heterogeneity of resources—is suggested to enjoy first-mover advantages (Barney, 1991, p. 104); first movers may enhance their competitive advantage by adding features or other customer values (Keen, 1991, p. 49). Then, the needs to integrate and customize IT products/service are very high (Piccoli & Ives, 2005). On the contrary, homogeneous resources (i.e., low uniqueness of IT products/services) can be offered by numerous competitors. Commoditization may occur over time and as barriers for imitation by competitors are lowered (Keen, 1991, p. 49), competitive advantages reduce. Then, IT products/services become more standardized with little need for integration (Piccoli & Ives, 2005).

A competitive advantage is sustained if competitors do not imitate the products/services or offer substitutes. Low costs for IT resources and imitation may rapidly decrease competitive advantage from IT (Ciborra, 1994, p. 283). Physical IT resources can be acquired by competitors on markets, and IT systems may easily be duplicated. These IT investments do not contribute to sustained competitive advantage (Bharadwaj, 2000).

Isolating mechanisms in RBV denote entry barriers (Mahony & Pandian, 1992, p. 371) to prevent product/service imitation. An entry barrier may be raised by technical complexity or customers' loyalty to products (McFarlan, 1984, p. 99); such a barrier increases competitors' risks and costs for producing and delivering comparable products. IT products/services might also be protected from imitation by intellectual property rights that are licensed to users, proprietary protocols, or encryption of software code. Finally, business processes supported by IT can create capabilities that cannot simply be copied from competitors and can, therefore, uphold sustained competitive advantage (Kohli & Devaraj, 2004, pp. 59–60).

The building of entry barriers is one out of nine ways for competitive advantage through IT that Atkins (1994, pp. 124–125) listed. Six out of them can be attributed to the generic strategies and the customer value disciplines that have been discussed before. The others refer to market access via distribution channels (Cash & Konsynski, 1985) and switching costs (McFarlan, 1984). The first will be omitted in this dissertation because of its limited relevance in the IT architecture context; the second is discussed later in the IT vendor context.

None of the strategic approaches enumerated by Atkins (1994, pp. 124–125) relates explicitly to the RBV but all are exogenously relevant. This corresponds to a central critique on RBV as a strategic tool given by Priem and Butler (2001): the essential notion of "value" is outside the RBV. Value from resources and capabilities likely depend on products and customers. Priem and Butler (2001) emphasized the need for a more integrated theory.

2.2.7 Summary: The RBV and IT

In view of the preceding discussion on the RBV in relation to IT, the key points are reflected in the following paragraphs.

1. The RBV provides a general framework for assessing firm-internal aspects of competitive advantage. There is academic consensus that IT resources alone are not valuable but their combinations to build IT capabilities.
2. The definitions of the fundamental RBV notions—resources, assets, and capabilities—and their categorizations vary broadly and are conflicting in both the IT field and in general. For semantic consistency, definitions for IT resources, IT capabilities, and IT assets have been provided by the author.
3. Human skills are decisive in IT management. Numerous authors agree on distinguishing technical skills from managerial skills. Both impact competitive advantage, and managerial skills even impact its sustainability. More detailed skills categories are scarce in the IT literature.
4. The uniqueness of IT capabilities—that is, the degree of customization—makes a firm distinctive from its competitors; it is a central source of competitive advantage. IT

planning is a process of creating unique (IT) capabilities from the integration of IT resources. The IT planning effectiveness strongly depends on skilled human resources that guide the planning process and create policies, procedures, and standards. A competitive advantage is sustainable if IT products/services are difficult to replicate by competitors (e.g., proprietary technologies, technical complexity).

5. The main critique of the RBV is that competitive advantage also requires exogenous perspectives: the RBV lacks views on products, customers, and value creation. Thus, a more integrative theory is necessary.
6. Momentous endogenous contributors to sustainable competitive advantage are IT planning and IT-strategy integration, as proposed by Powell and Dent–Micallef (1997). The next section shows that both are intertwined.

2.3 IT planning and IT architecture

2.3.1 IT planning is crucial for IT value and competitive advantage

Improvement of IT planning has been one of the most critical matters among IT managers in practice (Earl, 1989, p. 27; Reich & Benbasat, 1996, p. 55). The aim of strategic planning is to create competitive advantage (Mohr, Sengupta, & Slater, 2005, p. 51). Successful IT planning integrates business planning and IT development (Galliers, 1993, p. 200). Accordingly, IT planning processes concentrate on the use of IT and on the business value creation from IT developments (Ward & Peppard, 1996, p. 39). The quality of IT planning processes impacts business value creation, which is reflected in a firm's performance data, such as sales revenue or return on investment (Premkumar & King, 1991, p. 56). Value from IT resources can only be gained from IT planning and IT resources must be planned to support the business strategy of a firm (Oh & Pinsonneault, 2007, p. 240). IT planning processes and their results may provide superior performance and competitive advantage (Das, Zahra, & Warkentin, 1991, p. 976). IT planning effectiveness is vital; IT potentially impacts the position of a firm in its competitive environment (Henderson & Sifonis, 1998, p. 2). However, the effective and consistent translation of IT investments into business value remains a problem within academia and in practice (Doherty, Ashurst, & Peppard, 2012, p. 11).

The literature on IT does not provide definitions of IT planning or related processes that are generally accepted. The strategic IT planning process has remained unexplored. There are no studies that explain detailed processes concerning IT strategy and there is no recent research regarding human resources working on IT strategies in actual settings (Peppard, Galliers, & Thorogood, 2014, p. 3). "Even the terminology in use is inconsistent: IS planning; IT planning; strategic IS planning (SISP); IS strategy; IT strategy, etc." (Peppard, Galliers, & Thorogood, 2014, p. 2). Instead, there are numerous unsorted analytical tools and techniques for IT planning from which an organization may choose (Robson, 1997, p. 166). In practice, there is no industry standard and no widespread methodology for IT planning; numerous firms use their own approaches (Flynn & Goleniewska, 1993, p. 294) or proprietary methods (55% from of 245 investigated firms) (Premkumar & King, 1991, pp. 46–47). The following descriptions reveal the notion of IT planning.

IT planning is a process in which a firm develops a long-term plan for applications to achieve its business goals (Lederer & Sethi, 1991, p. 104). Long-term planning refers to "visions of IT" in a five-year horizon. Short-term IT planning within a one- to two-year timeframe relates to the current objectives of a firm (Reich & Benbasat, 1996, p. 72). However, pressures on IT planning, such as system integration requirements or changes in technology (McFarlan, McKenney, & Pyburn, 1983), can rapidly influence both long- and short-term plans.

IT planning is an IT capability that enables IT service delivery; it transforms the firm's IT inputs into IT outputs. IT planning enables the identification of business priorities and aligns IT objectives with these priorities (Ravichandran & Lertwongsatien, 2005, p. 245, p. 249). Duncan (1995, p. 40) regarded three success factors for IT planning: first, the alignment of IT planning to business goals; second, technology plans and architecture; third, human resource skills as part of IT resource management.

Bradley, Pratt, Byrd, and Simmons (2011, p. 79) delineated the traditional IT planning approach, in that the overall business strategy from the top management serves as a relevant input to IT solution design. IT solutions are designed by business and IT managers and are then implemented on the IT infrastructure. From their recognized literature review, Wade and Hulland (2004, p. 114) considered IT planning as a capability to plan appropriate technology architectures and standards. Key aspects are abilities to estimate future advances and to choose suitable IT platforms. Human resources in IT planning must understand business cases and actual usage of technologies to solve problems appropriately.

Sambamurthy and Zmud (1994) drew a model in which "raw materials" (i.e., IT, data, and knowledge) are converted into "IT impacts" (i.e., new/improved products/services, business processes, organizational capabilities) through IT management roles and processes. This model is useful for explaining the purpose of IT planning. IT planning is the process in which raw materials are combined (i.e., IT resources as defined before) into organizational values and products/services for customer value. Implementations of IT plans are sources of performance growth and competitive advantage. Further, Soh and Markus (1995, p. 36) exemplified IT impacts with statements derived from Sambamurthy and Zmud (1994). The author of this dissertation combined these with customer value disciplines from Treacy and Wiersema (1993, 1995) and the generic strategies from Porter (1980), as displayed in Table 4.

While the processes for strategic IT planning and IT value creation substantially lack academic clarity (Peppard, Galliers, & Thorogood, 2014; Schryen, 2013), the research on the related area of IT-business alignment is vivid. The relationship between IT planning processes and business processes has been investigated since 1978 (Sabherval & Chan, 2001, p. 12). IT planning can link the IT and business domains and enable coordination between both (Reich & Benbasat, 1996, p. 56). The research on IT-business alignment is reviewed in the following subsection.

2.3.2 IT-business alignment for value creation

The alignment of business and IT strategies increases IT effectiveness (Chan, 2002) and consequently, business performance (Avison et al., 2004; Sabherval & Chan, 2001) as well as market performance (Rivard, Sraymond, & Verreault, 2006). A firm can achieve extraordinary profits and competitive advantage from such strategic IT-business alignments (Powell, 1992, p. 128). On the other hand, a firm cannot compete if IT and business strategies are not aligned (Avison et al., 2004, p. 223). In such a case, firms are unable to generate value from their IT investments (Venkatraman, Henderson, & Oldach, 1993, p. 139). Therefore, the integration of business and IT is vital for firms to be competitive (Wegmann, 2003).

Although strategic business-IT alignment has been a key topic in IT management for approximately half a decade (Keen, 1991, p. 213), the literature is blurred on the essentials of alignment. First, there are no agreements on terms and definitions; numerous synonyms are used (e.g., fit, linkage, bridge) (Avison et al., 2004; Ullah & Lai, 2013). Second, there is no consensus if alignment must be treated as an outcome—that is, state of congruence—or as a dynamic process reflecting a capability (Avison et al., 2004; Reich & Benbasat, 2000; Sabherwal, Havakhor, & Steelman, 2019, p. 456). Third, little is known on how to integrate IT and business strategies and how firms must align (Avison et al., 2004). There are several mechanisms to achieve alignment—such as governance, processes, capabilities, and value management (Venkatraman, Henderson, & Oldach, 1993, p. 139)—but these are vague.

Statements (Soh & Markus, 1995, derived from Sambamurthy & Zmud, 1994)	**IT impact** (Soh & Markus, 1995)	**Customer value discipline** (Treacy & Wiersema, 1993, 1995)	**Generic strategy** (Porter, 1980)
IT has been incorporated into new products/ services	Increased customer satisfaction	Customer intimacy	Differentiation
Business processes have been redesigned using IT	Processes are more efficient or effective; Increased productivity	Operational excellence	Overall cost leadership
IT has enabled organizational decision-makers to improve their understanding of resource markets	Better sourcing of inputs	Operational excellence	Overall cost leadership
IT has enabled organizational decision-makers to improve their understanding of customers	Better product/service design, etc.	Product leadership	Differentiation
IT has enabled flexible and adaptive organizational structures among organizational members and with customers and suppliers	Decreased lead time in product/service *delivery*	Operational excellence (e.g., lower storage costs)	Overall cost leadership
	Decreased lead time in product/service *development*	Product leaderhip (shorter time to market)	Differentiation

Table 4: IT impacts from IT planning compared to customer value disciplines and generic strategies (Source: author)

The terms used for IT-business alignment are manifold and are used synonymously in this dissertation: strategic alignment of IT (Oh & Pinsonneault, 2007), business-IT alignment, strategic IT alignment (Sabherval et al., 2019), and alignment of IT (Dutta, 1996). From a common understanding, all expressions imply congruence of links between business and IT and IT strategies, including congruence of the objectives derived from these strategies (Reich & Benbasat, 1996, p. 63), so that IT applications are consistent with business strategies (Parsons, 1984, p. 59). Planning outputs—that is, the mission statements and the objective settings—from both business and IT strategies, must match and comprise external business and IT environments (Reich & Benbasat, 1996, p. 58). Consistency is crucial because IT decisions impact the business and business decisions affect IT. For example, IT designs can support or hinder subsequent business decisions (Keen, 1991, p. 65). A useful definition for IT-business alignment has recently been provided by Sabherval et al. (2019, p. 454): "the extent to which a firm's relative investments in different IT areas (e.g., hardware, application software, maintenance) is consistent with the firm's business strategy." Alignment embraces capabilities, priorities, decisions, and actions from IT areas to support the business strategy of a firm (Rivard, Sraymond, & Verreault, 2006, p. 36).

The foremost objectives of IT-business alignment are improvement of performance (lower costs, higher revenues, and higher returns on investment) and competitive advantage through IT. Moreover, additional goals may be quality improvement (Oh & Pinsonneault, 2007, pp. 244–245) or reactions to new opportunities (Avison et al., 2004).

The impact of IT-business alignment on performance is momentous but it depends on the business strategy. Sabherval and Chan (2001, p. 25) tested this association with three business strategy profiles and corresponding IT strategy profiles: defenders, analyzers, and prospectors. Defenders, for example, are risk averse, and only slightly proactive in view of new business options; they emphasize stability and utilize IT for operational efficiency. Thus, for defenders, the influence of IT-business alignment was less significant in contrast to that for analyzers and prospectors. Prospectors, as another example, are proactive risk-takers and quickly seize business opportunities; they use IT for market flexibility and rapid decision-making.

Sabherval et al. (2019) suggested the concurrent adoption of two views on IT-business alignment—as a state of congruence and as the capability to leverage IT investments. They found that both positively influence a firm's performance; the capability view is recommended in complex and dynamic industry environments. However, the "state of congruence" is superficially described (e.g., intended or realized strategies, examined through objective data) but not specified in detail.

Tallon (2007a) examined the perceived IT-business value of strategic alignment through a survey with IT and business experts from 241 firms. He used the customer value disciplines (Treacy & Wiersema, 1993, 1995) for the operationalization of business strategy and applied five primary processes from Porter's (1985) value chain as measures of IT strategy: supplier relations, production and operations, product and service enhancement, sales and marketing support, and customer relations. He found positive relationships at the process level for all customer value disciplines and suggested assessing IT-business alignment at the process level rather than at the firm level, which has been the prevalent view. Moreover, Tallon (2007a, p. 258) appreciated the academic and practical usefulness of the customer value disciplines from Treacy and Wiersema (1993, 1995) and recommended further use of this typology in research.

Reich and Benbasat (2000) presented processes and outcomes as two different research perspectives to accomplish alignment. Process research focuses on the logical dimension that encompasses planning approaches, activities, methods, structures, and contents. The outcomes are related to realized strategies and to research on the social dimension, thereby implying acting people, communications, personal value, etc. This research highlights job roles and related activities to understand better the logical dimension, in particular, processes and structures.

Predominantly, a firm's managers—such as senior managers, HR managers, or IT managers—determine how IT is planned and used (Boynton & Zmud, 1987, pp. 60–61). IT-business alignment is a central business responsibility that must not be outsourced in contrast to other IT functions (Dutta, 1996, p. 266). Business managers must take responsibility for the alignment process, instead of considering alignment as being the function of IT managers (Dutta 1996, p. 267). Business managers must actively contribute to IT planning, and IT managers must be involved in strategic business planning (Sabherval et al. 2019, p. 471). It is traditional for the alignment process to occur on top or higher management levels, such as IT and business executive levels (Luftman & Brier, 1999, pp. 110-111) or CxO-level such as Chief Executive Officer, Chief Information Officer, and Chief Digital Officer (Haffke, Kalgovas, & Benlian, 2016; Johnson & Lederer, 2010; Karpovsky & Galliers, 2015). However, apart from high-level business strategy skills, IT-business alignment also needs design skills for translating business needs into IT solutions (Karpovsky & Galliers, 2015).

One of the main competences for IT-business alignment is IT architecture, which examines the impacts of IT on business processes (Cumps, Viaene, & Dedene, 2006, p. 18). IT architecture is a central function in the alignment process, along with IT strategy, business strategy, and the organization (Baets, 1992). Like Henderson and Venkatramann (1999, p. 476), Luftman and Brier (1999, p. 111) considered IT architecture as a key alignment component in light of IT processes and infrastructure. IT architecture decides on IT resources required to provide an integrated platform. Therefore, the function of IT architecture and the corresponding role of IT architects are worth being further elaborated.

2.3.3 IT-business alignment by IT architecture

IT architecture is the core of a firm's IT strategy; it combines business strategy, IT, capabilities, and human resources. (Duncan, 1995, p. 41). The creation of IT architectures has been a priority concern of IT managers since the 1970s. (Keen, 1991, p. 213). Large companies began designing and implementing IT architectures in the late 1980s (Earl, 1989, p. 97). However, academic publications that describe IT architecture as a means for IT-business alignment emerged at the beginning of the millennium with an increasing frequency (Zhang, Chen, & Luo, 2018). Zhang, Chen, and Luo (2018) reviewed 111 papers, published between 2002 and 2016, from which 40 articles dealt with accomplishing IT-business alignment by using methods from IT architecture. IT strategy researchers have agreed that IT architecture improves IT-business alignment. However, there are differences in how researchers express the strengths of the need for IT architecture to IT-business alignment. For that aim, IT architecture has been seen as an "enabler" (Andersen & Carugati, 2014, pp. 2-3; Ross & Weill, 2002), as a "tool" (Ross, 2003, p. 32), or an "ability" (Kettinger, Marchand, & Davis, 2010, p. 105). IT architecture was also viewed in a "harder" sense, that is, as a necessary function for IT-business alignment. For example, Wegmann (2003) considered IT architecture as the "purpose" for IT-business alignment with the goal to define and implement strategies. According to Unde (2008, p. 7), IT architecture must define strategies and "make sure" that IT aligns to the business, which includes selecting appropriate IT platforms. IT solutions "must" be built so that they are aligned with the business (Cibrán, 2009).

Results from a survey in 2002 showed that for 21% of the respondents, the main reason for investing in IT architecture was the improvement of IT-business alignment (Gregor, Hart, & Martin, 2007, p. 115). Another survey in 2006 with 140 CIOs from hospitals in the USA revealed that the maturity of IT architecture had positive effects on the improvement of IT-business alignment and on IT value (Bradley et al., 2011, p. 73; Ross & Weill, 2005).

Kettinger, Marchand, and Davis (2010) described global business approaches that reflect how IT architecture can align to a firm's business. In accordance with the globalization approach, a firm can decide on more or less business flexibility and business standardization. Business flexibility offers high responsiveness and tailored product/services for maximized customer value on local markets; business standardization provides process and learning efficiencies and enables highest impact with global approaches. The IT architecture can build corresponding IT solutions with foci on local responsiveness or cost/learning efficiency; it may also create suitable designs for business approaches in between. Both IT applications (user software) and underlying IT infrastructure (e.g., server hardware, platform software, and networks) can be standardized or customized in accordance with a global business approach to generate the highest profits for a firm. Table 5 displays how strategic demands for business flexibility and business standardization may change in accordance with global business approaches. It also indicates how IT architecture strategies might align from case to case and what kind of customer value is delivered by customizing or standardizing the IT infrastructure and IT applications accordingly. According to Earl (1989, p. 62), IT applications may be aligned to one of three generic strategies from Porter (1980); the outer right column in Table 5 displays the applicable strategy. The alignment of the IT architecture to global business approaches is explained in the following paragraph.

Global business approach	Business flexibility	Business standard-ization	IT architecture		Customer value discipline	Generic strategy
			IT infrastructure	IT applications		
Multinational (e.g., 2...8 countries)	High	-	Locally customized	Locally customized	Customer intimacy (local responsiveness)	Differentiation (focus on a geographic market segment)
International (e.g., 9...25 countries)	Medium	Low	Regionally standardized	Locally customized	To be defined.	To be defined. Risk of "stuck the middle".
Transnational (e.g., 26...100 countries)	Low	Medium	Globally standardized	Regionally customized	To be defined.	To be defined. Risk of "stuck the middle".
Global (> 100 countries)	-	High	Globally standardized	Globally standardized	Operational excellence	Overall cost leadership

Table 5: IT-business alignment and value creation from IT architecture based on ideas from Kettinger, Marchand, and Davis (2010), Porter (1980), and Treacy and Wiersema (1993, 1995) (Source: author)

The multinational approach involves the conduct of business in a few countries; in this approach, customers benefit from local responsiveness. IT infrastructure and IT applications are designed to meet local requirements. The firm pursues a focus/differentiation strategy and customer value manifests from customer intimacy. On the other extreme, in global approaches—for example, selling/serving in over 100 countries, firms may compete in terms of price, which requires high standardization for all processes, IT infrastructures, and IT applications. The corresponding customer value originates from operational excellence, following a cost leadership strategy. International and transnational approaches lie somewhere in between multinational and global business strategies and these must weigh business flexibility (customization of IT) and business standardization. The IT architecture can be adjusted appropriately in favor of flexibility (higher responsiveness, higher costs) or standardization (lower responsiveness, lower costs). The point of differentiation or the cost leadership position may suffer, and the risk of “stuck in the middle” (Porter, 1980) increases. Yet, “stuck in the middle” can also be considered as an opportunity (Tallon, 2007).

2.3.4 IT architecture and customer value

Although the strategic importance of IT architecture has been emphasized in the literature, little has been said with regard to the impacts from IT architects on customer value. Figueiredo, de Souza, Pereira, Audy, and Prikladnicki (2012, p. 2) recommended IT architects to solve customers’ problems or business needs through the use of IT. Ross (2004) found that organizations with high strategic efficiency of IT architecture perform better than their competitors. Based on their findings, they suggest four strategic values for IT architecture: the three customer value disciplines (product leadership, operational excellence, customer intimacy) from Treacy and Wiersema (1993, 1995) and strategic agility—that is, a prompt response to competitor actions and new market opportunities (Ross, 2004; Ross, Weill, & Robertson, 2006, p. 100). In a research briefing from the Massachusetts Institute of Technology, Ross and Weill (2002, p. 2) delineated five IT architecture styles for distinct business cases. From their descriptions, four of them can logically be mapped to customer value disciplines (Table 6). As Ross and Weill (2002, p. 2) suggested, and as previously exemplified with various global business approaches, the customer value disciplines are suited to reflect the value creation from IT architecture.

Following Ross' (2004) suggestion, this dissertation considers customer value creation typified by Treacy and Wiersema (1993, 1995) as being the ultimate objective of IT architects. This assumption is in keeping with the previous definition of IT value.

Architecture style (Ross & Weill, 2002)	**High volume transaction processing**	**Real-time response**	**Analytical and decision support**	**Work group support**	**Enterprise System**
Business case (Ross & Weill, 2002)	Cost savings from product efficiency	Flexibility and growth from customer responsiveness	Profitability from market segmentation and/or risk management	- Innovation speed - Time to market - Reuse	Process improvement from integration and standardization
Customer value discipline (Treacy & Wiersema, 1993, 1995)	Operational excellence	Customer intimacy	Not applicable	Product leadership	Operational excellence

Table 6: Allocation of customer value to architecture styles (Source: adapted from Ross & Weill, 2002; Treacy & Wiersema, 1993, 1995)

2.3.5 Summary: IT planning and IT architecture

Together, the presented studies on IT planning, IT-business alignment, and IT architecture in context with IT value provide important conclusions:

1. IT planning is central to value creation and to the competitive advantage of a firm. IT planning encompasses strategic IT visions and short-term objectives that include business alignment, technologies, IT architecture, and IT resources. However, there is no IT planning process that is accepted in science or applied in practice, even basic terms are confused.
2. IT planning is the capability of designing IT for future needs by combining IT resources into capabilities for customer value creation and strategic differentiation. Competitive advantage and value creation have been intensively discussed in the IT-business alignment literature, but there is little clarity on alignment processes, IT value creation, and associated roles.
3. The literature suggests IT architecture as a suitable approach for IT-business alignment. IT architecture can support and leverage various business strategies and customer value

disciplines by varying standardization and customization. The global business approaches from Kettinger, Marchand, and Davis (2010) were used for exemplification.

4. The customer value disciplines—operational excellence, product leadership, and customer intimacy—from Treacy and Wiersema (1993, 1995) match different architecture styles and are viewed as the main outcomes from IT architecture, apart from agility (Ross, 2004; Ross, Weill, & Robertson. 2006, p. 100). Thus, it is evident that customer value disciplines are becoming increasingly important in IT research and are suited to define strategic value creation from IT (Tallon, 2007, pp. 285–286).

2.4 Essential roles in IT planning

2.4.1 The role of IT architects

IT architecture is concerned with IT planning (Earl, 1989, p. 62) and is inherent to an organization's IT (e.g., Venkatraman, Henderson, & Oldach, 1993). The creators of these IT architectures are often referred to as IT architects (Frampton, Thorn, Carroll, & Crossman, 2006a, p. 221), a term which is a representation of the role that is responsible for the development of IT architecture (Figueiredo et al., 2012, p. 2). The development of IT architecture is a key topic in strategic IT planning alongside IT-business alignment, competitive advantage, and IT resource management (Earl, 1990, p. 271). IT architectures are developed by defining IT capabilities in accordance with policies and technical choices to support the strategic objectives of an organization (Ross, 2003, pp. 32–33). However, there is no definition for IT architecture that is universal and generally accepted (Earl 1989, p. 97; Ross, 2003, p. 32). Occasionally, IT architecture is used as a synonym for IT infrastructure or technology standards of an organization (Ross, 2003, p. 32). The related notion of enterprise architecture can also be confusing (Ross, Weill, & Robertson, 2006, p. 48). If the terms IT architecture and enterprise architecture are not clear in academia, the roles of IT/enterprise architects in practice will also not be clear or consistent.

Seminal publications that treated IT architecture signified the need for effective and efficient selection and integration of IT. Zachman (1987, p. 276) outlined IT architecture as a logical construct to define interfaces and integrate all components of an IT system. Similarly, Earl (1989, p. 97) considered IT architecture as a framework for IT integration (systems, interfaces, and compatibilities) and IT choices over time. Keen (1991 p. 198) emphasized the need to balance competing demands with regard to the integration of all IT resources: maintenance of options for new IT resources, accommodation of standards, and protection of investments. The selection of IT resources requires trade-off analyses from IT architects (Armour, Kaisler, & Liu, 1999, p. 52). Further, IT architecture must provide structures to effectively and efficiently implement the requirements of the business (Earl 1989, p. 97). According to Henderson and Venkatraman (1999, p. 478), the role of the IT architect is to efficiently and effectively design and implement the IT infrastructure so that it is in line with the scope, capabilities, and governance of IT strategy. Efficiency and effectiveness are not only basic needs for architectural design and implementation but also criteria for the selection of IT resources (Keen, 1991, p. 239).

The extant literature provides various descriptions for IT architects that complement previous key attributes of IT architecture. The important features of IT architecture are guidance, standards, and business requirements. IT architecture sets guidelines for the development of IT applications, integrates open systems from multiple vendors, manages networks, and provides data access, security, and control to the organization (Croteau & Bergeron 2001, p. 87). IT architecture also provides guidance to an organization for analysis, design, and implementation of IT infrastructure to meet IT and business requirements over time (Earl 1989, p. 97). Further, IT architecture is a blueprint comprising long-term organizational requirements for IT at a high level as well as a detailed plan for combinations of IT and non-IT resources/capabilities within a cohesive whole (Duncan, 1995, p. 41). Architectural policies, plans, and standards mature as architecture develops. (Duncan, 1995, p. 41). Apart from the standards (i.e., rules, protocols, and specifications that are shared by various business entities), the IT architecture of an organization comprises IT applications and physical resources for data processing, storage, and transport (Sullivan, 1985, p. 9). Henderson and Venkatraman (1999, p. 474) divided IT architecture into data architecture, the IT application portfolio, and the configurations of hardware, software, and communication equipment. As indicated earlier, IT architecture helps create the IT platform for achieving business flexibility and business standardization (Kettinger, Marchand, & Davis. 2010, p. 97).

2.4.2 Types and tasks of IT architects

In this dissertation, IT architecture is used as a synoptic notion covering all architectural activities and outcomes. IT architecture embraces different levels and various functions with associated roles (e.g., enterprise architecture, solution architecture). As the terminology for IT architecture is not uniform, the subordinated expressions are also heterogeneous and occasionally confused. Organizations allocate IT architecture tasks to different roles with various names (Figueiredo et al., 2012). Although research on activities and types of IT architects has been scarce (Figueiredo et al., 2012), a few types of IT architects are presented in the literature, but these differ as well.

IT architects operate at distinct levels. Martin, Dmitrieva, and Akeroyd (2010, p. 6) reviewed information architecture literature and mentioned two main levels. The upper level is the enterprise level for delivering the value of “integration, flexibility, and reuse”; the lower level is the solution or project level in which individual systems are created. From qualitative research, Akenine (2008) identified IT architect roles at three levels: a strategic level connected to the business, a technical level for solution design, and an intermediate level between business and technology.

Akenine (2008) proposed four types of IT architects that were subsequently examined by Figueiredo et al. (2012, p. 1). Akenine’s (2008) goal was to recommend consistent roles for IT architects. A focus group comprising experts from distinct industries conducted workshops and reviews to characterize the roles of IT architects based on 40 artifacts and architectural deliverables. Consequently, four roles of IT architects were suggested that provided typical artifacts (Table 7).

Founded on 27 semi-structured interviews with 22 participants from nine firms and grounded theory methods, Figueiredo et al.’s (2012, 2014) study basically confirmed Akenine’s (2008) IT architect typology but suggested eliminating the business architect role. The business architect tasks are performed by enterprise architects or, in case of their unavailability, by solution architects. Figueiredo et al. (2012, 2014) made a few minor refinements in role and responsibility descriptions of the architecture types. These are integrated in Table 7.

Foorthuis and Brinkkemper (2008) conducted action research and focus group interviews in a governmental organization that engaged over 2000 employees in the Netherlands. They aimed to find best practices for business and systems analyses in context with projects and enterprise architecture. The authors distinguished two architecture levels: the enterprise/domain level and the project level. Foorthuis and Brinkkemper (2008, p. 38) defined enterprise architecture as “the high-level set of views and prescriptions that guide the coherent design and implementation of processes, organizational structures, information provision and technology within an organization,” where views and prescriptions refer to current (as-is) and future states (to-be). The domain architecture is optional and distinguishes from the enterprise architecture by relating to specific groups of products/services, processes, or functions. Finally, project architectures refer to single projects.

Architect type	Tasks and responsibilities (Akenine, 2008; Figueiredo et al., 2012, 2014)	Typical artifacts (Akenine, 2008)
Enterprise architect	- Overall IT strategy - IT support of business strategy - Cost-effectiveness of IT architecture (i.e., IT investments are aligned to the organization's business) - Governance - Global technical standards	- IT strategies - Capability maps - City plans - Integration strategies - As-is/to-be analysis - Architectural principles - Gap analysis - Life-cycle analysis - Application portfolio strategies
Business architect	- Requirement analysis (organization/business/processes, technical solution) - Process improvement - Process modeling - Benefit realization from projects	- Process maps - Use case - Information models
Solution architect	- Solution design based on requirements - Balance of functional and non-functional requirements (trade-offs, priorities) - Solution integration - Reuse of existing functions and services - Alignment of solutions to standards - Alignment of projects to architectural principles - Reuse of existing capabilities by in the project.	- Application diagrams - System maps - Service interfaces - Technical interfaces - Integration strategies
Software architect	- Structure and design of software systems - Functional requirements (flexibility, performance, reusability, testability, and usability) - Ongoing project support - Tasks may be like those given by solution architects	- Frameworks - Class models - Patterns - Aspects

Table 7: Architect types, main responsibilities, and typical artifacts (Sources: Akenine, 2008; Figueiredo et al., 2012, 2014)

There is no general consent given to enterprise architecture (Löhe & Legner, 2014, p. 103). Although it can be defined in numerous ways, there is little doubt in the literature that enterprise architecture represents the highest IT architectural view of an organization and that it connects IT strategy and business strategy (Ross, Weill, & Robertson, 2006; p. 9, p. 48; Tamm et al., 2011). The key aspects of enterprise architecture are integration and standardization of an organization's IT resources and capabilities that must be logically organized (Bradley et al., 2011; Fonstad & Robertson, 2006, p. 4; Ross, Weill, & Robertson, 2006, p. 9) by means of principles, methods, and models (Lankhorst et al., 2013). Because of its strategic nature, enterprise architecture adopts a long-term perspective.

The global leading architecture framework from The Open Group (2018, p. 474) categorizes IT architects in the following manner: enterprise architects ponder on business functions and leadership; segment architects focus on technical solutions for a specific business segment in the value chain; and solution architects concentrate on products, components, systems, and technologies for a specific matter. The segment architect from The Open Group Architecture Framework (TOGAF; The Open Group, 2018) corresponds to the domain architect from Foorthuis and Brinkkemper (2008). TOGAF does not present a project architect as others in the literature have done (Fonstad & Robertson, 2006; Foorthuis & Brinkkemper, 2008); instead, a solution architect is mentioned, which is comparable to the solutions architect from Akenine (2008). In large companies, IT architects may be employed on an intermediate business unit level. These architects concentrate on business unit strategies and coordinate with enterprise architects at the strategic level and architects at the project level (Fonstad & Robertson, 2006).

In a viewpoint article, Unde (2008) suggested three types of IT architects. The enterprise architect acts at the strategic level and is in line with previous descriptions; the technical architect works at the project level and is similar to the solution architect described by Akenine (2008). Unde's (2008) solution architect is a hybrid that is technically and strategically positioned between the other types at a program level. With the exception of the solution architect from Unde (2008), all other IT architect types can logically be allocated to either a strategy/business level or to a project/solution level. Table 8 presents an overview of the titles of IT architects from the reviewed works and their assignment to either the strategic/business or the project/solution level.

	Author	Akenine	Figueiredo et al.	Fonstad & Robertson	Foorthuis & Brinkkemper	The Open Group	Unde
Level	**IT architect type**	(2008)	(2012)	(2006)	(2008)	(2018)	(2008)
Strategy/ Business	Enterprise	X	X	X	X	X	X
	Business	X*		X**			
	Segment					X	
	Domain				X		
Project/ Solution	Solution	X	X			X	X
	Software	X	X				
	Project			X	X		
	Technical						X

* Business *analysis* ** Business *unit*

Table 8: Architect types given by various authors

As stated earlier, the use of IT architecture terms is confused in the literature, particularly when other types apart from enterprise architects are discussed. For example, Casas, Sánchez, and Villalobos (2017, p. 108) describe IT architecture in a way ("…comprises the design and planning of the IT solution," "…includes the implementation of that solution.") that other authors would specify as solution architecture.

It must be noted that specific human resource skills are required to perform the tasks and to meet the expectations on the IT architect role. Next, the literature on the skills of IT architects is reviewed.

2.4.3 Skills of IT architects

In contrast to other job roles within the IT field, there exist only a few findings regarding the skills required for IT architects (Frampton, Thom, & Carroll, 2006a). Research on the requisite key skills for IT architects has been rather limited, whereas—outside the literature—industry descriptions on the skills required for IT architecture are available (Frampton, Thom, & Carroll, 2006).

In order to obtain knowledge on skill requirements for IT architects, Ho and Frampton (2010) interviewed 14 practicing IT architects from five different industries with international work experience. The sample included various types of IT architects (enterprise architecture, software architecture, and security architecture). Each semi-structured interview with open-ended questions took between 40 and 95 minutes. The audio-recorded transcripts were coded with a pre-tested coding scheme and content analysis software. Counts of codes matched in the transcripts reflected the importance of each competency. The authors derived a list of 14 IT architect skills, which are presented in Table 9.

The most significant (top five) skills constitute 63.1% of all counts for codes:

- technology knowledge, architectural techniques (e.g., service-oriented architectures, system design)
- work experience—that is, project management, software development life cycle, and credibility
- stakeholder communication
- analysis and problem-solving, including application of rules, procedures, principles
- conceptualization and abstraction to further develop IT architecture practices (e.g., frameworks, standards, methods)

Six of the remaining (nine) competencies refer to soft factors, such as, motives, traits, or self-conceptualization. These do not appear to be particularly relevant in contrast to the top five skill requirements mentioned above.

Ho and Frampton (2010) examined various types of IT architects but did not distinguish skill requirements for each IT architect type. Although Unde (2008, pp. 8–9) offered an IT architect typology based on tasks, he presented only generic skill requirements. Unde's (2008) skill suggestions are briefly listed below:

- leadership and decision-making
- strategic and abstract thinking
- stakeholder communication (internal and external, e.g., vendors, partners)
- business analysis techniques (business cases, requirements)
- technologies and vendor offerings
- project management

Rank	**IT architect skills** (Ho & Frampton, 2010)	Counts
1	Technical knowledge	86
2	Work experiential knowledge	79
3	Communication skills	62
4	Critical analysis and problem solving skills	59
5	Conceptualization and abstraction skills	58
6	Passion	50
7	Contextual knowledge	26
8	Creativity	25
9	Comprehensive knowledge	21
10	Skills to manage situational politics	19
11	Open-mindedness	19
12	Visionary	16
13	Walking the middle ground	13
14	Resilience	12

Table 9: Required skills of an IT architect (ranked according to importance) (Source: Ho & Frampton, 2010).

As described earlier, Figueiredo et al. (2014) strongly agreed to the role description from Akenine (2008), except that they did not suggest the role of the business architect. Akenine (2008) delineated the following required skills for an IT architect (key words):

- enterprise architect: business, IT, enterprise architecture, business modeling, governance, project management, economics, leadership, negotiation
- business architect: business, process modeling, requirement analysis, workshop moderation
- solution architect: technology, infrastructure, data modeling, service orientation, enterprise architecture
- software architect: programming, frameworks, standards, technical modeling

Twenty-three skill categories required for IT architects were identified by Casas, Sánchez, and Villalobos (2017) by reviewing academic and industry publications and by conducting surveys and interviews with IT experts and IT trainers. Table 10 displays the findings; the order does not reflect importance.

Specific skills are required to perform architectural activities and help in understanding what architects are expected to do. While industry frameworks like TOGAF (The Open Group, 2018) offer detailed skill profiles for numerous IT architecture roles, the literature provides little information on the skill requirements for IT architects. The literature lacks detailed descriptions of skills, classification of skills, allocation of skills to IT architecture types, and required levels for each skill and IT architect type. The lack of such skill profiles with proficiency levels are a research gap.

ID	**IT architect skill category** (Casas, Sánchez, & Villalobos, 2017)
1	Analyze and understand problems, requirements, and constraints
2	Design, document, and justify proposed solutions
3	Build, implement, operate and manage designs
4	Manage IT projects
5	Work in multidisciplinary teams
6	Work with other IT roles
7	Recommend implementation projects prioritization
8	Guarantee quality in IT
9	Lead work teams
10	Communicate business and IT concepts
11	Give value to business through IT
12	Understand the organizations business
13	Align business and IT
14	Define the scope of business projects
15	Manage software
16	Design software
17	Develop business strategies
18	Define the IT architecture
19	Optimize business capabilities
20	Manage the integration and reuse of existing elements of the enterprise architecture
21	Design solution architecture
22	Integrate technologies
23	Provide recommendations regarding to the appropriate solutions for specific problems

Table 10: Skill categories identified by Casas, Sánchez, and Villalobos (2017)

2.4.4 The role of project portfolio managers

Project portfolio management is another key function within organizations that is connected to strategy and value creation. Project portfolio management is the interface between project management and strategic management. The following paragraphs demonstrate these links in the literature.

Portfolios connect projects to strategy

The success of an IT project is influenced by its contribution to a firm's competitive strategy. The more a strategy is supported, the more successful the project will be (Parsons, 1984, p. 58). In the worst case, that is, inconsistency of IT projects and competitive strategy, IT projects are at a risk of failure (Lederer & Mendelow, 1987, p. 397). Portfolio management is an approach for avoiding or mitigating these risks (McFarlan, 1981).

Business strategies must jointly be planned with IT strategies to ensure alignment (Farbey, Land, & Targett 1992, p. 110). IT project portfolio management is an established function that links IT projects to the strategic planning process (Daniel, Ward, & Franken, 2014). Research has realized the contributions of IT project portfolio management at the strategic planning level; it evaluates and weights alignment needs, risks, values, and project interdependencies

(Daniel, Ward, & Franken, 2014). A result of this strategic planning process is a stack of projects—that is, the project portfolio; it includes change initiatives for IT applications and/or IT infrastructure (Farbey, Land, & Targett; 1992, p. 110). The activities of project portfolio management include assessment of project performance and value delivery, priority setting for projects according to the business strategy, and resource planning (Daniel & Ward, 2015). Project portfolio management comprises all program and project deliverables of a firm (Daniel & Ward, 2015). Programs are bundles of related projects that are conjointly controlled (Pinto, 2016, p. 550). Programs are optional and placed at an intermediate level between portfolios and project level (PMI, 2013, p. 3).

Value from portfolios

The overall purpose of project portfolio management is to generate maximum returns from the total investment budget (Baldwin & Curley, 2007, p. 31). Each single project that is part of a portfolio delivers value. The dependencies among projects require consideration from a portfolio because they impact the total value of a portfolio (Bardhan, Bagchi, & Sougstad, 2004, p. 36, p. 52). The values that specific projects provide may have different strategic significance. Portfolios link projects to the business strategy and can decide on the best sequence of project implementation in accordance with strategic priorities (Garcia, Vasconcelos, & Fragoso, 2018). Thus, portfolios optimize value creation between the project and strategic management levels. Laursen and Svejvig (2016, p. 744) proposed the integration of the management practices for strategy, portfolio, programs, and projects because of their interconnectedness and relevance for value delivery. A holistic approach with appropriate governance structures can ensure strategic consistency and exploitation of values.

The role of the project portfolio manager

Jonas (2010) suggested a dedicated role for administering and controlling project portfolios: the project portfolio manager performs regular activities to shape, steer, and evaluate the portfolio, as well as to plan project resources. This role interacts with senior managers and functional managers and does not focus on IT. The project portfolio manager adjusts the portfolio with all strategies at a functional unit level—for example, marketing, finance, human resources, and IT. The strategic project portfolio is periodically reviewed, project proposals are evaluated, and projects are prioritized and selected founded on strategic business needs. Resources are allocated to projects accordingly and resource conflicts are mitigated. Finally, learnings from steering and evaluating portfolios are fed back into the planning loop.

IT planning and implementation

Portfolio and project management imply IT planning methodologies (Ramanujam & Venkatraman, 1987, p. 39). IT planning discusses and documents strategic options for IT strategies, objectives, resource allocation, programs, and IT architecture, and courses for program/project implementation (Prekumar & King, 1991, p. 433). Implementation begins after planning and design, including installation, configuration, training, and reorganization (Piccoli & Ives, 2005, p. 761). Implementation of programs/projects is an important measure for IT planning success (Mohdzain & Ward, 2007). Implementation may cause difficulties resulting in delays or even termination, if plans are not followed up or fulfilled (Earl, 1993, p. 187). The project manager bears the responsibility of planning and implementation. Strict monitoring and controlling and project management guidelines help avoid deviation from plans. The project manager must ascertain that IT products/services are implemented within time and budget constraints (Galliers & Sutherland, 1991, p. 105). Further, poor project management is a well-known risk to implementation effectiveness (Soh & Markus, 1995, p. 38). Stated differently, project management is a success factor for implementation and, therefore, critical for strategic IT achievements. However, the ultimate success of IT planning is mirrored in the performance of the firm (Prekumar & King, 1991, p. 433).

2.4.5 Collaboration of IT architects and project (portfolio) managers

The strategic IT planning process involves various contributions from IT architects: analysis of technologies and their influence on the firm and the industry, requirements analysis, architectural development, etc. The results from these tasks are necessary inputs for decision-making on strategic programs (Premkumar & King, 1991, p. 43). At this stage, plans developed by IT architects must match schedules from project portfolio management that involve interdependent projects (Tamm, Seddon, Shanks, Reynolds, & Frampton, 2015, p. 182). To this end, close collaboration between IT architects and project portfolio managers is desirable. Enterprise architects must constantly monitor and evaluate each project of a portfolio in terms of technical compliance to the overall enterprise architecture and its strategic enhancement (Andersen, Carugati, & Sørensen, 2015, p. 4089). Cumps, Viaene, and Dedene (2006) found that firms with superior processes for project (portfolio) management, enterprise architecture, strategic management, etc. provide better alignment for their IT investments. Analysis of IT investments must involve IT architecture to ensure technical consistency and manageability as well as project (portfolio) management to prioritize IT investments for pursuing objectives in the long term (Cumps, Viaene, & Dedene, 2006, p. 22)

At the project level, collaboration between solution architects and project managers was found to be beneficial in a case reported by Tamm et al. (2015, p. 182). Foorthuis and Brinkkemper (2008) also argued for the involvement of IT architects in projects, which may be an active project engagement or more a consultancy support in the background. Ross, Weill, and Robertson (2006, p. 105, p. 112) recommended the engagement of IT architects early in project teams to control architectural standards, that is, to comply with them or to decide on exceptions if valuable. In addition, the authors proposed that IT architects must review requirements and determine the necessary capabilities in IT projects (Ross, 2004). Other good reasons for the involvement of IT architects in projects are improved project implementation (Tamm et al., 2015), evaluation of architectural consistency (Andersen, Carugati, & Sørensen, 2015), and technical consultancy (Foorthuis & Brinkkemper, 2008).

2.4.6 The role of senior managers in committees

Although it has been argued that project (portfolio) management and IT architecture can support investment decision-making through evaluations, scheduling, etc., a few authors presented processes for IT investment and governance without these roles. Instead, senior management and committees set project priorities and governance standards.

Avison et al. (2004) narrated a case of a firm in which a stack of project proposals was prioritized from a committee. This project prioritization committee comprised executives from the business and from the IT management. The committee examined the strategic IT-business alignment of the project proposals and then accepted or rejected these. If accepted, the committee allocated resources to the projects.

Nolan and McFarlan (2005) recommended an IT governance committee for decision-making pertaining to IT investment. This committee includes top executives, from that one person should possess IT expert knowledge. For defensive strategies—that is, low to medium needs for new IT, the committee is informed with regard to strategic projects on a quarterly basis and receives architectural updates as needed; revisions on project investments may be done annually.

A major objective of IT governance is the alignment of IT investments to strategic business priorities (Weill & Ross, 2005, p. 26). According to Weill and Ross' (2005) approach, IT governance includes five main topics: IT principles, IT architecture, shared IT infrastructure, IT applications requirements, and prioritization/investment decisions. The authors presented six typical ways for decision-making from that the anarchical way is unrealistic. The other five options grant decision-making rights to C-level managers, executives, business unit leaders, etc. that make the IT investment decisions in committees. It may be a CIO that converts IT investments decisions into IT architecture capabilities (Weill & Ross, 2005).

2.4.7 The role of IT vendors

IT vendors (synonyms: IT product vendors, IT suppliers, IT service providers) are important to a firm's IT in many ways and require special attention in the IT planning process. They affect both competitive advantage and value generation and are related to IT architecture and IT projects.

Relationships to suppliers are sources of sustainable competitive advantage for a firm (Powell & Dent–Micallef, 1997) and are meaningful sources of value (e.g., Lankhorst et al., 2013, p. 114, Tallon, 2007a). For example, IT applications can have valuable external interfaces with IT suppliers (Clemons, 1986) to share information resources (Keen, 1991, p. 198). On the highest stage of Galliers and Sutherland's (1991) growth model are IT systems that link a firm to its suppliers for new product/service development—that is, customer value creation. Such IT systems enable accelerated developments for early availability of products/services on markets (Sambamurthy & Zmud, 1994) (for product leadership) or short lead times for established products/services (for operational efficiency). IT systems that connect IT suppliers with firms can also be used to reduce supply costs and to improve the quality of supplied products (Rackoff, Wiseman, & Ullrich, 1985, p. 291). Thus, relationships with key IT suppliers provide value to firms that even customers may perceive (Broadbent & Weill, 1997). Finally, close supplier-relationships provide access to IT knowledge; they also improve IT suppliers' capabilities, which are beneficial in case of IT outsourcing (Levina & Ross, 2003, p. 332). The value of supplier-relationships is articulated in the IT/RBV literature as an intangible asset (Wade & Hulland, 2004, p. 109) or relationship asset (Weill & Ross, 2004, p. 7). The IT supplier-relationship has also been understood as an important factor of a firm's functional capabilities (Ravichandran & Lertwongsatien, 2005, p. 247).

Switching costs from IT denote a strategic approach to competitive advantage (e.g., Bakos & Treacy, 1986); it binds customers to a firm by making the changes to competitors' products/services expensive and difficult (Rackoff, Wiseman, & Ullrich, 1985, p. 291). This customer "lock-in" effect was considered as a value-driver (Weill, 2002b, p. 8) or a source of competitive advantage (Clemons, 1986, p. 134), whereas Mata, Fuerst, and Barney (1995) were skeptical with regard to "capturing customers" in this manner. Switching costs are created when IT investments are special to a particular IT supplier (Mata, Fuerst, & Barney, 1995, p. 489) and turn into effect when this particular IT supplier is changed (McFarlan, 1984, p. 99). Money and efforts are consumed to search for a new IT supplier, negotiate a contract, and ensure supply continuity (Clemons, 1986, p. 134). As a countermeasure, costs for searching for new IT suppliers must be kept low to retain a firm's own bargaining power and maintain its own competitive advantage (Johnston & Vitale, 1988, p. 153, p. 158). The firm's IT department must leverage own bargaining power (Bakos & Treacy, 1986) and reduce that of IT suppliers (Earl, 1989, p. 55; Johnston & Vitale, 1988, p. 156). A firm's IT may simplify the search for alternative IT suppliers so that switching costs are low (Hitt & Brynjolfsson, 1996, p. 136; Hitt, Brynjolfsson, & Walsham, 1994, p. 272). Another way to increase the power over IT suppliers is to introduce a multiple vendor strategy in order to not be completely reliant on one IT supplier (Tamm et al., 2015, p.186).

IT suppliers must strategically be counted in because they impact value and competitive advantage. The external aspect of a firm's strategy does not only contemplate the buyer-supplier relationship but also the IT supplier's capabilities and product/services (Venkatraman, Henderson, & Oldach, 1993, p. 141). The latter strongly influences a firm's IT strategy (Ward, 2012, pp. 166–167). The strategic IT vision is frequently shaped by IT suppliers (Peppard & Ward, 2005, p. 57). The IT suppliers' view on a firm's competitive strategy is of high research interest, since IT suppliers and their strategies considerably impact a firm's IT strategy (Ward, 2012, p. 165). It is the IT suppliers' responsibility to "produce significant strategic differentiation" from a firm's IT (Carr, 2003, p. 4). They must explain value creation from IT, instead of presenting IT as a tool or panacea (Carr, 2003, p. 4). Competitive advantage originates from identifying new ways to create customer value, which requires an in-depth understanding of the buyer's objectives and use cases. Thus, suppliers design products/services in a backward manner to deliver superior value (Woodruff, 1997, p. 148). IT suppliers must understand a firm's needs; otherwise new products are unlikely to succeed (Teece, 2007, p. 1324).

The IT supplier's role is highly relevant to both strategic and tactical IT management. IT managers that are accountable for IT planning, IT architecture, IT projects, and IT operations, deal with IT suppliers and outsourcers (Weill, Subramani, & Broadbent, 2002, p. 8). Consequently, governance for IT management (e.g., policies, procedures) does not only concern the internal organization but also external IT suppliers/service providers (Venkatraman, Henderson, & Oldach, 1993, p. 144).

IT projects are the means to realize IT architectures (Anderson, 2016) and they actualize technological changes. IT suppliers may play an essential role in cooperation with a firm's IT specialists and are a success factor of an IT project (Markus, 2004, p. 7). High-quality capabilities and skilled IT consultants from IT suppliers might be required to successfully implement technological changes within the firm (McAfee & Brynjolfsson, 2008, p. 107).

2.4.8 Summary: Essential roles in IT planning

The literature review on relevant roles in IT planning may be summarized in the subsequent paragraphs:

1. In IT planning, the main objective of IT architects is to effectively and efficiently select and integrate IT resources in the firm's IT environment to meet business requirements over time. IT architects provide guidance for analysis, design, and implementation of IT by setting standards (rules, specifications for interfaces, protocols, etc.), guidelines, and policies. IT architects must balance flexibility and standardization of a firm's IT to meet business needs. Although IT architecture is central to IT planning, the role of the IT architect is hazy in theory.
2. IT architects work at different levels: the upper strategic level connects IT architects to the business for value creation; the lower project level refers to solutions design in projects. There might be a domain/segment level in between if necessary.
3. Different types of IT architects have been suggested, but these vary among researchers. The enterprise architect role has been considered by numerous authors at the strategic level but there is no uniform definition for this role. Other IT architect roles are also insufficiently defined.
4. There are only a few studies on the skills of an IT architect. The literature still lacks a detailed description of skills, classification of skills, and allocation of skills to various types of IT architects.

5. Project portfolio management is another key function within the organization that is connected to strategy and value creation; it constitutes the interface between project management and strategic management. The overall objective of project portfolio managers is to maximize value from the total investment budget. They are involved in the strategic business planning process for evaluations (foremost value creation, dependencies, and risks) and help prioritize all project proposals based on business needs. Selected projects are scheduled and receive budgets and resources for implementation.
6. Project management concentrates on the implementation of IT strategies. IT architects engage in projects mainly to control architectural compliance and provide technical expertise; therefore, IT architects cooperate with project managers.
7. Committees comprising business managers and IT executives may decide on project priorities, approve investments, and provide governance (e.g., IT principles, IT architecture, requirements).
8. IT vendors strategically influence a firm's IT and impact value creation and competitive advantage. IT vendors must understand a firm's needs in order to offer IT products/services that are in accordance with the firm's IT strategy. Relationships to IT vendors are beneficial in numerous ways—for example, by sharing information, building IT architectures, developing products/services, and optimizing the supply chain. However, firms must be careful to avoid the "vendor lock-in," which results in switching costs when changing the IT supplier.
9. IT vendors connect to both IT architecture and project management. IT architects choose products/services provided by a few or multiple IT vendors and balance needs for integration and dependencies from IT vendors that are mirrored in (switching) costs. The quality of IT vendors is crucial for successful project implementation.

3 Motivation and overall research questions

This dissertation strives to answer four main research questions concerning value creation by IT architects, their roles in IT planning, and their relationships with other roles in a firm. The research questions are based on the conclusions of the overarching literature review (OLR). The following statements justify the need to answer these research questions.

3.1 Strategic views for IT value and competitive advantage

IT architects are involved in the strategic planning process and are decisive to align IT strategies (OLR, section 2.3, subsection 2.4.1). An analytical framework for competitive advantage and IT value help IT architects align IT strategy to the business strategy. A suited framework has to be specified for that purpose.

The RBV is useful to evaluate the relationship between IT and business strategy (Wade & Hulland, 2004, p. 109). The RBV as an analytical method for competitive advantage has been dominating IT research (Peppard, Galliers, & Thorogood, 2014, p. 3). However, there is a controversy regarding the adequacy of the RBV for the strategic analysis of (IT) value. Wade and Hulland (2004, p. 109) described RBV as a convincing means for IT value analysis, whereas Priem and Butler (2001) complained about the RBV's shortcomings in terms of value, which are gained outside the firm; they indicated the need for a more integrative theory that includes external viewpoints as well. Thus, extant IT literature is unsatisfactory in terms of considering the external environment for IT value (Schryen, 2013, p. 12).

According to Reich and Benbasat (1996, p. 58), the results from strategic business planning and strategic IT planning must be internally consistent and externally valid—that is, exogenous analyses of business and IT are required. In this regard, the RBV is insufficient. The first research question strives to enhance the perspectives for the strategic analysis of the business and IT:

RQ1: What strategic view is appropriate for the analyses of IT value and competitive advantage?

In order to answer RQ1, Article 2 provides a theoretical analysis on the complementarity and togetherness of the RBV and the industry view. The overarching discussion extends the context to include customer value perspectives.

3.2 Tasks and skills of IT architects

IT architecture forms the core of the IT strategy (Duncan 1995, p. 41; Keen, 1991, p. 239). IT architects play a key role in the IT planning process (OLR, subsection 2.4.1). They essentially contribute to IT-business alignment, which is pivotal to IT value generation (ORL, subsections 2.3.3 & 2.3.4).

Although enterprise architecture has been of high research interest for over 35 years (e.g., Ross, Weill, & Robertson, 2006), its definitions and standards remain inconsistent (Halawi, 2018, p. 1) and the role of the enterprise architect is unclear both in theory and practice (Olsen, 2017, Thönssen & von Dewitz, 2018). Other roles of IT architects are also nebulous in the literature; it appears that all IT architect roles have been underestimated (Gøtze, 2013).

Despite the acknowledged importance of the IT architecture function, the tasks of IT architects are barely understood (Figueiredo et al., 2012). Moreover, there is a lack of research on the skills that an IT architect requires (e.g., Frampton, Thom, & Carroll, 2006), even though the RBV has emphasized the significance of managerial and technical skills.

In order to understand the value-creating activities of IT architects and the skills they need to perform these, research question 2 is proposed:

RQ2: What are the required tasks and skills of IT architects?

The tasks and skills of IT architects were examined with the aid of job advertisements (Article 4). The analytical techniques are described in the following methods chapter.

3.3 IT value from IT architects

Although there has always been a general awareness of the importance of IT value, the notion is IT value has been fuzzy in the literature for several decades and there is no theory on IT value (Schryen, 2013, p. 150; OLR, subsection 2.1.1). Further, the categories of IT value are inconsistent (OLR, subsection 2.1.2). IT architects play a key role in IT planning, which is central to the value creation and competitive advantage of a firm (OLR, section 2.3). However, there is a lack of understanding of the value created by IT architects (Foorthuis, van Steenbergen, Brinkkemper, & Bruls, 2016; Gong & Janssen, 2019; Tamm et al., 2011).

This dissertation investigates the creation of both customer and organizational values by IT architects as part of the IT planning process; it seeks to answer the third research question:

RQ3: What types of value result from IT architects?

The IT value categories from the overarching literature review and the tasks from RQ2 (Article 4) were compared to discover the value created by IT architects.

3.4 The links of IT architects in IT planning

Strategic IT planning and IT-business alignment are central to value creation (OLR, subsections 2.3.1 & 2.3.2). However, there is no IT planning process that is generally accepted in the literature (OLR, subsection 2.3.1). Thus, processes for value creation must be investigated (Schryen, 2013, p. 150).

Strategic IT planning influences the uniqueness of a firm's capabilities and their replicability (OLR, subsection 2.2.6). Therefore, managerial resources in IT planning are essential for sustainable competitive advantage. Yet, research on roles that actively engage in strategic IT planning is very scarce (Peppard, Galliers, & Thorogood, 2014, pp. 3–4).

IT architects have been identified as playing a key role in the IT planning process (OLR, subsection 2.4.1; Article 4). However, the literature is controversial with regard to the essential roles for IT-business alignment—they may be senior managers or IT architects (OLR, subsections 2.3.2 & 2.4.1). The fourth research question addresses alignment and managerial relationships between IT architects and other roles in the IT planning process. These links enhance the understanding of strategic and tactic IT planning. RQ4 seeks to provide more clarity on IT planning processes and structures.

RQ4: How are IT architects linked to other roles in IT planning?

The empirical evaluation of the tasks and skills of IT architects (Article 4) reveal links to project management. Articles 5 and 6 discuss strategic and tactical relationships between IT architects and project (portfolio) management by aid of practitioner frameworks and industry standards. The overarching literature review (sections 2.3 & 2.4) provides further information to answer RQ4.

4 Methods

4.1 Selection of methods

The research strategies and the methods of data collection and evaluation are founded on the philosophy of pragmatism. Ontology, epistemology, and axiology are taken on as apposite for solving the problems (Saunders, Lewis, & Thornhill, 2016). Pragmatists focus on outcomes and solutions and have free choice in terms of techniques that are suitable for the purpose (Creswell, 2013).

Articles 1, 5, and 6 combined concepts from practitioner publications and industry standards, whereas Article 2 reviewed the academic literature and discussed coherence of foundational theoretical perspectives. Two articles in the dissertation applied content analysis, which is a qualitative research method with a quantitative evaluation method. An innovative approach was content analysis on IT value in annual reports from IT vendors (Article 3). Another method was content analysis of job advertisements for IT architects. This is basically explained in Article 4 and is further elaborated here.

Most IT job studies are surveys; few IT job studies analyze job advertisements (Wilkerson 2012, p. 86). This dissertation is the first to employ content analysis on job advertisements for examining the tasks and skills of IT architects; these have previously been studied in other ways: through interviews (Casas, Sánchez, & Villalobos, 2017; Figueiredo et al., 2012, 2014), workshops (Akenine, 2008), or surveys (Casas, Sánchez, & Villalobos, 2017). Apart from the shortcomings that were indicated in the overarching literature review, these studies presented outcomes from subjective perspectives of research participants. Content analysis provides more objectivity, as described in the next section.

With the aid of coding software, Ho and Frampton (2010) analyzed subscripted contents from interviews with IT architects, which increased objectivity of data collection. However, their focus was on actual IT architect skills, whereas the author searched for the required skills and tasks of IT architects. Content analysis on job advertisements of IT architects was selected for three main reasons. First, it delivered results on necessary tasks and skills rather than on actual tasks and skills. Second, content analysis on documents is more objective than content analysis of interviews or other qualitative methods. Third, this study is the first that applied content analysis to job ads for IT architects. The following sections expound on the characteristics of content analysis and its application with job advertisements.

4.2 Content analysis

Content analysis was the empirical research method, which was chosen to find the most significant customer values from IT products/services and to recognize tasks and skills from IT architects. Content analysis is a mature scientific method that adheres to the principles of objectivity, systematic structure, and generalizability. It is broadly used in numerous scientific disciplines (e.g., communication research) but scarcely employed in IT research (Surakka, 2005, p. 104; Todd, McKeen, & Gallupe, 1995, p. 24). Content analysis is recognized in research for its objectivity but is different from established and popular IT strategy research techniques such as questionnaires, interviews, or group techniques that "are based on collective, subjective perceptions of current practice" (Todd, McKeen, & Gallupe, 1995, p. 24).

Content analysis helps answer research questions that have a wider exploratory purpose (Saunders, Lewis, & Thornhill, 2016). One purpose of this methodology is to pose the features of the content. It is based on coding and categorizing qualitative data for quantitative evaluation. Quantitative expressions can be made that provide specific and objective data regarding the phenomenon and yield meaningful results (Prasad, 2008)—for example, concepts or categories, which describe the phenomenon (Sandelowski, 1995). Textual data create categories and explanations (Pope, Ziebland, & Mays, 2000).

The data collection and the numerical analysis of document contents strove for objectivity and avoided conscious bias. An outstanding feature of content analysis is its "non-disturbance"—that is, data occur independent from research activity (Surakka, 2005, p. 104). In contrast to the data collection, the discussions of findings and conclusions are interpretations (Pane & Pane, 2004, p. 51) and, hence, value laden.

4.2.1 Content analysis on IT job ads

The roles in organizations are stated in job descriptions and express the expectations of the organizations on people that potentially take on that role (Gallivan, Truex, & Kvasny, 2004, pp. 70–71; Peppard & Ward, 2004, p. 181). Content analysis on job ads is appropriate because data is organic and naturalistic; in practice, it reflects desired job characteristics from the views of human resource searchers and experts (Harper, 2012; Verma, Yurov, Lane, & Yurova, 2019). Job advertisements represent ideal attributes of particular jobs; they do not reveal what candidates or employees actually provide (Harper, 2012). Ideal attributes are posted to attract applicants with the best skills to meet the needs of the organization (Todd, McKeen, & Gallupe, 1995, p. 24). Skills in job advertisements reflect what organizations actually value, rather than the skills that exist within the organization (Todd, McKeen, & Gallupe, 1995, p. 25). Further, researchers consider job ads as unobtrusive measures of market demands on skills (Gallivan, Truex, & Kvasny, 2004, pp. 70–71) and clear definitions of job categories can be made in terms of skill demands (Amit, Yurov, Lane, & Yurova, 2019). Thus, jobs advertisements are imperative data sources for investigations of skill requirements (Pejić–Bach, Bertoncel, Meško, & Krstić, 2020, p. 418).

There are two accepted ways for conducting a content analysis on job ads—one is content analysis by manual coding and the other is automated text analysis by software, also referred to as text mining (Pejić–Bach et al., 2020, p. 418). Manual content analysis takes substantial human efforts and provides richer insights from smaller samples sizes in contrast to text mining, which takes little time for examining a large number of samples (Pejić–Bach et al., 2020, p. 418). However, manual coding is preferable because human judgement can consider the context of codes (Harper, 2012).

IT scientists have been utilizing content analysis of job ads since the middle of the 1990s (Gallivan, Truex, & Kvasny, 2004, pp. 70–71). Harper (2012) reviewed 70 studies that applied content analysis on job ads in library and information science. He observed a growing tendency of this method between 2000 and 2010 and described how content analysis was used. Typical was purposive sampling for large sample sizes as well as little use of automatic text mining, inferential statistics, and complementary empirical methods. Mixed methods are uncommon in job ads analysis (Wilkerson 2012, p. 86). Approximately 90% of the studies that Harper (2012) reviewed were conducted in one country only. The USA was the most widely selected country for such studies (76%). An overview of 11 content analyses for IT roles reviewed by the author is presented in Table 2 of Article 4. These reviews confirm Harpers (2012) remarks, except the one on the use of software for text analysis (six out of eleven).

4.2.2 Frequency

Frequency of codes is a recommended evaluation technique for content analysis (Prasad, 2008; Stemler, 2001). Specific codes (e.g., words, phrases) are searched in a text and counted to infer significance (Myers, 2013, p. 172; Vaismoradi, Turunen, & Bondas, 2013, p. 401, Verma et al., 2019, p. 245). The frequency of a code in a text indicates its relevance (Pejić–Bach et al., 2020, p. 420) in answering academic questions regarding "most typical" patterns (von Eye, 1996, p. 302). For example, skill types can be ranked on their "frequency of mention" in job advertisements (Todd, McKeen, & Gallupe, 1995, p. 12) or on the number of job advertisements that contain at least one skill of that skill type (Verma et al., 2019). The ratio of job ads that include at least one code in the total sample is often expressed in percentages (e.g., Pejić–Bach, 2020, p. 420; Surakka, 2005; Webb, 2006). Krippendorff (2004, p. 45) denoted the evaluation of frequency of codes as attribution analysis. In a comparative attribution analysis, two or more lists of percentages for codes can be compared to find the similarities and differences among them (Krippendorff, 2004, p. 202). This method was used to compare tasks and values of different types of IT architects.

4.2.3 Deductive and inductive approaches

Documents were analyzed following the step models from Mayring (2000). One step model is deductive and is founded on a selected theory; the other step model is for inductive category development from the content.

The deductive method was appropriate to examine the customer values from IT products. Annual reports of 32 global market-leading IT vendors were studied to detect patterns and correlations of coded content. Deductive content analysis uses coding categories from theory (a priori coding) (Stemler, 2001, p. 2). The coding categories were based on a theory from Treacy and Wiersema (1993, 1995). The codes were taken from the descriptions of the customer-value disciplines—that is, product leadership, operational excellence, and customer intimacy. Frequency was the selected as the evaluation method (Prasad, 2008; Stemler, 2001). The numbers of context units found in an annual report were recorded. The strength of associations between customer-value categories was determined by multivariate statistical analysis (Cohen, Cohen, West, & Aiken, 2003).

The inductive approach for content analysis was used for recognizing the tasks and the skills of IT architects in job ads. The inductive method is suitable if no earlier research exists with regard to the phenomenon (Elo & Kyngäs, 2008, p. 107). The conventional content analysis (Hsieh & Shannon, 2005) is an inductive coding approach that derives codes from data. A coding scheme was developed during data analysis as codes emerged (Stemler, 2001, p. 2) in the job advertisements. Meaning units were manually searched in 112 job postings and allocated to categories for tasks and skills. These categories were created from data and iteratively readjusted until saturation (Hsieh & Shannon, 2005, p. 1286).

The selected methods for content analysis on job ads for IT architects comply with established research techniques from the literature (Harper, 2012): manual content analysis (intense research efforts that yield rich data with comparatively low sample size), purposive sampling, no complementary empirical methods, evaluation by frequency of codes, presentation of tasks and skills as percentage value (relative number of ads containing at least one code to the total number of job ads). This research assessed job ads data from two countries (Germany and the United Kingdom), whereas approximately 90% of comparable research designs focus on merely one country (Harper, 2012).

Most content analyses on IT job ads focus on needed skills and only a few studies assess tasks. This dissertation investigates both tasks and skills to learn about the role of the IT architect. In addition, comparative attribution analysis of tasks to identify types of architects is another unique characteristic of this work.

4.3 Conceptual synthesis

Conceptual researchers suggest new relationships and/or integrate ideas. The objectives of conceptual research are to identify logical relationships among constructs and to propose relationships instead of verifying these using data. Conceptual articles connect disciplines, offer perspectives at various levels, and, therefore, help develop the scholars' way of thinking (Gilson & Goldberg, 2015). The bridging of backgrounds from different disciplines and the combination of ideas are the main characteristics of an ideal review article (Short, 2009, p. 1316). Thus, conceptual papers can be viewed as highly advanced literature reviews.

"Conceptual thinking may involve the visual representations of ideas in the form of typologies, process models, figures, flow charts, or other visual depictions." (MacInnis, 2011, p. 140). Every conceptual article of this dissertation illustrates thoughts and propositions in the form of models or process charts. The conceptual methods were applied in building the sequential chain for IT value planning (Article 1) and for identifying the IT architecture and project (portfolio) management relationships (Articles 5 and 6). Overall, these methods were beneficial for answering RQ 4: "How are IT architects linked to other roles in IT planning?"

The examination of practitioner frameworks on logical connections is a special feature of this dissertation. The method is similar to a literature review; however, practitioner frameworks were studied in addition to contemporary scientific articles. The review of frameworks written by practitioners for application in actual businesses can be considered as an observation of practices. The positions resulting from conceptual synthesis are beneficial to establish new research directions and new agendas (Buhl, Fridgen, König, Röglinger, & Wagner, 2012, p. 177).

5 Content and main outcomes of the published articles

5.1 Article 1

Bridging IT requirements to competitive advantage: The concept of IT value planning

Purpose/content: This article introduces the concept of IT value planning that portrays the relationship between competitive advantage as defined in a firms' strategy and requirement collections as part of IT projects. This conference paper presents logical links between business strategy and requirements for IT products. Expected relationships between requirement categories and competitive impacts are presented along with the research approach.

Main outcomes and suggestions: The process of IT value planning is drafted; it founds on artifacts from sequential planning phases. This helps understand the need to verify IT product requirements in view of its strategic contribution to competitive advantage. Knowledge of the links between IT products and competitive advantage enable practitioners to inspect requirements in IT planning. This paper does not provide scientific insights but shows procedural and conceptual ideas as a foundation for Articles 3, 4, 5, and 6.

5.2 Article 2

Cohesion of RBV and industry view for competitive positioning and for strategic IT planning

Purpose/content: This review paper examines supplementation of leading theories on competitive advantage and combines the most influential concepts on firm resources and industrial forces to create a complementary picture for competitive positioning. Seminal contributions from Edith Penrose (1959) and Michael Porter (1980) as well as subsequent research were investigated on connectivity and togetherness. A strategy literature analysis shows that these traditional theories complement each other. A review of the IT strategy literature reflects that the cohesion of the RBV and the industry view is also pertinent in the IT realm. The article includes conceptual discussions of resources, capabilities, and assets that are defined by recalling the resource descriptions from Penrose (1959) and by considering capabilities as value chain activities that combine resources.

Main outcomes and suggestions: A conceptual model for competitive positioning extends existing theories on the complementarity of the RBV and the industry view. It provides a broader picture including SWOT and macro-environmental factors that impact both sides—the endogenous and the exogenous. Inside-out constructs on resources and capabilities must match outside-in constructs on industry and markets in order to achieve competitive advantage. This article proposes adopting both views simultaneously for the formulation of both business and IT strategies. IT resources are combined to create capabilities that are qualified IT services supporting value chain activities. IT resources can be acquired in markets, while (IT) capabilities must be developed within organizations. IT planning is a capability that connects internal and external processes for value creation. The conceptual model for competitive positioning is useful for strategic IT planning, including IT-business alignment.

5.3 Article 3

Operational excellence as the main customer value: information technology vendors′ perspective

Purpose/content: This paper explores the connection between IT products and customer value. It aims to identify customer-value disciplines and discover the patterns among them. The phenomena may be studied from the perspective of the customer or the IT vendor. In this paper, the latter is selected. This research investigates the product descriptions from IT vendors and analyzes patterns and correlations of coded content. The annual reports of 32 global market-leading IT vendors were examined through direct content analysis. Codes for customer-value disciplines (Treacy & Wiersema, 1993, 1995) and customer advantage were searched for in the product and business descriptions of the annual reports.

Main outcomes and suggestions: Half of the annual reports mention the competitive advantage of buyers; 84% of the sampled reports relate to customer-value disciplines. Moderate positive and monotonic relationships were detected between customer value disciplines. Operational excellence is the most prevalent value discipline followed by product leadership. Further, the customer-value disciplines described by Treacy and Wiersema (1993, 1995) are applicable for classifying customer value created from IT.

Renowned authors claimed that IT products deliver value and provide competitive advantage (Clemons & Row, 1991; Drnevich & Croson, 2013; McAfee & Brynjolfsson, 2008; Peppard & Ward, 2004, 2005; Venkatraman, Henderson, & Oldach, 1993), but they did not provide corresponding empirical proof. Data from Article 3 provides evidence for this statement by providing positive moderate correlations between competitiveness and two value types (customer intimacy, product leadership).

5.4 Article 4

Types of IT architects: A content analysis on tasks and skills

Purpose/content: This research highlights the roles of IT architects by investigating the required activities and skills demanded in the human resources market. This research works out characteristics relevant to IT architects and provides detailed catalogs of the tasks and skills of IT architects. Manual content analysis was applied on job advertisements, and categories were inductively developed and readjusted by allocating meaning units until saturation: 2438 meaning units were assigned to 37 task categories and 49 skill categories.

Main outcomes and suggestions: IT architects must provide high proficiency in social skills, particularly verbal and written communication, teamwork, and leadership. System and technology knowledge are both of great importance and methodological backgrounds in engineering, design, development, and architecture are crucial. Business and legal knowledge is required mainly for enterprise architects.

Three main types of IT architects with distinctive profiles were identified:

- Enterprise architects align IT strategies with the business and are responsible for methods, governance, policies, principles, and processes. They develop roadmaps for IT products/services, define reusable artifacts, and create structural models.
- Solution architects specify system requirements and functions as foundations for detailed solution or system designs. These architects specify hardware and software components and the interaction between them.
- Software architects collect and analyze software requirements and design the software accordingly.

Both enterprise architects and solution architects are leadership roles that collaborate with various stakeholders. Data from job ads pointedly reveal that both roles engage in projects.

5.5 Article 5

Connecting enterprise architecture and project portfolio management: a review and a model for IT project alignment

Purpose/content: Based on the findings related to the role of the enterprise architect, this conceptual paper explores the coherence of enterprise architecture (EA) and project portfolio management (PPM) and their functional alignment to the business and to IT projects; it is founded on concepts from practitioner frameworks and newer IT research. Connections, structural similarities, and common grounds from both areas were searched. The article views strategic and tactical alignment of EA and PPM and elaborates on the emerging notion of IT project alignment.

Main outcomes and suggestions: This paper reveals common grounds and structural attachment of EA and PPM, substantiates relations between them, and demonstrates their cohesiveness. An IT project alignment model is suggested that integrates EA and PPM over two levels. At the strategic level, EA and PPM analyze requirements, feasibility, value, risks, and dependencies. The results from both sides are combined to jointly propose, select, prioritize, and schedule IT projects through road-mapping. At the tactical level, EA and PPM provide governance through frameworks, policies, and principles to guide solution architects and project managers, respectively.

5.6 Article 6

Collaboration of solution architects and project managers

Purpose/content: This paper utilizes data from Article 4 (solution architects supporting projects) and ideas from Article 5 (the tactical level governed by EA and PPM). Like Article 5, this paper is conceptual and combined ideas from practitioner publications and from latest academic research. The purpose of this paper is to gain a deeper understanding of the relationship between IT architecture and project management. IT architecture and project interrelatedness were highlighted by analyzing the tasks and skills of solution architects and project managers in terms of supplementation and work organization.

Main outcomes and suggestions: This conceptual paper bridged ideas from solution architecture and project management into an integrated model for collaboration over an IT solution life cycle. Technology skills from solution architects complement planning and organizational skills from project managers for accurate requirements and scope definitions. Solution architects specify requirements and create appropriate IT solutions for a firm, whereas project managers focus on organizing the work and managing personnel. Close and structured collaborations between project managers and solution architects enhance IT-business alignment and increase the efficiency and effectiveness of IT projects.

6 Overarching discussion

The overarching discussion chapter describes the significance of the findings in the articles in relation to the research questions and the reviewed literature. It explains how the outcomes from the articles help answer the overall research questions as phrased in chapter 3. The results are contrasted and compared to the relevant studies from the overall literature review. Based on these learnings, conceptual propositions for IT value and competitive advantage are presented and recommendations for IT planning by architects and project (portfolio) managers are made. The discussion chapter also highlights the theoretical and practical contributions of this dissertation as a bundle of interrelated articles. Finally, limitations and methods for future research are indicated and the key points are summarized. The overarching discussion does not repeat the discussion points and conclusions from the individual articles; its main purpose is to elucidate the relatedness of the articles and to highlight enhancement of knowledge in IT planning from the answers to the overall research questions.

6.1 Answers to the overall research questions

6.1.1 RQ1: What strategic view is appropriate for the analyses of IT value and competitive advantage?

The RBV is the prevalent framework of the analysis of competitive advantage from IT; however, it is insufficient because it neglects the external view on markets, customers, products, etc. (OLR, section 2.2). Priem and Butler (2001) noted the need for an integrative view.

Article 2 provides in-depth analyses on the coherence of the RBV and Porter's (1980) industry view for general business strategies and IT strategies. A review of the IT literature (Article 2, section 2.5) provided ample arguments that IT planning must integrate internal resource-based views and external views on the industry, including SWOT analysis and the macro-environment (PESTEL analysis). The model for competitive positioning (Article 2, Figure 1) is instrumental to IT-business alignment. The combination of both views improves the analysis of competitive advantage but still lacks the customer value perspective.

For competitive advantage, rareness and value are more significant for product/services (customer-value view) than for the resources and capabilities of a firm (resource-based view). As Martin (2014, p. 83) noted, "capabilities themselves don't compel a customer to buy. Only those that produce a superior value equation for a particular set of customers can do that." Further, differentiation from competitors (industry view) is mandatory but insufficient for competitive advantage; the customer-value view is needed in addition.

In the overarching literature review, the relationship between IT value and competitive/comparative advantage is revealed (subsection 2.1.6). Data from Article 3 provide significant correlations between codes for competitiveness and customer value discipline. Therefore, a concurrent analysis of competitive advantage and customer value is suggested. For an integrated analytical model, the RBV (Penrose, 1959), the industry view (Porter, 1980), and the customer value disciplines (Treacy & Wiersema, 1993 1995) are proposed. All views are necessary but insufficient if considered alone. The RBV neglects markets and customers, the industry view underrates resources and capabilities, and the customer value-based view is fully focused on clients. All views complement each other and must be combined.

Figure 2 displays an integrated model for competitive/comparative advantage. It is an advancement of Figure 1 in Article 2 (conceptual model for competitive positioning) that takes the conclusions from section 2.1 (OLR, IT value and competitive advantage) into consideration.

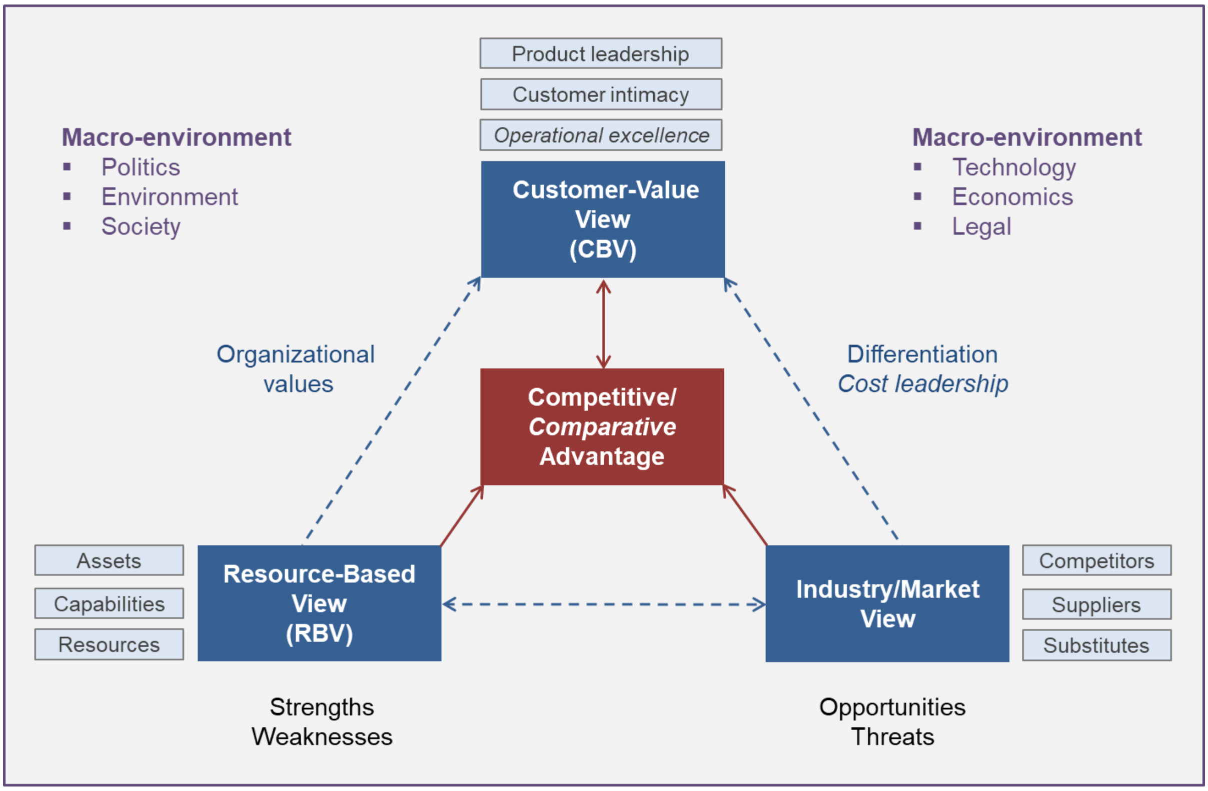

Figure 2: The integrated model for competitive/comparative advantage (Source: author)

The RBV is suitable for explaining organizational values that are preconditions to customer value creation. The value disciplines from Treacy and Wiersema (1993, 1995) are useful to strategically formulate customer value. These correspond to the generic strategies given by Porter (1980).

6.1.2 RQ2: What are the required tasks and skills of IT architects?

Tasks and types of IT architects

The job content analysis in Article 4 yielded 37 task categories required for IT architects (Article 4, Table 4). These comply with task descriptions of IT architecture in the literature (OLR, subsection 2.4.1):

- integration of components, systems, and interfaces (Croteau & Bergeron 2001; Earl, 1989; Keen, 1991; Zachman, 1987)
- specification of IT and business requirements (Duncan, 1995; Earl 1989)
- setting and ensuring standards, rules, and specifications (Duncan, 1995; Keen, 1991; Kettinger, Marchand, & Davis, 2010; Sullivan, 1985)
- providing guidance (guidelines) and governance (Croteau & Bergeron 2001; Duncan, 1995; Earl, 1989; Henderson & Venkatraman, 1999)

- defining policies (Ross, 2003)

While the terms *IT resources* and *IT capabilities* are often used in the IT RBV literature to describe architectural tasks and to define, select, and combine these (Croteau & Bergeron, 2001; Duncan, 1995; Keen, 1991; Ross, 2003; Sullivan, 1985), they were not found in the job ads. Instead, the according activities are included in the task categories “create/propose designs, developments, solutions, products, applications” and “create/propose/manage architecture.”

The implementation of IT infrastructures (Earl, 1989; Henderson & Venkatraman, 1999) is not reflected in the sampled job ads of IT architects. However, codes were found for *planning* and *support* of implementation.

From the content analysis of job ads and the comparative attribution analysis (Krippendorff, 2004) in Article 4, three types of IT architects are suggested: enterprise architects, solution architects (synonym: system architects), and software architects. This typology agrees with that of Figueiredo et al. (2012) (OLR, subsection 2.4.2, Table 8). The tasks of these roles also fit to the tasks and responsibilities listed in Table 7 (OLR, subsection 2.4.2). The business architect suggested by Akenine (2008) is not supported by the job ads data. This role is similar to that of the business analyst as proposed by IIBA (2015).

In accordance with Foorthuis and Brinkkemper (2008), two architectural levels are suggested. The strategic level for enterprise architects and the project level for solution and software architects. The strategic role of the enterprise architect that connects IT and business strategy (Ross, Weill, & Robertson, 2006; p. 9, p. 48; Tamm et al., 2011) is also backed by the job ads data (57.4% of job ads). Integration and standardization of IT resources have been regarded as key objectives of enterprise architecture (Bradley et al., 2011; Fonstad & Robertson, 2006; Ross, Weill, & Robertson, 2006) but cannot be confirmed from the job ad data. Integration as an architectural task was distinctly found with greater frequency for solution architects (32.6%) and software architects (40.0%) than for enterprise architects (9.3%). Standardization is an obligation for each architect type; the corresponding code appeared with almost equal frequency in the job ads (enterprise architect: 31.5%; solution architect: 30.2%; software architect: 33.3%).

Casas, Sánchez, & Villalobos (2017) presented 23 skills for IT architects that in fact describe activities (OLR, subsection 2.4.3, Table 10). The phenomenon of tasks being mixed with skills was also observed in the job ads analysis. The items from the authors comply with the tasks identified in Article 4. However, the following items differ:

- development of business strategies
- definition of the scope of business projects
- management of IT projects
- building, implementing, operating, and management of designs

These activities are *supported* by IT architects, but other roles have the main responsibilities (e.g., business managers, project managers). The activity “recommend implementation projects prioritization” was not found in the job ads but is suggested in Article 5.

A detailed list of architect tasks is provided in Article 4 (Table 4). The proposed IT architect types are described in section 4.5 of Article 4.

Skills of IT architects

The list of 49 required skills for IT architects is another key result from Article 4 (subsection 4.4.3, Table 5). The research results provide more details (number of needed skills) and a useful grouping of these (social, technical, methodological, standards, frameworks, business, certifications, legal/regulatory). Such detailed IT architect skill sets have not been provided before.

A skill analysis at the aggregated level revealed that all types of IT architects must provide strong managerial, technical, and methodological skills. The job skill categories given by Wilkerson (2012; OLR, subsection 2.2.5) are applicable to the patterns that were found for different types of IT architects (Article 4, Table 6). All IT architects must provide a high level of interpersonal skills; organizational and core managerial skills are more pronounced for enterprise architects, while solution architects and software architects require deeper technical skills.

Enterprise architects provide managerial IT skills that are sources of sustainable competitive advantage (OLR, subsection 2.2.5). In contrast, the required skills for solution architects and software architects are more technical than managerial. Technical skills are also important for competitive advantage but are not an attribute of sustainability because technical skills are not unique and are "mobile,"—that is, they are acquirable on job markets (Mata, Fuerst, & Barney, 1995; Ray, Muhanna, & Barney, 2005, p. 628).

In comparison to previous research, the top five skills given by Ho and Frampton (2010) and those given by Unde (2008) can be confirmed (OLR, subsection 2.4.3). The outcomes from Akenine (2008) also fit with the results from the job ads analysis (OLR, subsection 2.4.3; Article 4, subsections 4.4.3 & 4.4.4). However, these prior studies do not provide rich details.

6.1.3 RQ3: What type of value is created by IT architects?

The overall literature review indicated that the notion of IT value can be interpreted in numerous ways. An integrated definition for IT value was induced from previous research; it combines customer value and organizational values (OLR, subsection 2.1.5). This definition established the theoretical foundation for examining value from IT architects.

Customer value from IT architecture

The customer value disciplines operational excellence, product leadership, and customer intimacy (Treacy & Wiersema, 1993, 1995) were suggested by Tallon (2007, p. 258) for IT-value research. Their appropriateness to mirror IT value was empirically tested. Article 3 revealed that the customer value disciplines are relevant and suitable for expressing IT value. Codes for customer-value disciplines were searched for in the product and business descriptions of annual reports from world-leading IT vendors. IT vendors play an essential role in IT planning and IT value creation; they connect to IT architects (OLR, subsection 2.4.7)—84% of the sampled annual reports from IT vendors relate to the customer-value disciplines as proposed by Treacy and Wiersema (1993, 1995). Thus, these customer-value disciplines are useful to describe value from IT planned by IT architects.

Ross, Weill, and Robertson (2006) used these value types to describe value from enterprise architects. In section 2.3 of the overarching literature review, various means of how IT architects generate customer value are revealed (e.g. IT impacts, global business approaches, architecture styles). It can be concluded that IT architects create all types of customer value.

Table 2 in subsection 2.1.5 (OLR) presents 88 values activities/indicators found in the literature; 40 of these have been mapped to customer value disciplines. Further, 20 out of these 40 (50%) customer value activities/indicators were logically allocated to operational excellence, while 15 line items in Table 2 (37,5%) were assigned to product leadership. A similar picture on the prevalence of operational excellence is gained from the analysis in Article 3. The main customer value in the annual reports from IT vendors was operational excellence (58%), followed by product leadership (31%). From this data it may be argued that one of the main drivers of IT investments is process efficiency to achieve cost advantages for customers. However, this statement is daring; the implication of the relative shares of customer value from IT (architects) is a suggested future research topic.

Organizational value from IT architecture

In subsection 2.1.5 of the overarching literature review, organizational values were defined from the categorization of IT value activities/indicators in the literature. These organizational value types were compared with the activities identified in job ads for IT architects (Article 4, Table 4). The IT architect tasks that were assignable to organizational values are presented in Table 11.

Organizational value	Architect tasks	Enterprise Architect	Solution Architect	Software Architect
Strategic planning/decision-making	Ensure compliance with business/**business strategy**	57,4	41,9	26,7
	Develop/maintain roadmap/**product strategy/IT strategy**	51,9	18,6	20,0
	Create/propose/manage **architecture**	44,4	46,5	73,3
	Define/specify requirements	29,6	46,5	40,0
	Review (assess, validate,....)/**Decide** designs, developments, solutions, products, applications, SW	25,9	20,9	20,0
Flexibility/agility	**Integrate** (software, systems)	9,3	32,6	40,0
	Create/review/enhance/maintain design or development guidelines, best practices, concepts, **standards**	31,5	30,2	33,3
	Ensure consistency/alignment/adherence/compliance to **standards**	22,2	14,0	13,3
	Create/maintain/enhance **platforms**	14,8	18,6	20,0
Strategic alliances/supplier relationships	Research market/technology/trends/**products**	16,7	30,2	40,0
	Purchase/procure/source, for example, infrastructure, assets, tools; **manage vendors**	13,0	9,3	0,0
	Build/maintain **relationships**	7,4	4,7	26,7
Enhanced skills and capabilities	Create/review/enhance/maintain architecture strategy, framework, approaches, methods, governance, policies, principles, rules, processes, tools	61,1	37,2	40,0
	Define reusables, blueprints, building blocks, patterns, templates, generic HW, applications, references	29,6	9,3	13,3
	Provide training/presentations	3,7	20,9	6,7

>= 25%

Table 11: IT architects' tasks for organizational value with percentage shares of job ads that contained the tasks (Source: author).

Numerous tasks from Table 4 (Article 4) were not assignable to organizational values; they contribute to customer value creation (e.g., customer support, quality assurance, efficiency improvement, and process modeling) or are general activities (e.g., stakeholder communication, leadership, and support of other internal tasks). The numbers in Table 11 represent the percentage share of job ads that included the tasks. The blue highlighted cells in Table 11 represent values that are equal to or higher than 25% for better visibility of significant accumulations.

Table 11 indicates that all types of IT architects provide organizational value through strategic IT planning and decision-making. IT architects create architectures and develop IT product strategies that comply with business strategies; they also specify the requirements (i.e., technological needs based on business needs) and make decisions on solution designs and products. The enterprise architect type dominates in this organizational value category.

Further, IT architects contribute to organizational flexibility through standardization and integration of IT. Standardization and integration improve processes (Ross & Weill, 2002). Flexible IT platforms must provide ways for future developments and organization-wide initiatives (Wade & Hulland, 2004; Weill & Aral, 2004). Developments of IT platforms are also significant for flexibility but did not stand out in the job ad samples (14.8%–20.0%). Agility is a special feature of software development (Beck et al., 2001). However, the role of architects in software development remains unclear (Article 6, section 6.6) and is an interesting subject for further research.

Surprisingly, the connection between IT architects and IT vendors, as explained in the literature, (OLR, subsection 2.4.7) was not evident in the job ads data, except for the exploration of new products by solution and software architects that requires the involvement of IT vendors. The task “build/maintain relationships” was at the bottom of the task ranking for solution architects (4.7%); this was also very low for enterprise architects (7.4%) in contrast to software architects (26.7%) (Table 11; Article 4, Table 4). The task “purchase/procure/source, for example, infrastructure, assets, tools; manage vendors” showed low percentages for enterprise architects (13.0%) and solution architects (9.3%) and no codes for software architects (0%) (Table 11; Article 4, Table 4).

IT architects improve organizational capabilities by creating and fostering approaches, methods, processes, etc. for IT planning. Enterprise architects define “reusables” and building blocks for flexibility. Modularity is a key word in the literature (e.g., Weill, Ross, & Robertson, 2006, pp. 181-186) that relates to flexibility/agility (Gong & Jansson, 2019, p. 4); it was only found twice in the samples. However, the idea of modularization was indicated by the terms building blocks, reusables, patterns, etc. These are capabilities that IT architects develop for organizational flexibility, thereby enabling prompt responses to market changes or to establish initiatives that drive markets. Thus, IT architects create dynamic capabilities (Teece, Pisano, & Shuen, 1997).

Gong and Jansson (2019) reviewed the literature on the value of enterprise architecture and concluded that enterprise architecture enables value creation but does not provide value by itself. Gong and Jansson (2019) failed to distinguish customer values (profit generation) from organizational values (“enablers” of customer value). However, they offered nine value categories that are compared to the value categories from this dissertation (Table 12).

All organizational value types and all customer value types from this doctoral thesis are reflected in the enterprise architecture value categories from Gong and Jansson (2019). This supports the validity of the findings for RQ3. The implementation of strategies in cooperation with project (portfolio) management was defined as “transformational” value (Gong & Jansson, 2019, p. 4), whereas this dissertation presents corresponding activities as part of the “model for IT value planning” that is presented in the following subsection (Figure 3).

EA value category (Gong & Jansson, 2019)	**Value descriptions** (examples) (Gong & Jansson, 2019)	**Corresponding value category** (author)
Strategic and political	IT-business alignment, decision-making in IT investments, compliance	Organizational value: strategic planning/decision-making
Flexibility and agility related	IT flexibility, agility (market responsiveness)	Organizational value: flexibility/agility
Related to integration and interoperability	Integrate business processes, IT resources	Organizational value: flexibility/agility
Inter-organizational	Improve acquisition management, external relationship management	Organizational value: strategic alliances/supplier relationships
Communicational	Improvement of communication	Organizational value: enhanced skills and capabilities
Related to knowledge management	Knowledge sharing between business and IT staff, knowledge source for	Organizational value: enhanced skills and capabilities
Economic	Reduce IT costs, reduce operational costs	Customer value: operational excellence
Others	Increase spending on emerging technology and innovation	Customer value: product leadership
Others	Ensure client orientation (client satisfaction)	Customer value: customer intimacy
Others	End-to-end security, service analysis, information management	Not applicable
Transformational	Navigate from strategy to the delivery of projects and portfolio management	Not defined as value. Presented as model for IT project alignment.

Table 12: Enterprise architecture values from the literature review (Sources: Gong & Jansson, 2019; author)

6.1.4 RQ4: How are IT architects linked to other roles in IT planning?

The relationship between IT architects and project (portfolio) management

Several roles of IT architects have been highlighted in section 2.4 of the overall literature review. It has been reflected that IT architects participate in projects and collaborate with project (portfolio) managers (e.g., Andersen, 2016; Foorthuis & Brinkkemper, 2008; Figueiredo et al., 2012; Ross, Weill, & Robertson, 2006). The relationships among these roles combine technical and managerial IT skills for competitive advantage (OLR, subsection 2.2.5).

The examined job ads (Article 4, Table 4) confirm the linkage between IT architects and projects. Over half of the sampled enterprise architect job ads contain codes for "project support" (50.9%). The relative number of job ads for solution architects with codes for "project support" is slightly lower (46.5%), whereas the corresponding value for software architects is significantly lower (13.3%). It may be concluded that most software architects work on agile projects in which the role of the project manager is unknown (Article 6, section 6.6). Thus, links between IT architects and project managers assume predictive approaches (Article 6, section 6.6).

Enterprise architects act at the strategic level and solution architects perform at the project level (OLR, subsection 2.4.2, Article 4). Project portfolios are related to the business strategy

(OLR, 2.4.4.) and are linked to subordinated levels such as programs or projects (Article 1, Figure 1). Yet, the literature does not provide any insights on strategical and tactical structures between IT architecture and project (portfolio) management (Article 5).

Article 5 suggests logically connecting enterprise architecture with project portfolio management because both align to the business strategy. EA and PPM must align when it comes to selecting and prioritizing projects. The scope of EA is within IT (technical goals and constraints), while PPM considers all the projects affecting the organization and its goals and constraints. EA and PPM analyses include requirements, feasibility, value, risks, and interdependencies. The results from both sides are combined to jointly propose, select, prioritize, and schedule IT projects. Further, roadmapping is a suitable approach to bring together plans from EA and PPM.

Data from Article 4 reveal that solution architects support implementation (37.2%) much more than enterprise architects (20.4%). This supports the statement that solution architects work more in tactical ways—that is, they are more project-oriented. Article 6 elaborates on the relationship between solution architects and project managers at the tactical level. In projects, translations from strategic requirements into technical requirements require competencies on the part of the solution architect. Technology skills from solution architects complement planning and organizational skills from project managers for accurate elicitation of requirements, solution design, and project planning.

The described relationships were conceptually associated based on theories and practitioner publications (Articles 5 and 6). They were not tested in real-life settings; further research is required to provide suggestions in this regard.

Links and levels for governance

Both strategic functions EA and PPM govern their subordinated roles at the tactical level through frameworks, policies, principles, etc. Enterprise architects guide solution architects (Article 5, subsection 5.4.1), while project portfolio managers govern project managers (Article 5, subsection 5.4.2). The goals are to increase IT planning efficiency through standardization, process homogeneity, and consistency.

Senior managers participate in IT planning (Sabherval et al., 2019, p. 471) and are members of committees that provide IT governance (OLR, subsection 2.4.6); senior managers make IT investment decisions in this manner. As an alternative approach, Jonas (2010, p. 824) suggested that PPM makes decisions on IT investments based on standards defined by the senior management. These standards determine the mechanisms for project evaluation, selection, and prioritization. Senior managers delegate decision-making rights to PPM within a portfolio that they approve. This is in line with Müller (2019, p. 8), who delineated governance at three levels: the top business level, the project portfolio level (over all projects), and the project level. These suggestions from Jonas (2010) and Müller (2019) fit with the ideas from Article 5: decision-making for project selection/prioritization is done at the PPM level from which all projects are governed. The approval of the entire portfolio and the setting of governance standards are part of the business-project alignment between business strategy and PPM (Article 5, Figure 1).

IT-business alignment

The literature is conflicting with regard to the roles for IT-business alignment that represent the IT side—it may be senior IT managers or IT architects (OLR, subsections 2.3.2 & 2.3.3). However, there is a strong tendency towards IT architects, specifically the enterprise architects (OLR, subsection 2.3.3; Article 4). Over half of the job ads for enterprise architects hit the code “ensure compliance with business strategy” (57.4%) (Article 4, Table 4). Thus, the data of this research supports the proposition that enterprise architects play a key role in IT-business alignment. The integrated model for competitive/comparative advantage (subsection 6.1.1, Figure 2) enables IT architects to align IT to the business with senior managers from the business and from IT. This model includes analyses of strengths, weaknesses, opportunities, and threats (SWOT), which are performed by IT architects (Casas, Sánchez, & Villalobos, 2017, p.113).

A model for IT value planning

Figure 3 illustrates the proposed links in a planning chain to create IT value. It displays the key ideas of this dissertation from the overarching literature review and from all the articles. EA and PPM align to the business strategy and jointly evaluate, select, and prioritize projects (i.e., the process of IT project alignment). EA and PPM govern the project level and enable the selection of projects that are implemented by project managers and solution architects. Project managers and solution architects are skilled managerial resources who build unique capabilities (by the aid of IT) for customer value and competitive advantage (or capabilities for operational efficiency and comparative advantage). Further, IT architects, IT planning processes, and resulting capabilities are sources of sustainable competitive advantage.

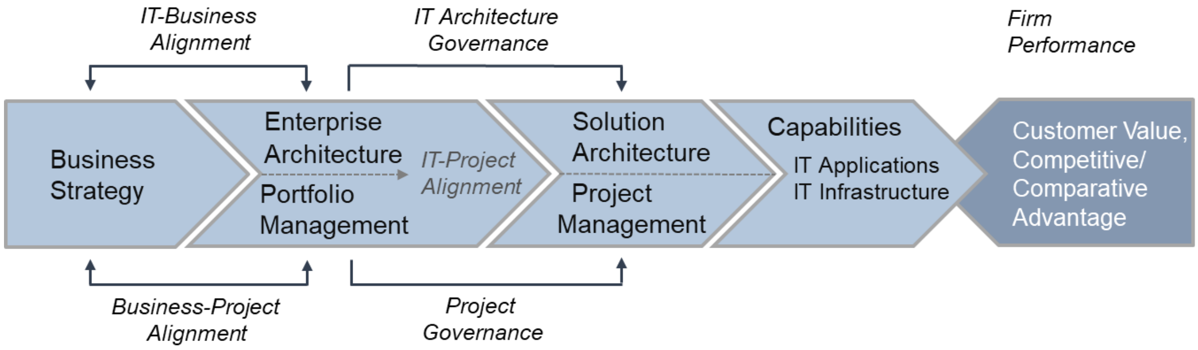

Figure 3: Model for IT value planning integrating IT architecture and project management (Source: author)

IT vendors

IT architects need to take IT vendors into account (Armour, Kaisler, & Liu, 1999, p. 53). At the strategic level, IT suppliers are selected for best achievement of the platform objectives (Keen, 1991). At the product/service level, IT vendors are selected on the basis of their product/services offering to best meet customer and business requirements (Armour, Kaisler, & Liu, 1999). IT architects define all components that collectively comprise the enterprise architecture and specify how these are integrated into capabilities. They also recommend what must be acquired from IT vendors or may be developed in-house (Figueiredo et al., 2014).

IT product/services can be purchased from multiple IT vendors, which require open standards for integration into the enterprise architecture (Croteau & Bergeron, 2001, p. 89). Products/services from few IT vendors provide high compatibility and low integration needs but increase IT vendor dependence and switching costs from vendor "lock-in" (OLR, subsection 2.4.7). Sourcing of IT products/services from multiple vendors increases integration efforts and incompatibility risks but lowers switching costs. Effective enterprise architecture balances these conflicting aims (Keen, 1991, p. 239).

IT architects must understand the strengths and weakness of IT vendors and their products/services in order to make the best choices (Unde, 2008). For this reason, IT architects should maintain personal relationships with IT vendors (Unde, 2008, p. 8). IT architects may even be delegated from IT vendors to firms (Wegmann, 2003).

"Supplier relationship" denotes a type of organizational value (OLR, subsection 2.1.5) that has scarcely been seen in IT job ads for enterprise/solution architects (Table 11). However, the links between these IT architects and IT vendors are crucial for the reasons mentioned earlier and for creating customer value (Article 3). More research on this relationship is desirable.

6.2 Theoretical contributions

The present dissertation contributes to theory by providing definitions, typologies, integrative models, and figures. The empirical outcomes (Articles 3 and 4), the concepts, and the models (overarching literature review, Articles 2, 5, and 6) provide new understandings (MacInnis, 2011) of IT value, IT architecture, and IT planning.

The overarching literature review contributes to the IT theory by extending the views on IT value and competitive advantage (customer value/product rareness matrix; OLR, subsection 2.1.6). The theoretical relationship between IT value and competitive/comparative advantage was elaborated by combining the customer-value disciplines (Treacy & Wiersema, 1993, 1995), the generic strategies (Porter, 1980), and the notion of comparative advantage (Bakos & Treacy, 1986).

IT value was redefined by integrating five previous definitions from the literature. Two major categories for IT value have been worked out: customer value for firm performance and non-monetary organizational values as conditions to create customer value. The following types of organizational values were induced from IT value activities/indicators:

- strategic planning/decision-making
- flexibility/agility
- strategic alliances/supplier relationships
- enhanced skills and capabilities

The following types of customer values were taken from literature (Treacy & Wiersema, 1993, 1995), following Tallon's (2007) suggestion:

- product leadership
- customer intimacy
- operational excellence

These so-called "customer-value disciplines" were assigned to IT value activities/indicators from the literature. The appropriateness of the customer-value disciplines was empirically verified in Article 3; the codes for these were found in product descriptions of annual reports of IT vendors.

Further, this thesis (Article 2) discussed the cohesion of the RBV and the industry view in depth—in general and in the IT context. As a result of the discussions in Article 2 (section 2.5) and from the IT value considerations (OLR, section 2.1), an integrated model for competitive/comparative advantage was introduced (subsection 6.1.2, Figure 3). It connects the industry view to the RBV and integrates the customer-value view. This combined view overcomes the insufficiencies of the RBV, particularly its missing considerations of markets, customers, and values. The integrated model for competitive/comparative advantage links the main analytical aspects for IT planning that are addressed in the literature.

The terms resources, capabilities, and assets have been confused in the literature. They were defined (Article 2) by recalling the resource descriptions from Penrose (1959) and by considering capabilities as value chain activities (Porter, 1985) that combine resources. Therefore, adequate definitions for the IT realm have been provided in the overarching literature review (subsection 2.2.4). IT planning was theoretically worked out as a source for value creation and sustainable competitive advantage. It is a process for creating unique IT capabilities that are difficult to duplicate. IT planning comprising IT architecture is a capability that enables the creation of customer value.

Empirical research on value of IT architecture is scarce. Gong and Jansson (2019) found 18 papers that used surveys, interviews, and cases studies for examining value from enterprise architecture. This dissertation employed a novel empirical method to identify value from IT architecture, not only from enterprise architects but also from solution architects.

The tasks and skills of IT architects have been researched through workshops and reviews (Akenine, 2008), interviews (Figueiredo et al., 2012, 2014), and content analysis of interview transcripts (Ho & Frampton, 2010). This dissertation presents the first content analysis of job ads for IT architects and provides detailed lists of required tasks and skills. The architect typology of Figueiredo et al. (2012) and the architecture levels of Foorthuis and Brinkkemper (2008) have been confirmed. In addition, tasks, skills, and types of IT architects have been compared to those from previous papers.

6.3 Practical contributions

This doctoral thesis provides routes for use in real businesses. In particular, the propositions from Part II provide several methods for practical application. Stakeholders dealing with IT management can gain more clarity with regard to the core tasks and key competencies of the various types of IT architects (Article 4). The listed task and skill categories may be used as catalogs. Managers and recruiters may benefit from these catalogs by selecting the necessary items when creating their job ads.

The answers to the overall RQ4 indicate the central connections among key roles in the IT-planning process that are useful in practice. Tasks and responsibilities can be shifted from senior management to PPM (decision-making for project selection and prioritization) and to EA (IT-business alignment). The model for IT value planning (Figure 3) illustrates the connected functions between business strategy and customer value realization as well as the links for alignment and governance.

This thesis demonstrates the coherence of IT architecture and project (project) management and their alignment at both the strategic and the tactical level. The emerging notion of IT project alignment was redefined, and a two-dimensional alignment model was presented. Enterprises may modify their organizational structures and governance processes to be in tune with the IT project alignment model (Article 5, Figure 1) and the corresponding process (Article 5, Figure 2). The model can be used as a blueprint for regular alignment between EA and PPM. For example, EA and PPM stakeholders may periodically conduct planning meetings to jointly update the roadmap. Solution architects focus on collaboration with project managers for requirement specification, solution design, and technical support (Articles 4 and 6). A responsibility matrix and a lifecycle model for cooperation between solution architects and project managers are suggested for application in actual life.

The integrated model for competitive/comparative advantage (subsection 6.1.2, Figure 3) is suited for business analysis by enterprise architects, business executives, and project portfolio managers. It is a tool for strategy formulation and helpful for IT-business alignment by enterprise architects. Finally, the IT vendor role and their strategic impacts have been illuminated (OLR, subsection 2.4.7; section 6.1; Article 3). The relationships between IT architects to IT vendors must be fostered to increase organizational value and decrease switching costs.

6.4 Limitations

The methodologies employed in this thesis have several limitations. Although objectivity has been highlighted for content analysis, interpretations of codes by the researcher are subjective. The same or equivalent codes may unconsciously be understood in different ways and be inconsistently assigned to categories. Coding errors also occur from misinterpreting and overlooking codes. Moreover, data evaluation was done by a single researcher, and a larger number of coders would have improved reliability.

The job ads content analysis took samples from two countries opposed to the vast majority (~ 90%; Harper, 2012) of job ads content studies that were conducted in only one country. Notwithstanding, the generalizability is constrained. The required tasks and skills for IT architects may differ by country or region. For example, level and nature of social skills might vary in accordance with the sociocultural contexts of countries ("collectivism" vs. "individualism"); leadership and governance tasks may depend on local "power distance"; and tasks and skills for strategic analysis may vary with country-specific "long-term orientation" (Hofstede, 2020). Thus, the samples are not sufficiently representative to generalize the results to global requirements for IT architects. The content analysis of job ads using the same coding scheme can be continued in other countries to increase generalizability.

Although the evaluation of frequency of codes in contents is an established technique to determine significance (ORL, subsection 4.2.2), it can be criticized: the frequency of a specific item in a text certainly cannot completely reflect its importance (Dixon–Woods, Agarwal, Jones, Young, & Sutton, 2005, p. 50). The job ads analysis provided findings on task and skill requirements, but not on actual tasks and skills in professional life. Job ads represent ideal pictures of a role; however, actual jobs deviate from the corresponding job advertisement. Surveys in real-life settings and interviews with active IT architects enhance scientific contributions. This dissertation compared the outcomes from the job ads content analysis (Article 4) with the findings from authors who interviewed and surveyed IT architects (OLR, subsections 2.4.2, 2.4.3 & 6.1.2).

6.5 Future research

This dissertation has thrown up numerous questions that could be explored in further research on IT value and IT architecture. Among various directions for future research that are mentioned in the articles, the central recommendations are presented here.

The applicability of the customer value disciplines to denote monetary value from IT could be further investigated. The importance of operational excellence as IT value in comparison to product leadership and customer intimacy is of interest, since data (Article 3) and theory (subsection 2.1.5) indicated a dominance of operational excellence. Four types of organizational values are suggested as preconditions to customer value. Upcoming empirical or conceptual research may support or reject these propositions. Similarly, the statements and results from theoretical discussions and conceptual synthesis, mainly customer value/product rareness matrix and the integrated model for competitive/comparative advantage, are topics for additional academic treatment.

Although this dissertation enriched the knowledge on IT architects regarding tasks, skills, levels, and types, future research on these aspects is required. Generalizability can be increased by extending the job ads content analysis to countries that possess cultural norms and behaviors that are very different from the European ones. Further, surveys and/or structured interviews among IT professionals would provide useful quantitative data for testing the results from the content analysis. Differences from ideal attributes (jobs ads) and real job aspects could infer new implications for the roles of IT architects. For example, little is known about IT architects in agile environments.

Digitalization provides new business opportunities and threats in numerous industries and also impacts IT planning. For example, the search string “digit” was found 44 times within 187 codes in the annual reports of IT vendors (Appendix A3). Thus, it is evident that the role of the digital architect is emerging (Article 4); it broadens the scope of IT architecture in terms of innovation, business modeling, and customer value. The new research project entitled “Enterprise Architecture 4.0: How Digital Architects Create Value” will highlight digital services and value-generating activities from enterprise architects that create digital applications. The literature on digital technologies, digital business, and enterprise architecture will be reviewed and data will be collected from architects and managers engaged in the development of digital services. The aim is to explore strategic ways for novel services based on digital data streams.

Further, the links in the IT project alignment model (Article 5) require empirical inquiries in real-life contexts. Case studies or participatory action research can deliver new knowledge on the relationship between enterprise architects and project portfolio managers at the strategic level and solution architects and project managers at the tactical level (Article 6). Content analysis on internal guidelines or planning handbooks would help clarify the planning and alignment processes, but these documents are typically confidential and, therefore, barely accessible.

IT vendors play a central role in IT planning and this role is underrated in the literature (subsection 2.4.7). A research focus on the relationship between IT vendors and IT architects is recommended (subsection 6.1.4). Other job roles that participate in IT planning are also favorable sources of new knowledge. Content analysis on job ads for IT managers, business analysts, system engineers, software developers, etc. will be useful to understand these roles and their integration in IT planning processes.

The elicitation of requirements and the selection of appropriate products are central tasks of IT architects (Article 4, Table 4; Article 6, Table 2) and key outcomes from IT planning (Article 1). Another interesting question is how fulfilment of requirements may positively or negatively impact competitive advantage. For example, Article 1 hypothesized that the failure of meeting non-functional requirements (e.g., poor system performance, security vulnerabilities) results in competitive disadvantages. Additional knowledge on requirement fulfilment and competitive impacts may be gained from semi-structured interviews with IT architects.

6.6 Conclusions

IT architecture, IT value, and IT planning have been academically treated for almost four decades. Their importance to a firm's performance is broadly acknowledged. Yet, the term IT value is nebulous and there are no universal agreements on IT architecture and IT planning. Little is known with regard to the process for generating value from IT investments; therefore, the planning activities through which IT architects provide value needed to be researched.

Key findings

A new definition for IT value has been proposed. It comprises four types of organizational values as preconditions to the three customer values disciplines from Treacy and Wiersema (1993, 1995).

The RBV and the industry view complement each other for strategic formulation of competitive advantage. IT value and competitive advantage are interrelated. Thus, the customer-value view must be added to the RBV and the industry view to complete the framework for strategic business analysis. The links between the customer-value view and the industry view were theoretically demonstrated. Organizational values from IT connect the RBV to the customer-value view. The integrated model for competitive/comparative advantage illustrates these relations and can be used by enterprise architects for IT-business alignment as per the contingency theory (section 6.1.1, Figure 2).

Further, the tasks and skills of IT architects were identified in detail. IT architects provide organizational value through strategic planning, decision-making, and the development of firm-internal skills and capabilities. In addition, standardization and integration of IT provide flexibility so that internal capabilities can be promptly adapted to external needs. The relationships between IT architects and IT vendors are beneficial but underestimated in practice.

This dissertation combined views on processes and structures for IT value generation. Enterprise architects act at the strategic level and govern solution architects at the tactical/project level. At these two levels, they connect to project portfolio managers for IT project alignment and to project managers for requirement elicitation and solution design. Enterprise architects align IT to the business with the help of senior managers from the business and the IT, which can be organized through committees.

Differentiation from previous research

The methods employed in this thesis and the findings are distinct from those of previous studies. Other studies on IT planning focused either on IT value or on competitive advantage; this study has adopted a concurrent perspective on both. Competitive advantage included two complementary views: the RBV and the industry view.

The thesis has placed particular emphasis on customer value from IT, as proposed by Tallon (2007); this has not been done by other authors thus far. The thesis revealed three more types of organizational value created by IT architects, which are beyond the flexibility/agility that Ross (2004) found for enterprise architects.

The content analysis on job ads for IT architects provided more objective data and represent ideal tasks and skills. Previous studies on IT architects employed conventional research methods, such as interviews, surveys, or focus groups. Outcomes from the job ads analysis were discussed in combination with project (portfolio) management (Articles 5 and 6) by using industry standards and practitioner frameworks that also describe perfect conditions (best practices). Thus, the findings and models refer to optimal target states opposed to as-is states from other studies.

Significance of findings

This doctoral thesis provided a comprehensive and comprehensible definition of IT value. It has also provided greater clarity on the roles of the IT architects and their activities to create value.

In essence, IT architects

- are sources of sustainable competitive advantage,
- are planners of IT value—that is, planners of (IT) capabilities that attracts money from customers,
- are central managerial resources in IT planning including IT-business alignment,
- need to understand and shape the business strategy, and
- provide dynamic capabilities.

New knowledge has been gained on how IT architects may be embedded in the IT planning process and how they must interact with project (portfolio) management. The model and the process of IT project alignment enhance the IT strategy literature and may be used as blueprints for IT planning in practice.

Recommended courses of actions in practice

- Organizations must recognize the central role of IT architects and grant them with rights required for decision-making and governance.
- Enterprise architects must engage in strategic business planning with senior business managers to formulate and pursue (IT) strategies for competitive advantage and customer value.
- The integrated model for competitive/comparative advantage (Figure 2) can be used for business analysis and IT-business alignment by enterprise architects.
- Enterprise architects must regularly select, prioritize, and schedule future IT initiatives with project portfolio managers.
- Solution architects must connect to project managers and engage in every IT infrastructure project.
- IT architects must build relationships with IT vendors to identify market trends and decrease switching costs.

Final citations

IT architecture includes IT strategy and IT planning (Earl, 1996, p. 55; Keen, 1991, p. 239), and IT architects are planners of IT value. What Teece (2007, p. 1329) pronounced for product architecture applies equally to IT architecture: “The design and performance specification of products…help define the manner by which the enterprise delivers value to customers, entices customers to pay for value, and converts those payments to profit.”

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ARTICLES PART I

Value from IT and Strategic IT Planning

Article 1: Bridging IT Requirements to Competitive Advantage: The Concept of IT Value Planning

Article 2: Cohesion of RBV and Industry View for Competitive Positioning and for Strategic IT Planning

Article 3: Operational Excellence as the Main Customer Value: Information Technology Vendors' Perspective

1 BRIDGING IT REQUIREMENTS TO COMPETITIVE ADVANTAGE: THE CONCEPT OF IT VALUE PLANNING

Abstract

As other investments within an enterprise, information technology (IT) must support the business strategy of a company and provide value to it. IT projects and their engineering requirements must include aspects of competitive gains in accordance with the strategic position of the company. I suggest that IT managers and engineers must consider competitive strategy when specifying the requirements for a new IT product and check that its operation supports competitive objectives. This paper introduces the concept of IT value planning that portrays the relationship between competitive advantage, as defined in enterprise strategy and requirements collections as part of IT projects. Further, hypotheses on the relationships between both variables are presented along with the research approach.

1.1 Introduction

In every industry, information technology (IT) plays a decisive role with regard to operational efficiency and value delivery to customers. Value creation and competitive advantage are treated in a wide variety of publications comprising manifold management disciplines, such as strategic IT planning, innovation management, or value analysis. Moreover, numerous papers, IT frameworks, and so-called bodies of knowledge (e.g., Business Analysis Body of Knowledge (IIBA, 2015); Project Management Body of Knowledge (PMBOK; PMI, 2017); Enterprise IT Body of Knowledge (IEEE & ACM, 2017)) deal with links between information systems and business objectives. These are comprehensive documents with strong foci on special topics (e.g., business analysis, project management, system engineering) but they are not connected and do not, therefore, provide orientation over the entire IT planning chain.

In academia, "IT-business alignment" expresses planning of IT to meet business strategies, whereas practitioner publications use the term "business requirements" that are translated into technical requirements for IT products (e.g., IIBA, 2015; PMI, 2017). These books and papers from practice and the literature have the same intention—that is, to best design IT in accordance with the business strategy of increasing a firm's performance and its competitive position. However, IT planning processes are blurred; there is no best way for IT planning that is recognized (OLR, section 2.3).

Artifacts are documents that are outputs from a planning stage and contain useful information as inputs for the subsequent planning stage. For example, a marketing plan can provide information on target customer segments. An aligned IT plan may contain IT architectures that help address these customers. A list of requirements for a new customer application can be a corresponding output from project planning (PMI, 2017). If artifacts are consistent over several planning stages, then the requirement documents reflect the strategic ways. Therefore, requirement is a useful variable for examining strategic IT planning. Artifacts from IT planning provide deep insights into IT planning, if they are accessible for research.

This paper includes requirements for IT products in the discussion on value and competitiveness, examines the logical context between them, and discloses the dependencies. The literature review in the next section provides brief insights on popular technology management methodologies, explains how they refer to business and strategy, and highlights linkages and gaps. These insights support synthesis of the concept of IT value planning that depicts logical links between IT products and competitive advantage and that helps practitioners in planning and inspection of requirements. The research objectives, the research design, and the expected relationships between requirement categories and competitive impacts are presented.

1.2 Literature review

Competitive positioning and approaches for achieving competitive advantage are part of a firm's strategy. The IT strategy must fit with the business strategy and, therefore, support a firm's methods to obtain competitive advantage. However, the processes for aligning IT strategies to business strategies are unclear (OLR, section 2.3). Requirements describe capabilities from IT products to satisfy business needs and are results of the IT planning process (PMI, 2017). Thus, IT product requirements must refer to objectives for competitive advantage. Yet, IT planning is unclear both in the literature and in actual life (OLR, section 2.3). Consequently, requirements of IT products and competitive strategies are likely not connected.

IT products denote IT investments to increase profits and competitive advantage (OLR, chapter 2). Therefore, the relation of IT products requirements and competitive advantage is of great interest, in particular, how IT product requirements influence competitiveness. Several practitioner frameworks suggest comprehensive ways for structured planning of IT solutions over specific process phases. Prominent examples of frameworks for IT planning are the IT Infrastructure Library (ITIL) (Axelos, 2014), The Open Group Architecture Framework (TOGAF) (The Open Group, 2011), Enterprise Information Technology Body of Knowledge (EITBOK; IEEE & ACM 2017), business analysis (e.g., IIBA, 2015), project management (e.g., PMI, 2017), and system engineering (e.g., BKCASE, 2018).

Business analysis estimates total sales, costs, and profits after the creation of marketing strategy for a new product, thereby enabling a company to determine if its objectives may be met (IIBA, 2015, p. 2; Kotler, 2003, p. 193). Strategy analysis as part of business analysis provides context to requirements analysis and design definition for a given change (IIBA, 2015, p. 99). The role of a business analyst and his/her deliverables explains the benefits of this management discipline. He/she takes information from strategic plans and goals to conduct a feasibility study and develop a business case that includes cost estimates and business benefits. On this basis, a decision can be made by the sponsor. This implies that a proposal for a new project is being selected or rejected (IIBA, 2006, p. 19). If a project proposal is approved, a project manager will initiate the project. According to the PMBOK (PMI, 2017), projects are initiated because of internal business needs or external influences, which inspire needs analysis, business cases, and feasibility studies. Hence, one of the deliverables of a business analysis is linking strategy with projects. The Business Analysis Body of Knowledge (BABOK; IIBA, 2015, p. 5), the dominant practitioner handbook for business analysis, illustrates the relationships between its knowledge areas. At the core, the link between strategy and requirements is presented (Figure 1). Requirements analysis is an essential part of scope management following project initiation. Again, links among company strategy, projects, and product requirements become apparent.

Portfolio management is applied by companies to meet organizational strategies and achieve strategic objectives (PMI, 2013c). It is an integral element of the strategic plan of a company. The realization of benefits to the company is a measure of portfolio success. Operations, programs, and projects are components in the layer below a portfolio. Business value increases by effective use of project, program, and portfolio management processes that help meet strategic goals (PMI, 2013b; PMI, 2013; PMI, 2016). Moreover, portfolio management aligns programs and projects to strategy and benefits (PMI, 2013a). Thus, projects are linked to strategy via portfolios or programs.

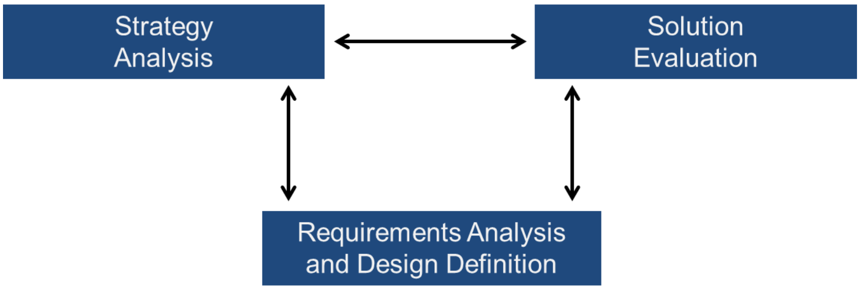

Figure 1: Relationships between core knowledge areas derived from BABOK (Source: adapted from IIBA, 2015).

Depending on the size of an organization and the extent of strategic changes, projects might be part of a program or a portfolio, which organizes programs and projects. The utilization of a portfolio, program, and project management possesses the ability to employ processes to meet strategic objectives and achieve higher business value. Irrespective of whatever structure is appropriate for a major endeavor, each level must support the goals of the business strategy. If organizations initiate projects without structuring them under portfolio or program umbrellas, they must directly derive project objectives from strategy or check for their compatibility to strategic objectives (Figure 2).

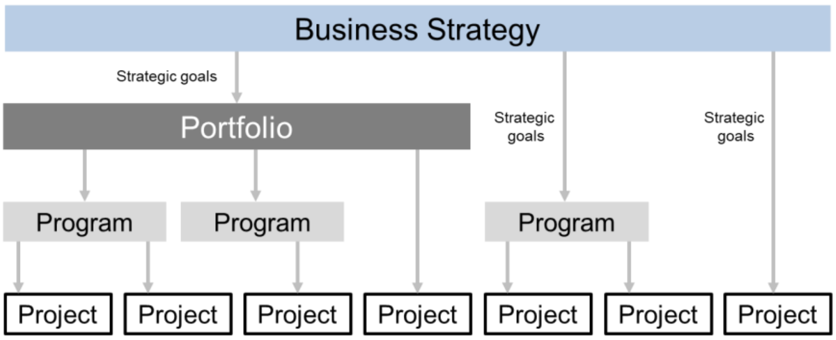

Figure 2: Project objectives directly derived from business strategy or via portfolio/program (Source: adapted from PMI, 2016).

Project failures are frequently a consequence of vague requirements or fuzzy project objectives because of unclear or unknown company strategy. Project managers must be aware of superordinate goals elucidated in strategic plans. Empirical data from IT projects reveal lack of recognition of company objectives—18% of IT managers who were questioned stated that the absence of clear business objectives is the biggest problem. Hence, clarity of business strategy and its consideration by project managers are crucial success factors for IT projects (GPM, 2010, pp. 113–114). Through all planning stages, from competitive positioning as part of strategy development to requirement analysis as part of IT project management, cohesion must be maintained and organized to succeed in IT delivery—that is, to provide more value and, therefore, to increase competitiveness.

Architecture management by TOGAF (The Open Group, 2011) also reflects the relationship between strategy and requirements via initial phase architecture vision and subsequent phase business architecture. Architecture vision includes strategic topics such as mission statement and business value, whereas business architecture encompasses documents that are crucial inputs for project deliverables.

Innovation management is a business science and practice that contemplates processes to successfully translate ideas either in operational improvements or into profitable products in a market. These products must possess new or advanced characteristics that are valued by customers. Technological development and their early conversion to beneficial product attributes are key to gain advantage in marketplaces. New product development (NPD), a strategy for growth, encompasses activities and goals that are consistent or equal to the ones in research focus. Viewing the eight-stage linear model for NPD from Trott (2012, p. 433), the stages of idea generation, idea screening, concept testing, business analysis, and product development can also be identified in project management, particularly prior to project initiation.

Practitioner frameworks from global institutions view the IT planning processes from the perspective of different functions—for example, architecture, system engineering, and project management. The proprietary and copyright-protected practitioner frameworks for IT planning compete and are disconnected. A general, coherent IT planning process that is generally applied does not exist; there is no authoritative source that defines the knowledge across the whole enterprise (IEEE & ACM, 2017).

Practitioner frameworks deliberate the strategic dimension of technology but do not comprise competitive advantage and context in IT specifications (Daulatkar & Sangle, 2016; Rupp, 2014; Thiry, 2013; Tiemeyer, 2014). The relationship between competitive advantage and requirement specification is a gap that requires exploration. Accordingly, research must extend the theory on competitive advantage gained from IT; practitioners could check the strategic consistency of requirement specifications for IT products.

1.3 The concept of IT value planning

Requirement specifications are part of requests that are sent to IT vendors in order to receive an offer that describes IT products/services that must meet these requirements (Robson, 1997, p. 468). A "procurement statement of work" contains IT requirement specifications (e.g. quality levels, performance data) and is a part of requests to IT vendors and a portion of a contract with the IT vendor (PMI, 2017, p. 477).

From my observations in practice, IT requirement specifications were often decoupled from business. For over eight years in practice, I wrote, collected, and evaluated numerous detailed lists of requirements from two sides (IT vendor and IT buyer) in my function as bid manager and project manager. Requirements were intensively discussed with IT managers, sales representatives, IT architects, and system engineers on how the offered IT products meet the requirements. However, discussions on business value and competitive impact of the requirements were very rare. There were abstract value discussions between business managers and salespeople concentrating on the advantages of features and functions of IT products rather than on the actual needs (i.e., requirements) for these.

Other reasons for neglecting the requirements-business relationship can be missing interfaces in a firm's organization, insufficient processes, or poor communication between strategic management and IT management. Apart from organizational shortcomings, there are different people, various interests, diverse business mindsets, or other underlying behavior. However, it can be asserted that a definition of requirements must be set and verified in close context with business strategy through all intermediate stages. Over this extensive path, competition-critical information can be lost. Thus, there is a need to examine the coherence of planning outcomes in the top-down process of IT value planning. Each planning stage requires inputs as well as resources and capabilities for processing to generate outputs. IT value planning concentrates on the outputs of the planning stages (artifacts) rather than the assets, tools, or skills to generate them. The chain and the concept of IT value planning are based on previous brief analyses and the following logic:

- Enterprises in competitive environments must sustain their competitive advantage (Porter, 1985).
- Competitive advantage is a key topic in business strategy (Kotler et al, 2016, p. 358). Business strategy is based on competitive position in targeted market segments and competitive priorities (Anupindi, Chopra, Deshmukh, van Mieghem, & Zemel, 2014, p. 20).
- IT strategy and architecture must support the business and align to business strategy (Luftman, 2003; The Open Group, 2011).
- Portfolios, programs, and projects must be aligned to strategic goals (Axelos, 2014).
- IT products (systems, services, or results) are introduced by applying project management methods (Mulcahy, 2009).
- Requirement analysis is part of scope management in project management (PMI, 2013a, pp. 110–119).
- IT products are designed on the basis of collected requirements (Ullah & Lai, 2011).
- IT products in operation are investments must provide value—that is, returns on investments (ISACA, 2010).

Therefore, I conclude that requirements for IT products must refer to competitive advantage. The chain in Figure 3 depicts the main planning stages for producing IT values in a chronological order and represents the proposed conceptual model. It outlines an IT planning sequence and is utilized throughout the research work to explain the connection between IT product requirements and competitiveness. Each planning stage must process the outputs from the preceding stage by breaking them down and detailing them for the purpose of the ensuing stage.

Figure 3 illustrates possible outcomes (artifacts) from each phase of the IT value planning chain. The bridge refers to main outcomes from the IT product requirement phase, the requirements specification, and its coherence to the stated competitive advantage from a firm's marketing strategy. The key challenge is to sustain consistency of value contributions over the long chain, which encompasses a wide variety of managerial activities and roles. IT project managers are invited to verify items in the list of requirements and their reference to attributes of competitive advantage from a marketing plan. As an example, how would a specified functional requirement for a new monitoring and reporting system of a customer contact center relate to the strategic statements for competitive advantage?

The concept of IT value planning is of high practical use, as it connects marketing management with IT management over various phases and reveals artifacts from each stage. The application of the IT value planning concept will enable companies to track the value creation over all phases from the rough competitive plan to detailed product design. IT architects and requirement engineers may refine IT requirements in order to achieve better competitive impacts as provided in the strategy.

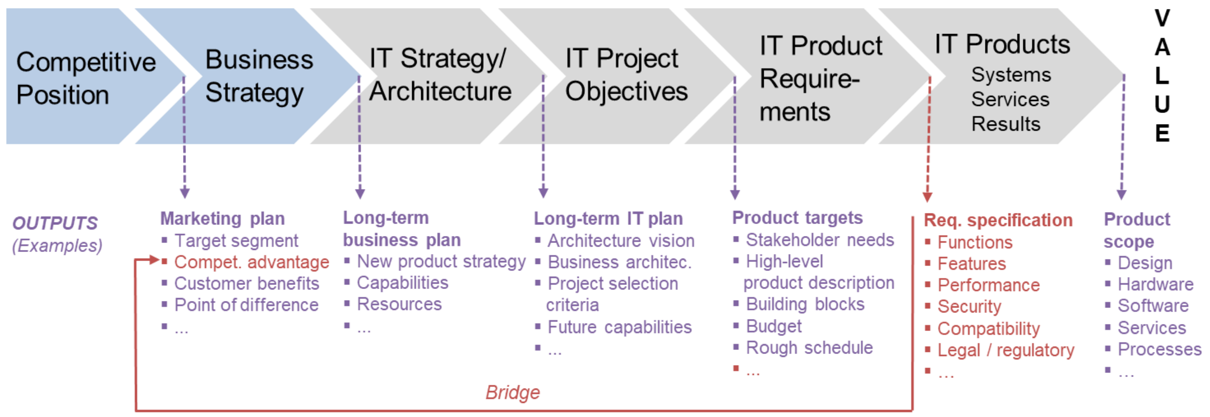

Figure 3: IT value planning for deriving IT product requirements from competitive position (Source: author).

IT managers and project managers must verify whether or not the requirements are compatible with their companies' competitive strategy. If not, requirements can be adjusted to provide IT solutions that comply with the strategy for competitive advantage. Understanding the link between both helps to realign the requirements and subsequently refine or correct IT product design. Further, best practices and metrics can be derived for measuring competitive impacts. Requirement specifications might be looped back into the firm's strategy (e.g., by benchmarking) in order to adjust it. Research results can inspire or motivate decision-makers to modify the communication and process flows between marketing management and IT engineering.

Requirements may be categorized in various ways. There is no common standard for requirements analysis. Pataki, Dillon, and McCormack (2003) distinguished between functional requirements that impact business processes, technical requirements that affect the system infrastructure, operational requirements that impact support and operations, and transitional requirements that are required for implementation. BABOK (IIBA, 2015) described functional requirements as needs for capabilities and specific behaviors of IT products, whereas non-functional requirements were described as conditions for IT effectiveness and IT qualities. I define functional requirements as needs for features and functions that support the value creation of the business, while non-functional requirements are the necessary qualities for IT operation (e.g., availability/reliability, performance, security, and service level agreements) and integration (e.g., compatibility, extensibility, scalability, and compliance).

1.4 Research objective and research question

The goal of this research is to test a theory that explains the relationships between types of requirements for IT products and the strategic impacts on competitive advantage. The theory will help to answer the following research question: "How will fulfilments of various types of IT requirements impact the competitive advantage of an enterprise?"

1.5 Research methodologies

The study is exploratory in nature and employs multiple methods. The approach is abductive, a mix of inductive and deductive reasoning in two phases. Abduction is suitable for introducing new ideas by combining deductive and inductive approaches (Suddaby, 2006). In the first phase (induction), theory is developed from data; in the second phase (deduction), the theory is tested (Saunders, Lewis, Thornhill, 2016, p. 148, p. 710). In this research design, the findings from the first phase provide the theoretical premise for the second phase.

In the induction phase, a content analysis on vendors of IT products has already been conducted. The analysis investigated the perspective of IT vendors on the relationship between competitive advantage of their customers and the IT products that vendors sell. Consequently, IT vendors clearly emphasized the competitiveness of their buyers. Noticeable patterns and moderate positive correlations among competitive strategies were found. The perspective of the IT vendors may lead to the conclusion that IT products impact competitive advantage (Article 2). Thus, the requirements for such IT products must then also relate to competitive advantage. This can be tested in a second research phase by stating and testing hypotheses.

The deduction phase tests hypotheses through a sequential mixed methods study. It includes both research methods, qualitative and quantitative, that enable the testing of theory (Myers, 2013, p. 33). Deduction begins with primary data collection from non-probability sampling by using questionnaires. A set of hypotheses will be tested by collecting and analyzing data from IT managers to confirm or contradict the hypotheses (Myers, 2013, p. 23).

Research will continue with the execution of semi-structured interviews to probe the significance of quantitative results by exploring with a few participants at a selected enterprise as a case study. Obtaining statistical results from a sample and following up with few individuals will help explain quantitative results in greater depth (Creswell, 2008, pp. 121–122). The interviews will also help when questionnaires reveal unexplainable results or insufficient data. Another reason for following up with qualitative research is to better understand causality—that is, to explain the relationships among variables.

Quantitative evaluation will involve Pearson correlation coefficients for each value combination of nominal variables. The independent variables are requirement categories (e.g., workplace features, security, performance, etc.) while the dependent variable is the impact on competitive advantage, which is also categorical. Further, Cronbach's α will be calculated to check for internal consistency (Cronbach, 1951). The average inter-item correlation is corrected by the Spearman-Brown formula. Cronbach's α values greater than 0.7 will be accepted (Nunally, 1978). In addition, Spearman's rank order rho will be calculated to examine the monotony of the course.

Apart from correlation, statistical tests will be performed by configural frequency analysis (Von Eye, Spiel, & Wood, 1996) to determine types and antitypes in contingency table. Further, Pearson's χ^2 will be used to assess independence. χ^2 test statistics are computed for each observed value at a level of significance $\alpha = 0.05$ for critical values.

1.6 Hypotheses testing and theory building

A theory will be constructed to explain the relationship between the types of requirements and competitive impact. This theory will be based on results from examinations of four hypotheses:

H1: Successful specification and fulfillment of functional IT requirements increase competitive advantage.

H2: Failure to identify and meet functional IT requirements will have minor impacts on competitive advantage in the short-term.

H3: Successful specification and fulfillment of non-functional IT requirements will have minor impacts on competitive advantage.

H4: Failure to meet non-functional IT requirements will result in competitive disadvantage (competitive losses).

For each of the six categories of requirements, it will be asked if competitive advantage is assumed to increase, provided that requirements are successfully met and the IT product is operational. Options to answer are "Yes" or "No". For functional requirements, a significantly higher number of "Yes" responses are predicted compared to the number of "No" responses. For non-functional requirements (performance, security, legal/regulatory), a significantly higher number of "No" responses are predicted compared to "Yes" responses.

The next question for all requirement groups will ask for competitive impact if requirements are not met. In this case, negative competitive impact is predicted for non-functional requirements, while non-fulfillments of functions have less severe or no impact on competition. In Table 1, the assumed results are indicated by the symbol "X."

	Competitive advantage			
	What is the impact on competitive advantage if requirements will be successfully met?		What is the impact on competitive advantage if requirements will NOT be met?	
IT products requirements for	Gain in competitive advantage	No or neglectable impact on competitive advantage	No or neglectable impact on competitive advantage	Competitive disadvantage
Customer experiences	X		X	
Workplace features	X		X	
Supply chain efficiency	X		X	
System performance		X		X
Security		X		X
Legal/regulatory		X		X

Table 1: Expected relationships between categorical values (Source: author).

1.7 Conclusions

The link between competitive advantage as defined in strategy and requirements collections for IT products exists and is worth exploring in depth, since increasing competitiveness is key for companies to survive in marketplaces. The concept of IT value planning was introduced here. In contrast to other conceptual frameworks for business-IT alignment, IT value planning is founded on artifacts from sequential planning phases. This helps to understand the need to verify specified requirements in view of their contribution to strategy and competitive advantage. Engineers and IT managers must verify each requirement and its relation to competitive advantage as defined in business strategy.

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2 COHESION OF RBV AND INDUSTRY VIEW FOR COMPETITIVE POSITIONING AND FOR STRATEGIC IT PLANNING

Abstract

The discussion on competitive advantage started about half a century ago but foundational theories still lack connectivity. The resource-based view (RBV) concentrates on concepts internal to a firm and disregards the world outside, whereas the industry view neglects internal antecedents and consequences.

This review paper examines complementation of leading endogenous and exogenous theories on competitiveness and combines most influential concepts on firm resources and industrial forces to a complementary picture for competitive positioning. Seminal works from Edith Penrose and Michael Porter as well as subsequent research have been investigated on connectivity and togetherness. Inside-out constructs on resources and capabilities must match outside-in constructs on industry and markets in order to achieve competitive advantage.

The article includes conceptual discussions of resources, capabilities, and assets. Resources combine to capabilities that are qualified services and value chain activities. Resources can be acquired on markets, while capabilities must be developed within organizations.

Finally, this article takes a look into the IT strategy literature to demonstrate that the cohesion of RBV and the industry view is also pertinent the IT realm.

2.1 Introduction

Strategy in business and economics is a field that comprises manifold areas, levels, and phases. It is being discussed among scientists from various groundworks and viewpoints, each dealing with specific sections and linkages to other subjects within the space of strategy science. There is no sole description for strategy that is generally accepted, it appears multi-dimensional. Mintzberg (1987, p. 20) provided five different definitions for strategy that interrelate in various manners, and that in some ways compete, and in other ways complement each other. Mintzberg and Lampel (1999) classified ten different schools of scientist groups that take different dimensions and positions on strategic management. Kenworthy and Verbeke (2015) counted 194 different theories in empirical research displayed in strategic management journals. No model, concept, or theory can cover all factors influencing strategy. However, consistency and coherence are required within the set of external and internal strategic objectives. This article attempts to identify connections between some of the most cited strategy theories with different perspectives, the endogenous and the exogenous view on a firm, and examines their complementation.

Two considerations should be brought into an optimal equilibrium: what a firm might do in view of chances in the environment and what a firm can do in view of abilities (Andrews, 1971, p. 85). Porter's analytical tools support answers to the first question, while Penrose's ideas refer to the latter. The same applies to two out of four strategy components defined by Andrews (1971, p. 9): first, market opportunity, and second, corporate competence and resources. The first component is the key subject in Michael Porter's recognized monograph 'Competitive Strategy' (1980) and his subsequent contributions, the second component is core in the resource-based view (RBV) to which Edith Penrose (1959) principally contributed. Both elements and both authors provided understandings from different directions that are central in strategy formulation and competitive positioning (Grant, 1991).

Porter's market-oriented approach, also referred to as industrial organization economics (Black & Boal, 1994; Conner, 1991; Hoskinsson, Hitt, Wan, & Yiu, 1999), is outside-in, meaning the strategic position of the firm depends on the analysis of the famous five forces. Penrose's approach goes the other way, inside-out. The resources possessed by the firm determine both, the rate and the direction of growth. Available productive services may drive expansion and raise competitive advantage (Penrose, 1959, p. 76). Both approaches seem to be antithetical. Indeed, they ask different, frequently complementary questions (Teece, Pisano, & Shuen, 1997, p. 516). Hooley, Broderick, and Möller (1998, p. 98) denote them two streams of research from relatively independent literatures. They mention coherence and propose contemplating both streams together for competitive positioning and strategy formulation. However, their appealing suggestion is insufficiently substantiated.

Although Porter and Penrose delivered highly influential contributions to strategic management science, their basic concepts have barely been analyzed in depth for consistency. The terms 'Porter' in conjunction with 'Penrose' in search category 'Article title, Abstract, Keywords' of Scopus database results in just two hits for business and economics. One of them presents Ludwig von Mises as the one who linked the industrial and resource-based views, since he supervised the dissertations of Penrose's and Porter's supervisors (Powell, Rahman, & Starbuck, 2010). Powell et al. (2010) relate to scientific predecessors but did not provide any argument on connections in the contents of the scientific works from Penrose and Porter. The other hit, a more cited paper from Hoskinsson et al. (1999) acknowledges Porter's and Penrose's contributions to strategic management research. The authors considered significant theoretical and methodological bases but did not find cohesiveness between RBV and the industry view.

The main goal of this paper is to investigate in supplementation of Penrose's and Porter's foundational views. This article tries to answer the research question 'Are theoretical groundworks on competitiveness by Penrose and Porter complementary for strategic positioning?' The paper compares notions from Porter, Penrose, and subsequent influential research on competitive advantage to investigate in matching traits and cohesiveness. It presents ideas that connect the industry-based view to RBV and vice versa and indicate their complementary scope for analyzing the inside/outside fit of strategic moves. An enhanced conceptional model is suggested for competitive positioning integrating the market/industry view, RBV, the macro-environment, and SWOT. Furthermore, definitions of resources, capabilities, and assets are reviewed and revised for more clarity and distinction. For practitioners, a template is proposed to assess own resources and capabilities in comparison with competitors. At last, a literature review in the IT strategy realm shows that the proposed conceptual model is also adequate for strategic analysis of IT.

2.2 Literature review on cohesion of RBV and industry view

The following literature review is subdivided in three parts. It starts with comparing Porter's and Penrose's traditional concepts and continues with short reflections on cohesiveness of RBV and industry view. Thereafter, more recent opinions on connectivity between RBV and the industry view will be presented.

2.2.1 Revisiting the roots of RBV and industry view

Penrose's early monograph 'The Theory of the Growth of the Firm' from 1959 is one most esteemed scientific contribution in strategic management and represents the groundwork for RBV. Porter's books 'Competitive Strategy' (1980) and 'Competitive Advantage' (1985) are also highly distinguished publications that have been pointing the way to strategic analysis. Those works have been examined for relatedness. The following paragraphs provide arguments in support of the thesis that Porter's industry view is interrelated to Penrose's ideas and RBV.

Porter's generic strategies require resources and specific skills. A strategic choice on a particular position in the competitive space depends on both. If a firm decides to pursue one of Porter's (1980) three generic strategies, it must develop or acquire its resources and skills accordingly. A cost leadership position, for example, would require low-cost distribution networks, highly efficient processes, modern productions technologies, lean management skills, etc. In contrast, a differentiation strategy would need strong marketing and product engineering capabilities. Focus strategy must possess skilled resources that are directed to particular target buyers (Porter, 1980, pp. 40–41).

Available managerial resources and the services they provide are sources of competitive advantage and incentives for a firm's growth (Penrose, 1959, p. 85). Porter (1980, p. 65) expressed the same idea in a different way. He included general management ability as an item in the list of business key areas to examine core capabilities and abilities to grow.

Porter (1985) introduced the generic value chain that depicts activities in all functional areas of a firm. Services imply functions and activities that productive resources perform (Penrose, 1959, p. 22). Value chain analysis is therefore an evaluation of activities and is essentially the same as the analysis of productive resources within a firm and the services they render.

Heterogeneity in RBV and differentiation rely on uniqueness. In RBV, specific sets of resources associated to various skills and capabilities are prerequisites for sustained superior returns (Rugman & Verbeke, 2002, p. 770). In a similar way, Porter (1980, pp. 39–41) suggested that unique combinations of skills are required for a differentiation strategy to earn above-average returns. Resource heterogeneity is a unique bundle of resources that is valuable and rare (Barney, 1991, p. 107). The unique character of a firm is the heterogeneity of available productive services from its resources (Penrose, 1959, p. 67). Hence, superior rents can be achieved by differentiating from competitors that rely on unique skills or capabilities composed of various resources.

Beside heterogeneity, Barney (1991, p. 101) described resource immobility as another key feature for sustainable competitive advantage. Certain unique characteristics of a firm are hard to copy, hard to imitate, or hard to substitute. Penrose (1959) and Barney (1991) mainly referred to human resources and to their knowledge, experiences, and relationships, while Porter (1980, pp. 172–174) elaborated on technological mobility barriers. These barriers include product technologies, process technologies, and proprietary know-how that should be protected by patents. Otherwise, mobility barriers will diffuse and tend to lower competitive advantage. Herewith, Porter supplements the immobility feature in RBV in three ways. First, by including technology as proprietary, i.e., as a unique capability. Second, by introducing the diffusion effect. Third, by referring to patents to protect competitive advantage.

Isolating mechanisms from the internal RBV correspond to the entry barriers that Porter (1980) described from an industrial standpoint (Mahony and Pandian, 1992, p. 371). Isolating mechanisms are barriers to imitation that are characterized by uniqueness and distinctiveness of resources, capabilities, and assets in RBV strategy literature. Mahony and Pandian (1992) regarded RBV and the Porter framework as complementary. For instance, sharing of intangible assets like brand names or know-how might promote economies of scale that constitutes a major source of barriers to entry (Porter, 1980, pp. 7–9).

RBV characterizes capabilities as a source for sustained superior returns (Rugman & Verbeke, 2002). The link between higher returns and capabilities has also been discussed from the industry view. Functional areas must be examined to determine a firm's current position in relation to the five forces and to identify core capabilities in each key area. Examples for functional key areas include research, product development, operations, marketing, and distribution. Ascertained core capabilities indicate abilities for strategic moves and for growths to gain above average returns (Porter, 1980, pp. 63–67).

The SWOT framework supports portraying cohesiveness of RBV and industry view. SWOT analysis describes links between internal and external models of competitive advantage (Barney, 1991, p. 100). Black and Boal (1994) explained that the external 'OT'-analysis, particularly on Porter's five forces, is importantly useful but limited. They suggest starting strategy analysis on RBV considering the internal part of SWOT. In his introduction, Porter (1980) proposed consideration of opportunities and threats to determine external boundaries for strategy formulation. Besides, strengths and weaknesses on internal factors are suggested to be examined (e.g., assets and skills, financial resources) to detect internal limits. As part of a consistency test, resource fit should be checked in order to ascertain resource availability and organization's ability to change for achieving the objectives.

2.2.2 Resources and capabilities must fit to the external environment

Internal strategic objectives must match external strategic objectives and vice versa. Anupindi, Chopra, Deshmukh, Van Mieghem, and Zemel (1999, p. 23) mentioned the need for strategic fit, i.e., consistency between the selected strategic position for competitive advantage and capabilities that a firm uses to accomplish that advantage. The target position is set by the balance of what a firm might do grounded on exogenous factors and what a firm is capable of performing. Anupini et al. (1999) suggested a two-pronged analysis for business strategy: first, competitive analysis of the industry in that an organization will compete, and second, critical analysis of skills and resources.

Rowe, Mason, Dickel, Mann, and Mockerl (1994) defined strategic management as the decision process to align internal capabilities of a firm with opportunities of the environment. The firm must then adapt internally to reach the target position in the long run. Amit and Schoemaker (1993) noted that the resource-based view is complementary to Porter's industry analysis. They provided a figure of key constructs with resources, capabilities, and assets on the firm side vis-à-vis the industry side covering Porter's five forces and environmental factors. The allocation of necessary resources to implement long-term objectives is also central in Chandler's definition of strategy (1962, p. 13): strategic decisions cannot be made before both sides are entirely analyzed. Mahony and Pandian (1992, pp. 366–367) regarded RBV as additional theoretical value for the firm's strategic direction, since it considers available resources inside the firm beside market opportunities outside.

As the environment is complex and changing over time, managers must continuously gauge and rearrange organizational resources in order to meet needs from the environment. (Johnson, Scholes, & Whittington, 1988, pp. 78–79). Kor and Mahoney (2004) argued for a proper match of resources and capabilities with external opportunities. This idea is in line with the dynamic capabilities approach to adjust internal settings to external changes (Eisenhardt & Martin, 2000; Teece, Pisano, & Shuen, 1997).

Priem and Butler (2001, p. 36) regarded the notion of value as "elemental strategy concept" that is exogenous to RBV, namely markets and customers. In contrast to them, Parnell (2006) emphasized value delivery in context with RBV and market control. He argued that value and market control are functions of resources of a firm that may be evaluated by applying RBV. Black and Boal (1994, p. 132) pointed out that value of resources are their combinations according to strategic fit to the external environment.

Hoskinsson et al. (1999) reviewed roots and developments in the theoretical field of strategic management and showed swings of a pendulum. They see RBV as an inside swing of the pendulum in contrast to Porter's industrial organization approach, that is, the outside swing of the pendulum. Insufficiently, they did not discover links or complements between the inside and outside. However, their rephrasing (Hoskinsson et al., 1999, p. 439) of Barney's (1991, p. 106) explanations on valuable resources precisely expresses the interrelationship between the internal RBV and the external industry view from Porter: "Value refers to the extent to which the firm's combination of resources fits with the external environment so that the firm is able to exploit opportunities and/or neutralize threats in the competitive environment." Combination of resources is crucial, as Penrose (1959) pointed out earlier.

Spanos and Lioukas (2001) conducted empirical tests and concluded that RBV and Porter's framework do not only co-exist but are also complementary to explain business performance. Both provide views on sources for competitive advantage in a balanced way.

2.2.3 Recent research on cohesion of RBV and industry view

After having portrayed some foundations of strategy and relevant literature around the millennium, newer publications will be presented as follows.

Kraaijenbrink, Spender, and Groen (2010) comprehensively reviewed critiques on RBV. The authors simply stated that development of RBV had been complementary to the industry view. They explained why RBV is not a replacement of the industry view. Yet, they did not elucidate on complementation.

Ritala and Ellonen (2010, pp. 374–379) highlighted interdependency for competitive advantage but displayed just one argument for complementation of resource-based theories and industrial organization economics. RBV's attention is on unique resources and capabilities. In case of low hurdles to enter a market, connectivity of industry analysis and resources/capabilities becomes relevant. In response to increasing competitive pressure, a firm needs to provide more distinctive capabilities than its rivals.

De Wit and Meyer (2014, pp. 184–191) regarded markets and resources as paradox on business level strategy but emphasized the fit. They suggested taking and adopting two perspectives: The inside-out, i.e., views on resources, competences and capabilities, and the outside-in, especially the five forces from Porter. The alignment of the two sides is the key to a firm's success. When choosing a competitive position in the environment, feasibility must be internally ensured, that is, resources and capabilities must be available, be developed, or be obtained.

Huang, Dyerson, Wu, and Harindranath (2015) examined how temporary competitive advantage can be converted to sustainable competitive advantage. They considered both, RBV and industry view, as core elements to competitive success but realized that studies on competitive advantage are mostly anchored to one side. In their article, Huang et al. (2015) integrated both views into one framework and called two driving forces: endogenous forces from resources and exogenous forces from market position. Both are sources of competitive advantage that result in higher profitability. The connection of the two streams increases economic rents or company performance.

Dixit (2016) described a case of a hospital offering orthopedic and spine services in which RBV was analyzed along with the industry view and a network perspective. Other hospitals may apply this analytical approach to accomplish sustainable competitive advantage.

Napshin and Marchisio (2017) regarded RBV and the industry view as most significant theoretical models in strategic management courses in the USA. They introduced the institution-based view as a supplement and connected it to the other two.

Again, SWOT is considered as an established methodology for strategic positioning (Helms and Nixon, 2010). The SWOT framework was rediscovered by Bell and Rochford (2016) for learning purposes. They stressed the integrational characteristics of SWOT and suggested to combine it with internal analysis (RBV), external analysis (five forces), and PESTEL. Liu, McKinnon, Grant, and Feng (2010) carried out an empirical study with logistics service providers and identified SWOT as a way to anticipate aspects and arguments from both sides to explain competitiveness.

2.3 Conceptual model for competitive positioning

Togetherness of Porter's industrial concepts and RBV has been reflected. Both views, one outside the firm, the other inside, are complementary to gain and maintain competitive advantage. Moreover, both approaches are the key to setting the strategic target, that is, the future location in the competitive sphere. Strategic formulation should consider both views simultaneously for making well-adjusted decisions towards a firm's future position. Thus, a conceptual model for competitive positioning is proposed (Figure 1) derived from Amit and Schoemaker (1993). Their key constructs demonstrate the complementing phenomenon of Porter's and Penrose's concepts but give reason for some refinements. First, as a conclusion from literature review, endogenous and exogenous strategic objectives are mutually dependent. Second, SWOT is supplemented because it provides arguments for combining both sides. Third, the linkages between resources, capabilities, and assets are revised as demonstrated in the next section. Fourth, macro-environmental forces were inserted between RBV and market view (political/legal, economic, environmental, socio-cultural, technological). These forces do not only affect the industry, but also the firm's resources and capabilities. Macro-environmental factors referred to as PEEST (Kotler et al., 2016, p. 152) or PESTEL (Peppard & Ward, 2016, pp. 58-60), must be considered on impacts that are internal to the firm as well as on effects in the industry. Amit and Schoemaker (1993) assigned technology and regulation as environmental factors to the industry part, whereas the author regards macro-environmental factors such as regulation, socio-culture, technological progress, and other economics, as influencers to both sides, resources and industry. Capabilities adjust on technology changes (Teece et al., 1997, p. 512). For example, new developments in technology will change production systems and processes inside a company and can also impact the transactions between buyers and suppliers. Politics, resulting in legislation and regulation, also affect resources, e.g., occupational health acts constrain resource availability out of standard working hours. Dynamics in socio-culture have also influences on a firm's infrastructure (e.g., use of enterprise social networks).

2.4 Resources and capabilities

2.4.1 Diverse understandings on RBV core elements

Ambiguity exists with respect to the core elements of RBV: resources, capabilities, and assets. There are manifold interpretations and various definitions within the body of strategy knowledge.

Cousins (2005, p. 407) uses the terms resources and capabilities interchangeably, while other scholars understand capabilities and competences as synonyms (Peppard & Ward, 2004, p. 174; Wade & Hulland, 2004, p. 109). Thereafter, one could logically deduct that resources are competences. This reasoning would be valid but false (Van de Ven, 2007). Resources are also regarded as collection of all capabilities and all assets of a firm (Hooley et al., 1998, p. 101; Wade & Hulland, 2004, p. 109), as a part of a function (Haapanen, Hurmelinna-Laukkanen, & Hermes, 2018), or as tradable/non-tradable assets stocks/flows (Saranga, George, Beine, & Arnold, 2018, p. 34). Resources that are hard to copy might be seen as firm-specific assets (Teece et al., 1997, p. 516). Resources also might be understood in context with customers, markets, or products. In Eisenhardt and Martin's opinion (2000, p. 1107), resources act in activity systems to address customers and markets in differentiated ways for competitive advantage. As part of a process, dedicated or specialized resources carry out a determined set of activities, e.g., aligned to a product (Anupindi et al., 1999, p. 10).

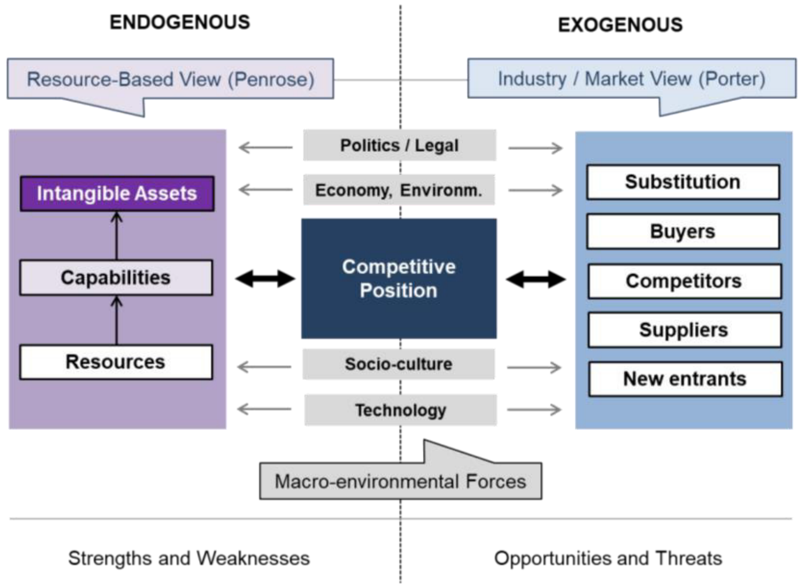

Figure 1: Model for competitive positioning (adapted from Amit & Schoemaker, 1993)

Diverse definitions of assets do not increase understanding of the topic. Amit and Schoemaker (1993) regarded strategic assets as resources and capabilities that are difficult to trade or tough to copy. Barney (1991) saw assets as firm resources along with capabilities, knowledge, and more. Kamasak (2017, p. 261) allocated assets, such as intellectual property rights, to the group of intangible resources items. Luo, Zhang, Bose, Li, and Chung (2018) expressed information technology as asset and as resource in the same article.

So, there are many inconsistencies about resources, assets, and the links between them. The newer the perspectives on the concept of resources, the more increases confusion. The author tries to provide more clarity by recommending the following definitions for capabilities and by recalling some early notions in the next section.

Capabilities relate to organizations (Saranga et al., 2018). Drnevich and Croson (2013, p. 485) defined capabilities as "a firm's capacities to deploy resources, usually in combination, using organizational processes, to affect a desired end". Helfat and Peteraf (2003, p. 999) referred a capability of a firm to an organizational ability to perform coordinated activities by using resources to achieve a defined result.

2.4.2 Recalling foundational ideas for redefinitions

Penrose (1959, p. 21) offered the groundworks for a rich distinction of resources that are tangible by definition. Resources are either physical objects used for production (e.g., plant, equipment, raw materials) or humans with various skills who are contracted by the firm. Skills might be creativity, knowledge, experience, etc. and always relate to human resources. In contrast, other authors relate skills to capabilities (Kamasak 2017; Wade & Hulland, 2004). Penrose (1959, p. 22) enumerated administrative, financial, legal, technical, and managerial work forces as human skills. A special skill at top management level is integration, i.e., knowing what managerial resources to combine and how to integrate them in effective ways (Kor & Mesko, 2013). Resources are inputs to production (Helfat & Peteraf, 2003, p. 999). The different types of resources provide activities in various combinations.

A firm's capabilities are linked activities or bundles of them that special resources, i.e., skilled humans and/or physical objects, provide in efficient and organized ways for delivering a differentiated product. Capabilities always refer to organizations since they are based on sets of activities to that various resources contribute. Typical examples of capabilities are tasks and processes within the fields of primary or support activities of the generic value chain from Porter (1985, p. 37) that is implicit in the model depicted as Figure 2. Porter (1980, pp. 64–67) listed capabilities in the areas products, distribution, marketing, sales, operations, research, engineering, costs, financial strength, organization, general managerial ability, portfolio.

According to Whittington (2008, p. 272), strategy should build on rare, hard-to-imitate, and hard-to-substitute resources. In contradiction to him, this paper suggests that strategy should build on rare, hard-to-imitate, and hard-to-substitute capabilities that might end up in intangible assets that can be protected by rights. Resources by themselves do not make the ultimate distinction from competitors but their qualities, skills, and the way they combine to capabilities make the difference.

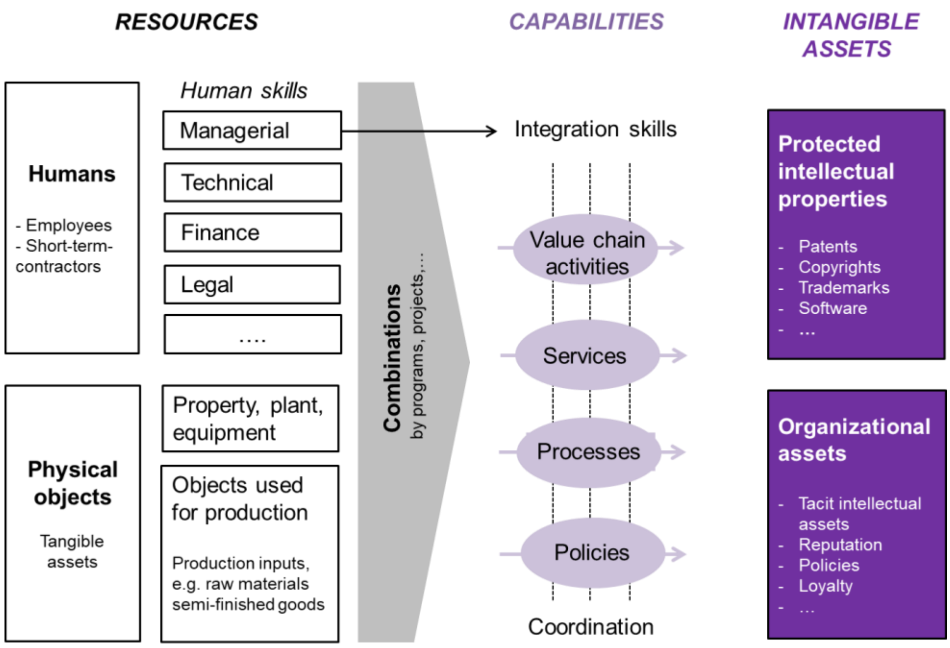

Figure 2: Resources, capabilities, and intangible assets (Source: author).

Core capabilities are the few ones that a firm carries out particularly well and in distinguished ways compared to competitors. *Competences* are core capabilities on business unit level and enhance competitive advantage. *Core competences*, in the eyes of Prahalad and Hamel (1990), are seen on corporate level by composing various competences to several core products managed from different business units within a company.

Rothschild (1976) classified capabilities into five main categories: abilities to conceive and design, to produce, to market, to finance, and to manage. All categories contain human resources with specialized skills. Besides, categories contain physical resources, processes, policies, and organization in various ways. Rothschild's classification provides a suited platform to verify required capabilities but gives reason for improvements by adding contemporary management processes (e.g., project management, IT management) and by distinguishing between activities (or services) and required resources to perform them. Figure 3 exhibits a template as suggestion for assessment and development of capabilities based on Rothschild's ideas (1976). It is to analyze what should be carried out and what resources are required to support the strategic position. The effectiveness of resources and the services they provide need to be thoroughly checked. Recognition of the organization's relative capabilities can draw on analysis of strengths and weaknesses of capabilities in all functional areas (Porter 1980, p. 111). The template also helps to identify areas in which a company significantly performs better than its rivals, i.e., core capabilities.

Essentially, RBV is about internal growth of assets (Peteraf, 1993, p. 188). Integrating Penrosean ideas and principles of financial accounting, the author recommends applying the notion of assets as

- physical resources used to produce (e.g., property, plant, equipment) or as inputs to production, and
- intangible assets that are
  - protected intellectual properties (e.g., patents, copyrights, trademarks, confidential documents, software), and/or
  - organizational assets (e.g., tacit intellectual assets, reputation, loyalty).

The author's definitions exclude financial capital, often expressed as financial asset or as monetary resource, by reason of interrelatedness to other external factors. Funding of a firm is a strategy of its own and requires further strategic lenses. Capital flows must be balanced between rents that shareholders demand and retained earnings that can be used for company growth.

2.4.3 Capabilities must be developed internally or acquired from external organizations

Resources can generally be transferred via markets for human resources or for physical objects. For example, skilled human resources, providing required experience and knowledge, can be contracted on labor markets. Physical objects, such as production materials and engines can be bought or leased. Buildings can be constructed or rented. Intellectual property rights can also be gained if traded on markets, e.g., by licensing. In contrast, capabilities cannot be bought off the shelf. They are immanent to a firm and must be developed within an organization. Capabilities make their organization's value and are not transferable to other organizations. Likewise, experience is not transferable from one human resource to another.

Capability category	Required skills (from human resources)	Required physical resources (physical assets)	Capabilities (activities, services, processes, policies)	Intangible assets (intellectual properties, organizational assets)
New product development				
Procurement, supply				
Production, manufacturing				
Marketing, sales				
Information systems				
Project management				
……				

Figure 3: Template for assessing capabilities and needed resources (Source: adapted from Rothschild, 1976).

It takes considerable time and money to establish capabilities within the own organization. Managers must think about accessing capabilities from other firms that have already established those capabilities and integrate them, loosely or tightly, within the own organization. The need to acquire productive services to complement existing activities might motivate a merger or an acquisition (Pitelis, 2009). Salter and Weinhold (1982) gave similar resource-based reasons for acquisitions. First, to supplement resources that already exist. Second, to complement resources for more effective combinations (synergies). Furthermore, acquisition strategies can also be oriented towards products to join attractive markets (Wernerfeld, 1984). From a combined resource-based and industrial viewpoint, acquisitions of organizations or alliances are to move to the strategic target position. If a firm does not develop capabilities internally and does not integrate them by acquisitions or alliances, it may contract other firms to purchase goods or services for transaction costs (Williamson, 1975).

2.5 The RBV and the industry view for strategic IT planning

2.5.1 IT strategy must integrate internal and external views

As the overall business strategy of an organization, the formulation of IT strategy must include internal and external facets. External facets include the marketplace, firm relationships, products, etc. Examples for internal facets are organizational structure, business processes, and human resource skills (Henderson & Venkatraman, 1999, p. 474).

Understanding the impacts of IT on the external environment and on the organization's strategy enables IT managers to prioritize objectives and allocate their resources adequately (Parsons, 1984, pp. 46-47).

Two considerations must strategically be balanced: first, what an organization must do in view of opportunities in the external environment, depending on pressures and impacts, and second, what a firm can do regarding its internal resources, capacities, and assets (Peppard & Ward, 2016, p. 261). Henderson and Venkatraman (1999) proposed a strategic alignment concept that emphasizes matches between internal and external domains for both business strategy and IT strategy in order to optimize the firm's performance.

SWOT ideas that link internal and external views are not only present in general strategy research but also in the IT strategy literature. IT strategies include assigning resources to profit from opportunities and to mitigate threats (Parsons, 1984, pp. 59–60). For example, Vitale, Ives, and Beath (1986, pp. 271–272) described an adaptive model for aligning external threats and opportunities with organizational resources and capabilities. However, Kohli and Devaraj (2004, p. 58) lamented that the evaluation of strengths and weaknesses is less pronounced in IT strategies in contrast to business strategies.

Strategic IT changes might be motivated from external forces, such as legislation, technology, or market trends (Keen, 1991, p. 47). Technology trends influence a firm's IT, and hardware and software markets must be assessed (Premkumar & King, 1994, p. 82). Market-driven organizations are superior in that they understand the market and the customers and in terms of how they develop capabilities accordingly. The creative use of IT provides opportunities for new capabilities and skills for distinctive products/services. The enhancement of capabilities includes analyses of current capacities, needs of future capabilities, and opportunities from IT (Day, 1994, p. 46). Thus, linking the industry view to the RBV helps to differentiate with IT and therewith extends competitive advantage.

Drnevich and Croson (2013) discussed business-level strategies that are important to IT value creation. The industry view and the RBV belong to the top eight theoretical perspectives in the IT strategy literature (Drnevich & Croson, 2013, pp. 486–487). The other six core theories build on the industry view and the RBV as theoretical platforms or are linked to at least one of both. For example, the knowledge-based view is an extension of the RBV to leverage skills (Drnevich & Croson, 2013, p. 493). The industrial-organization economics theory deals with collusion among market players to restrain rivalry or restrict entries from others; it is a research subarea within Porter's (1980) five forces model—that is, the industry view. The transaction-based theory deals with sourcing and/or governing of resources for efficiency in resource allocation (Drnevich & Croson, 2013, p. 487, p. 491). These resources require definitions in accordance with the RBV before decisions on their allocations can be made. The agency theory highlights costs that are associated with transactions and governance (Drnevich & Croson, 2013, p. 491). The dynamic capabilities theory advances the RBV for flexible reconfigurations of resources, capabilities, and assets in relation to conditions that can be analyzed with the industry view (Teece, Pisano, & Shuen, 1997). Finally, "real options", another core theory mentioned by Drnevich and Croson (2013), is a technique to evaluate IT strategies under risk aspects; it does not offer a strategic view in itself. In conclusion, the RBV and the industry view can be considered as foundations of other theories in IT strategy research.

The industry view and the RBV provide highly relevant strategic lenses for competitive advantage from IT. Bhatt and Grover (2005, p. 257) presented four perspectives on the sources of IT-based competitive advantage: the industry view (Porter's five forces and the generic strategies), the RBV, the complementary resource view, and the economic view. The economic perspective is constrained because its focus is on switching costs; therefore, it has low potential for differentiation. The complementary resource view is also of minor importance; it concentrates on uniqueness and does not sufficiently reveal the opportunities for dynamic resource management. Thus, the RBV and the industry view are most significant in the IT strategy science; together, they cover the interrelated external and internal sides of a firm.

The alignment of IT strategies to business strategies, also referred to as the contingency theory, complements the RBV in strategic analysis of IT value (Oh & Pinsonneault, 2007, p. 257). The contingency theory proposes that the overall business strategy of an organization and the IT strategy must be formulated in context; the better the match between both kinds of strategy, the higher is the resulting value (Oh & Pinsonneault, 2007). According to Kohli and Devaraj, (2004, p. 58) strategic IT-business alignment must not only consider resource needs but also external opportunities. Therefore, the industry view is another complement to IT-business alignment. In summary, it can be said that the proposed model for competitive positioning (Figure 1) also applies to IT strategy. This model integrates the internal RBV, the external industry view, and the SWOT framework; it is a complement to IT-business alignment.

As presented, the RBV and the industry view represent the most important theories in IT strategy. They integrate external and internal perspectives that are relevant for IT strategy formulation and both views constitute a foundation for other meaningful IT theories. In addition, IT-business alignment, a central IT strategy research area, supplements the RBV and the industry view. Next, the coherence of RBV and the industry view in the IT area is discussed.

2.5.2 The cohesion of the RBV and the industry view in IT strategy

In the area of business strategy research, a few authors found linkages between the RBV and the industry view (e.g., Hoskinsson et al., 1999); moreover, a few researchers revealed the complementary nature of both theories (e.g., Amit & Schoemaker, 1993; Spanos & Lioukas, 2001; Teece, Pisano, & Shuen, 1997), as described in the previous sections. A reconciliation of the RBV and industry views in business strategies has also been demonstrated by Henderson and Mitchell (1997) and Eisenhardt and Martin (2000). Henderson and Mitchell (1997) wrote a theoretical article on the impacts of strategy and performance from firm-internal capabilities and competitive environments. They concluded that competition (industry level) and capabilities (firm level) influence each other, for example, from experiences at both levels. The authors suggested that firms develop capabilities when operating in competitive environments. According to Eisenhardt and Martin (2000, p. 1105), the RBV complements the industry view to determine competitive advantage. Moreover, the authors suggested that organizational resources perform activities in different ways which are directed to specifics of externalities, thereby implying markets and customers, to enhance competitive advantage. An organization's capabilities do not only fit to market demands but also change or shape markets by establishing processes that enable new resource configurations. This approach is termed "dynamic capabilities."

In IT strategy research, both the industry view and the RBV have been theoretically utilized to understand the links between IT and business value (Rivard, Raymond, & Verreault, 2006, p. 33). However, in IT strategy research, only a few attempts have been made to demonstrate the cohesiveness of these links. Using a survey with 96 small and medium enterprises, Rivard, Raymond, and Verreault (2006) provided empirical evidence that the RBV and the industry view complement each other in terms of IT support for business performance.

Another essential theoretical contribution from Rivard, Raymond, and Verreault (2006, p. 35) was the illustrative mapping of the industry view and the RBV to the recognized strategic alignment model from Henderson and Venkatraman (1999, p. 476). For both business and IT strategy, the RBV relates to internal domains (infrastructure and processes) and the industry view to external domains. The integration of the RBV and the industry view into the IT-business alignment model from Henderson and Venkatraman (1999) supports the previous conclusion that the theoretical streams of the RBV, the industry view, and IT-business alignment complement each other. Alignment in terms of "fit" must be achieved in two ways: first, alignment between business strategy and IT strategy, and second, the consistency between the RBV and the industry view. A shortcoming of the "strategic alignment model from a dual perspective" from Rivard, Raymond, and Verreault (2006) is the absence of macro-environmental forces that affect all components in both dimensions. External environmental influences (e.g., governmental policies, worldwide economic situations, societal/cultural concerns, technology development) must be taken into consideration because they have a strong impact on IT strategy (Gregor, Martin, Fernandez, Stern, & Vitale, 2006, p. 253).

2.5.3 The RBV, the industry view, and IT value

Several efforts have been made by researchers to display and describe models for IT-business value. These models also reflect the coherence of the RBV and the industry view to improve organizational performance. Some authors used basic terms differently or provided a few elements of the RBV or the industry view in other combinations or in an incomplete manner.

An influential IT-business value model integrating the RBV and industry characteristics was drawn by Melville, Kraemer, and Gurbaxani (2004). They portrayed the RBV as a firm-internal IT business process that combines IT resources and organizational non-IT resources into value-generating processes that are embedded in a competitive environment, which, in turn, is surrounded by the macro-environment. This model is distinctive as it adds the macro-environment to the RBV and the industry perspectives. Yet, the industry perspective is different from Porter's five forces; it addresses organizational structure of industries, relationships among firms, regulation, technological change, etc. Moreover, the macro-environment is different from the well-known PESTEL frame, as it concentrates on country-specific factors.

Further, a process model for IT-business value was combined by Soh and Markus (1995) by capturing intellectual ingredients from previous IT-value process models. The resulting process does not explicitly incorporate the RBV and the industry view but elements of both—namely, IT assets that are processed to obtain organizational value in a competitive environment. Because the process is unidirectional and incomplete, this model fails to express the external forces that impact IT assets.

Schryen (2013) attempted to combine the two models mentioned earlier with two other IT business value models (Dedrick, Gurbaxani, & Kraemer, 2003; Dehning & Richardson, 2002). The integrated model depicts IT investments—that is, IT resources, IT capabilities, and IT assets, apart from contextual/environmental factors and non-IT investments as central drivers for organizational performance. The contextual/environmental factors include macro-economic and industry factors, but these are neither presented as the five forces (Porter, 1980) nor as PESTEL elements.

As reflected, only a few authors in business strategy research have emphasized the complementary traits of the RBV and the industry view. In IT strategy research, certain IT business value models illustrate the cohesion of the RBV and the industry view without denoting them explicitly; moreover, only a few models contain macro-environmental forces.

2.5.4 Impacts on strategic IT planning

IT planning requires both the external and internal perspectives, particularly with regard to competitive advantage from IT (Earl, 1989, p. 79). Attention to external and internal facets is important for strategic IT planning (Ramanujam & Venkatraman, 1987). The IT planning agenda comprises external aspects (e.g., politics, markets, technologies, risks) as well as internal items (e.g., IT infrastructure, organizational topics, risk averseness) to be analyzed (Boynton & Zmud, 1987). Lederer and Salmela (1996) suggested that effective and efficient IT planning depends on the stability of the external environment, the simplicity of internal environment, and high-quality planning resources. The external environment (e.g., new technologies, legislation, supplier trends, competitor activities, customer needs, etc.) needs to be known to take into account external changes. The internal factors refer to organizational structures, skilled human resources, planning software, etc. Internal and external analytical insights are required not only for the ends (product/services that create value) but also for the means in the IT-planning process. IT-planning practices are impacted by factors that are both internal and external (Premkumar & King, 1991). Thus, strategic IT planning must be adequate in terms of the efforts made to understand the external environment and the internal organization. Moreover, the strategic IT-planning process must also be sufficiently fast not to be overtaken by external or internal changes (Newkirk, Lederer, & Srinivasan, 2003, p. 202).

IT planning is a spanning capability that connects "outside-in" capabilities to "inside-out" capabilities based on the ideas from Day (1994) and Wade and Hulland (2004). Day (1994) classified external processes (outside-in), internal processes (inside-out), and spanning processes for successful market-oriented organizations. Spanning capabilities involve integrating external and internal processes to meet customer needs. In a technology context, new technologies and market demands can be monitored "outside," while the own-technology development is "inside," and product strategy—a spanning capability—connects inside and outside processes. Wade and Hulland (2004) transformed this concept to IT and exhibited IT planning as a spanning instance between inside-out items (IT infrastructure, IT skills, IT development, and IT operations) and outside-in topics (market responsiveness; external relationship management). Thus, IT planning as a spanning capability requires internal and external analyses to integrate the inside-out and outside-in capabilities of the organization.

Internal and external analyses are two major IT planning areas (Premkumar & King, 1994). IT planning is a process of analysis that also considers assessments of internal strengths and weaknesses and external opportunities and threats (Premkumar & King, 1991, 1994). Analysis of strengths, weaknesses, opportunities, and threats (i.e., SWOT) is a meaningful IT planning activity that had also been emphasized by Ramanujam and Venkatraman (1987) and Rivard, Raymond, & Verreault (2006). A SWOT-based approach is useful for IT planning; it is founded on the RBV and the industry view, which complement each other (Rivard, Raymond, & Verreault, 2006, p. 46).

In summary, IT planning is a strategic means for value creation and a spanning capability between external and internal processes. Therefore, the external environment and the internal organization must be thoroughly analyzed by IT planners. For this, the RBV and the industry view offer well-suited complementing perspectives along with the macro-environment. IT planning must consider and align in terms of two interrelated dimensions: internal/external and business strategy/IT strategy. The results from IT and business planning must be internally consistent and externally valid (Reich & Benbasat, 1996, p. 58)—that is, the IT plan must adequately address all pertinent factors (Henderson & Sifonis, 1988, p. 194).

2.6 Conclusions

Literature analysis showed that traditional theories from Edith Penrose (1959) and Michael Porter (1980) complement each other. Inside-out constructs on resources and capabilities must match outside-in constructs on industry and markets in order to achieve competitive advantage. This article proposes taking both views at the same time for business strategy formulation. Available competences may enable or motivate strategic moves of a firm in the competitive field. Also, strategic decisions in response to the five forces result in changes of capabilities and resources. A conceptual model for competitive positioning extends existing theories on complementation of RBV and industry view. It provides a broader picture including SWOT and macro-environmental factors that impact both sides of the proposed conceptual model, the endogenous and the exogenous.

The terms resources, capabilities, and assets were defined by recalling the resource descriptions from Penrose and by considering capabilities as value chain activities that combine resources. Own resources and capabilities must be aligned to exogenous strategy and be assessed in comparison with competitors. A template for capability assessment has been proposed for application in practice. Capabilities can only be developed within organizations. Inter-firm cooperation, mergers, and acquisitions are alternative approaches for gaining needed capabilities from other organizations.

Like business strategies, IT strategies require firm-internal and external evaluations, for which the RBV and the industry view are appropriate and complementary. Both views are interrelated and useful for understanding the value from IT investments and for IT-business alignment. Strategic IT analyses include SWOT and macro-environmental factors (PESTEL). IT planning must concurrently consider internal and external views; it is a capability that connects internal and external processes for value creation and competitive advantage. The suggested conceptual model for competitive positioning may be used to assess both business strategies and IT strategies. However, the challenge of *how* to align the business strategy with the IT strategy remains.

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3 OPERATIONAL EXCELLENCE AS THE MAIN CUSTOMER VALUE: INFORMATION TECHNOLOGY VENDORS' PERSPECTIVE

Abstract

Background: Information technology (IT) requires substantial investments from enterprises to build competitive capabilities. IT products are supposed to provide value to customers and to increase the competitiveness of enterprises. Vendors of IT products should take the competitive strategy and value creation for enterprise buyers into account. Objectives: This article takes the perspective of IT vendors (ITVs) and attempts to answer the research questions "What types of customer value do ITVs consider?" and "Do ITVs consider the competitiveness of enterprises?" Methods/Approach: This research investigates descriptions from ITVs and analyzes patterns and correlations of coded content. The annual reports of 32 global market-leading ITVs were examined through direct content analysis. Results: Half of the annual reports mention the competitiveness of enterprise buyers; 84% of the samples relate to customer-value disciplines. Moderate positive and monotonic relationships were detected between customer value disciplines. Conclusions: ITVs consider the competitiveness of buyers and noticeably regard customer value disciplines, mainly operational excellence, that in turn refers to process efficiency and cost-effectiveness.

3.1 Introduction

In order to increase their competitiveness, enterprises must acquire resources and enhance capabilities that provide customer value and that are hard for other market players to attain (Barney, 1991). Information technology (IT) products are central resources in an enterprise's operation and consequently provide the basis for building capabilities for value delivery and for competitive advantage (Clemons & Row, 1991; Drnevich & Croson, 2013; McAfee & Brynjolfsson, 2008; Peppard & Ward, 2004, 2005; Venkatraman, Henderson, & Oldach, 1993). In general, operational IT products are significant capital investments that should provide backflows (ISACA, 2010). IT strategy is concerned with IT supply (Peppard & Ward, 2016). Thus, vendors of IT products play a pivotal role in both IT strategies (Ward, 2012) and value delivery (Chicksand & Rehme, 2018). Their products must meet the requirements specified by enterprises (IIBA, 2015), and they are a source of innovation for introducing new products in enterprises (Vishnevskiy, Karasev, & Meissner, 2016). Therefore, IT vendors (ITVs) must be clear on how their products can enhance the competitiveness of their business buyers, i.e., enterprises, and must be clear on what type of value can be provided to end customers.

To date, business-systems science has paid little attention to ITVs and their perspectives on the enterprise competitiveness and customer value that result from their products (Singh & Paliwal, 2012). Furthermore, the types of values that IT products deliver needed more clarification (Gandelman, Cappelli, & Santoro, 2017; Lieberman, Balasubramanian, & Garcia-Castro, 2018). The values generated for customers by information systems might be low prices, new features or functions, or a solution to a customer-specific problem. Customer values can be distinguished in three distinct types, namely, product leadership, operational excellence, and customer intimacy (Treacy & Wiersema, 1995). These types and their significant implications for competitiveness have been neglected in past IT-strategy studies.

This paper proposes to explore the connection between IT products and IT strategy in view of competitiveness and customer value. It aims to identify the types of customer value provided by IT products and to discover patterns among them. The goal is to understand better the impacts of IT products on competitiveness and the types of value that IT products generate. The phenomena may be studied from the buyer or from the supplier side. In this paper, the supplier side has been selected, specifically ITVs. Despite an increased interest in business-IT alignment, it is surprising that so little research has been conducted on IT products and their competitive consequences, especially from the perspective of ITVs. This study remedies these deficiencies by revealing the views of ITVs on the competitiveness of their buyers and on the types of value delivered to end customers, as indicated when ITVs describe their products and their business in annual reports.

As little is known about the theoretical foundation of customer value from IT products, qualitative research was employed in order to explore the context (Creswell, 2013). Qualitative research is assumed to be better suited to building theories (Myers, 2013), and so the chosen approach was inductive. Exploratory research starts from the bottom and begins with data collection, followed by analysis and development of propositions (Myers, 2013; Van de Ven, 2007). The document-content analysis was the selected qualitative method; it concerns context, meanings, and intentions. Inferences are made about written texts in systematic and objective ways to describe and quantify a phenomenon (Downe-Wamboldt, 1992). Latent content analysis (Hsieh & Shannon, 2005) was applied to documents from ITVs. Annual reports were chosen as the document type because they are addressed to investors and they provide more reliable and more trustworthy information than marketing documents. Business descriptions and product presentations within the annual reports of 32 global market-leading ITVs were studied using codes for competitiveness and customer value. Content categories and coding units for customer value were defined using concepts from Treacy and Wiersema (1995). The frequency of hits of coding units was evaluated, and correlations were calculated.

This study of ITVs' views on customer value is significant to business systems theory for several reasons. First, it demonstrates that the customer-value disciplines of Treacy and Wiersema (1995) are appropriate for typifying IT values. Second, it generates the proposition that operational excellence is the most prevalent customer-value type from IT products. Third, the study discerns patterns and correlations between competitiveness and customer-value disciplines. IT strategists in practice may purposefully align their investments in IT products to customer values as defined in their business strategy.

The paper has been organized as follows. The literature review integrates the strategic implications of IT products and illuminates the role of ITVs in affecting customer value and competitiveness. The methods of content analysis are then presented in detail, including selections of content, samples, and units of analysis. Additionally, the coding agenda, containing the categories and coding units, is provided. The results are reported by the number of hits of context units in the studied annual reports. The findings are described by percentage shares of customer values and correlations among the content categories. The discussion and conclusion sections present interpretations of the findings as answers to the research questions, address the limitations and assumptions of the study, and suggest directions for future research.

3.2 Literature review

3.2.1 IT as an essential part of an enterprise's competitive strategy

According to Clemons and Row (1991), IT is central to a firm's competitive strategy. Strategic planning of IT comprises finding computer applications that help to achieve the business goals of an organization (Lederer & Salmela, 1996). All primary and support activities within the generic value chain generate and use information (Porter, 1985). Consequently, IT is present in all parts of the value chain and is critical for linking information between the activities of a firm.

Technology influences competitive advantage, if it affects costs or differentiation, and therefore it supports generic strategies such as cost leadership or focus (Porter, 1980, 1985). Technology strategy is the method of developing and applying technology to contribute to the overall strategy pursued by a company (Porter, 1985). For IT, this idea has unfolded in various approaches, such as architecture management (The Open Group, 2011), business analysis (IIBA, 2015), or the 'Enterprise Information Technology Body of Knowledge' (IEEE, 2017). The aim is to plan and implement IT that supports an enterprise's strategy for competitive advantage.

The need to fit IT with other elements of an enterprise's strategy is of growing interest in science and practice. For instance, the resource-based view, which is the dominant analytical, strategic tool for achieving sustainable competitive advantage, has been extended to analyze and plan IT capabilities (Wade & Hulland, 2004). Luftman (2003) suggested that the IT architecture and IT strategy should enhance the business and align to the enterprise strategy. Contemporary IT-management frameworks, e.g., TOGAF (The Open Group, 2011) or COBIT (ISACA, 2012), are becoming increasingly popular in industrial practice as ways to utilize technology for the support of competitive strategy in structured ways. There are many ongoing discussions on how best to develop IT in enterprises according to their business strategy. IT managers have stressed the importance of aligning IT with business strategy (El-Mekawy, Rusu, & Perjons, 2015; Luftman, 2003; Marrone & Kolbe, 2011). In 2013, researchers from IBM conducted interviews globally with 875 CEOs in various industries and found that most executives described a strong impact of technology on strategy (Berman & Marshall, 2014). IT is a crucial part of an enterprise's competitive strategy. IT capabilities must fit the enterprise's strategy and additionally provide value to customers.

3.2.2 Customer value from capabilities produced by IT products

Broadly speaking, the competitiveness of an enterprise is dependent on its ability to sell and deliver products (goods, services, results, or combinations) that are more highly valued by customers compared to those of its rivals in a specific market. Michael Porter has provided a meaningful definition of value (1985, p. 3): "Value is what buyers are willing to pay, and superior value stems from offering lower prices than competitors for equivalent benefits or providing unique benefits that more than offset a higher price." Value creation is the key to profitability and competitiveness (Dranove & Marciano, 2005). Although the notion of value creation has been discussed for several decades, its definition and the meaning of the concept are still unclear (Lieberman, Balasubramanian, & Garcia-Castro, 2018). Little research has been done on the concept of value, although IT value is one of the more investigated subjects. The research focus has been on evaluation methods for IT investments, and scholars have lacked an understanding of the concept of IT value (Gandelman, Cappelli, & Santoro, 2017).

Recognized studies regarded IT as an enterprise resource (Bharadwaj, 2000; Feeny & Willcocks, 1998; Wade & Hulland, 2004) or as an enterprise capability (Peppard & Ward, 2004) for value creation. Daulatkar and Sangle (2016) described the concept of IT business value and argued that IT supports companies in fulfilling their product objectives and their strategic vision for competing in innovative markets. Martins and Zacarias (2017) present products and values as elements of the service layer of "Business Process and Practice Alignment Methodology." Christensen (2010) connected the business value and competitiveness by saying that the type of value is of secondary importance; more relevant for competitive advantage is a customer or user's motivation for buying products from an enterprise rather than from its competitors.

Customer value from IT products requires more clarity and further exploration. Moreover, the relationship between customer value and an enterprise's competitiveness is of interest. Tallon (2007) analyzed IT business value under various strategies and used Treacy and Wiersema's (1995) value disciplines, which enterprises can use to create customer value. These value disciplines are three generic approaches to offering outstanding advantages to customers: product leadership, operational excellence, and customer intimacy. Companies compete on innovation, newness, superior design, and short time-to-market when pursuing product leadership, whereas operational excellence focuses on offering the lowest price by producing high volumes or providing high process efficiency. Enterprises may also compete by formulating and implementing customer intimacy as a value discipline, offering products tailored to individual needs and cultivating relationships with customers.

3.2.3 ITVs are connected to customer value and IT strategy

Chicksand and Rehme (2018) extended the definition of value to business relationships; total value integrates the perspectives of the buyer and suppliers that share the entire value. ISACA (2012, p. 17) demonstrates the increasing influence of external IT parties, such as service providers and suppliers, that contribute to delivering the expected value. Some external vendors play a critical role in supporting an enterprise's business (ISACA, 2012, p. 76). Suppliers provide specialist skills, goods, and services to create outcomes required by customers and users (Office of Government Commerce, 2002, p. 6). Moreover, suppliers build trustful relationships with their buyers (Duc, Siengthai, & Page, 2013). Feeny and Willcocks (1998) introduced nine information-systems core capabilities. In one of them, the "vendor development" capability, they identified the potential for long-term supplier/buyer relationships that extend revenues for both and allow them jointly to understand the business for common growth.

"The concept of IT-value planning" (Gellweiler, 2017, p. 145) reflects the dependency of IT products on enterprise strategy. It describes the link between competitive strategy and IT-product requirements. According to this idea, requirements for new IT products must support the competitive strategy of enterprises and must relate to value creation. Goods, services, and solutions from ITVs must meet the IT-product requirements that enterprises specify, e.g., new features and functions. Consequently, the requirements of enterprises need to be well understood by vendors and bidders (IEEE, 2017). The reliability of ITVs and the fulfillment of requirements may be formally assessed through responses to requests for information (RFI) or requests for proposal (RFP) from enterprises (IIBA, 2015). Products from ITVs are logically linked via these requirements to the competitiveness and value creation of enterprises. Figure 1 depicts an adapted sequence for IT-value planning and highlights ITVs, which must fulfill those requirements with their IT products.

In conclusion and according to Ward (2012), IT products and their suppliers exercise a critical influence on enterprises' strategic information systems. Singh and Paliwal (2012) have pointed out that value creation has been examined extensively in buyer/seller relationships, but research on customer value is still immature. They also stress the importance of creating value for end customers as part of the buyer's value chain.

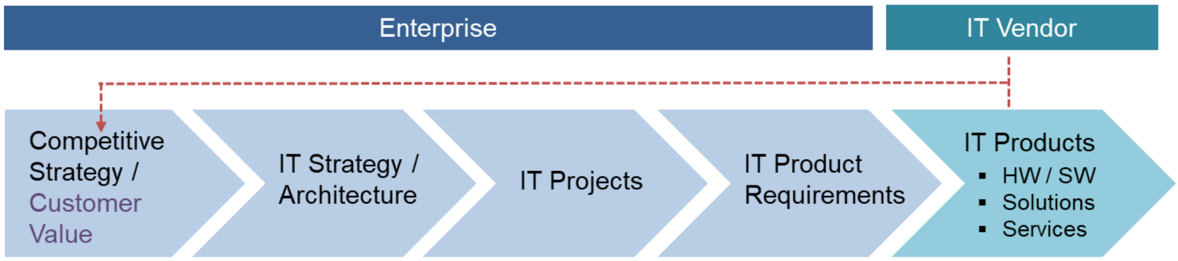

Figure 1: IT products meet requirements derived from the competitive strategy (Source: adapted from Gellweiler, 2017)

3.2.4 Research problem

This research explored the connection between IT products and business strategy from a vendor perspective. It attempted to discover whether ITVs reflect enterprise competitiveness and customer-value creation when describing their IT products and their business in annual reports.

ITVs are suppliers of hardware, software, and services to enterprises. Those deliverables may be considered as resources and inputs to an enterprise. Enterprises combine them and further develop capabilities within their organizations. Superior capabilities from combined IT products provide value to the customers of an enterprise and increase enterprises' competitiveness.

The research sought to answer two questions. The first, "What types of end customer value do ITVs consider?" asked for the typology of customer values from IT products and referred to the frequency of each type. The second, "Do ITVs consider the competitiveness of enterprises?" looked for the frequency of codes for competitiveness. Furthermore, patterns and correlations between competitiveness and value disciplines were examined. The contents of the annual reports of selected ITVs were evaluated on determined coding units to answer the research questions.

3.3 Methodology

3.3.1 Philosophical assumptions

Pragmatist philosophy underlies the selections of research strategy and methods of data collection and evaluation. Epistemology, ontology, and axiology are adopted as appropriate for answering the research questions (Saunders, Lewis, & Thornhill, 2016). Pragmatists focus on outcomes and solutions and have free choice on techniques that are suitable to the purpose (Creswell, 2013). The data collection and numerical analysis strove for objectivity and avoided conscious bias. In contrast, the discussion of findings and conclusion are interpretations and, hence, value-laden. They reflect the researcher's subjective views.

3.3.2 Content analysis

Content analysis was the chosen technique for gathering and analyzing textual content in documents. Textual data create categories and explanations in inductive ways (Pope, Ziebland, & Mays, 2000). "Inductive content analysis is used in cases where there are no previous studies dealing with the phenomenon" (Elo & Kyngäs, 2008, p. 107). Content analysis helps to answer research questions that have a wider exploratory purpose (Saunders, Lewis, & Thornhill, 2016). This methodology is based on coding and categorizing qualitative data for quantitative evaluation. Content analysis is a mature scientific method that adheres to principles of objectivity, systematic structure, and generalizability. One purpose is to pose the features of the content. Quantitative expressions can be made that provide specific and objective data about the phenomenon and yield meaningful results (Prasad, 2008), e.g., concepts or categories, that describe the phenomenon (Sandelowski, 1995).

The content analysis must be carried out in a transparent, replicable, and consistent manner (Saunders, Lewis, & Thornhill, 2016). In line with Prasad (2008), the following steps were carried out:

- selection of content and samples.
- development of content categories.
- selection of units of analysis.
- preparation of a coding agenda.
- data collection and evaluation.

3.3.3 Selection of content

To answer the research question, annual reports were selected for two reasons as the type of document under investigation. First, annual reports contain tight and meaningful descriptions of a business and the products that are created for investors. These descriptions are therefore more reliable and trustworthy than other sources. Annual reports are prepared for analysts and reflect strategy and financial performance by means of balance sheets, cash-flow statements, and income statements. Infringements in annual reports may result in notable impacts for ITVs, particularly losses in share value.

Second, annual reports provide better comparability between ITVs because of standardization and the similar lengths of texts for business and product descriptions. Also, annual reports are more self-reflective. Authors present the companies' views and not opinions from outside, such as those of industry or business analysts from external consulting firms or the press. Compared to advertising web pages, product sheets, or brochures that try to convince customers by using fashionable terminology, annual reports are not in suspicion because of the use of buzzwords or jargon. Thus, text coding is expected to be less distorted when analyzing annual reports. Another advantage of documents is their unaffectedness by the research process and their "unobtrusiveness" (Bowen, 2009).

Companies traded on stock exchanges in the United States are obliged to submit Form 10-K from the U.S. Securities and Exchange Commission (SEC). In addition to financial data, 10-K reports include the business section (Part I, Item 1), in which companies concisely describe their operation and their offers. For document analysis of companies that do not trade on stock exchanges in the USA, apposite sections of annual reports were selected.

The studied documents were the most recent annual reports published by the nominated ITVs at the time of sampling (November 2016). All reports were written in English so that a common linguistic platform would be available for coding.

3.3.4 Selection of samples

In qualitative research, the determination of a suitable sample strategy and size relies on the researcher's judgment and must be defended as reasonable for the purpose (Sandelowski, 1995, 2000). There is no recognized number of samples when applying content analysis. The sample size should be established as information is required to adequately answer the research question (Bengtsson, 2016), to draw conclusions from analytical findings (Brislin, 1979), or to provide results in a new and well-structured understanding (Sandelowski, 1995). According to Sandelowski (1995), at least 25 samples may be required. Goh and Ryan (2008) sampled 16 companies for content analysis and noted this sample size as a limitation. Robertson and Samy (2015) regarded 22 samples for content analysis of annual reports as a constraint for representativeness.

According to Palinkas et al. (2015), purposeful sampling is a broadly applied method in qualitative research for identifying and selecting cases that provide rich information on the phenomenon under investigation. Thus, purposeful sampling allows researchers to select cases for best achievement of their research goals. The representativeness of data collection can be increased by heterogeneous sampling (Saunders, Lewis, & Thornhill, 2016). For this study, 32 samples were selected for the purpose. The choice of ITVs was based on product type and size in terms of revenues. Another criterion for selection was the targeted customer category. Some ITVs operate only in consumer markets, while other vendors act as suppliers to other ITVs. For the sample selection, ITVs had to target enterprises that buy and use IT for primary and support activities in their value chain. The target enterprises did not consider IT their sole core competency but needed IT for innovation and competitiveness. At least one business segment of the ITV had to serve organizations in competitive environments, regardless of the industry. Vendors' products were not to be specific to one industry. Excepted were ITVs that mainly supply other ITVs. In addition, providers for Internet or data transmission services (so-called carriers, telecom-service providers, Internet-service providers, and network operators) were left out. Such services are considered commodities with low potential for IT product differentiation. In order to increase the variability of geographical distribution, samples were chosen across the continents.

For the assortment of ITVs to be sampled, the Forbes Global 2000 list for 2014 was used. It was downloadable as a file in CSV format for post-processing in Microsoft Excel. From there, I extracted all firms allocated to the sector "Information Technology," which is one of 11 sectors in the Forbes Global 2000 list. The next level down in selection was "Industry" as a parameter in the same list. The industry types "Computer & Electronic Retail," "Electronics," and "Semiconductors" were excluded from further analysis, while the industry types "Communications Equipment," "Computer Hardware," "Computer Services," "Computer Storage Devices," and "Software & Programming" passed this filtering stage. The type "Computer & Electronic Retail" was not investigated because target buyers include consumers. The types "Electronics" and "Semiconductors" were not examined, as these types of firms supply ITVs, i.e., they are parts of ITVs' value chains.

From the remaining industry types, I selected for each continent the four biggest vendors in terms of sales. The possible options for continents at this stage were North America, Europe, and Asia. Not every continent of those was represented by two vendors per industry type. Some ITVs had to be taken out of consideration because the business product and target groups were inappropriate, e.g., the target customers of Alcatel-Lucent and Ericsson are network operators or telecom/Internet-service providers. Other vendors were omitted because they solely supply to other ITVs (e.g., Western Digital's data-storage products) or provide IT commodities such as screens (TPV Technology). Out of 60 possible combinations (five industry types, three continents, four vendors per category and continent), 32 vendors were finally chosen for document research. Figure 2 depicts the scope of vendor/buyer relationships for answering the research questions. Excluded types of vendor/buyer relations are symbolized by gray arrows and boxes.

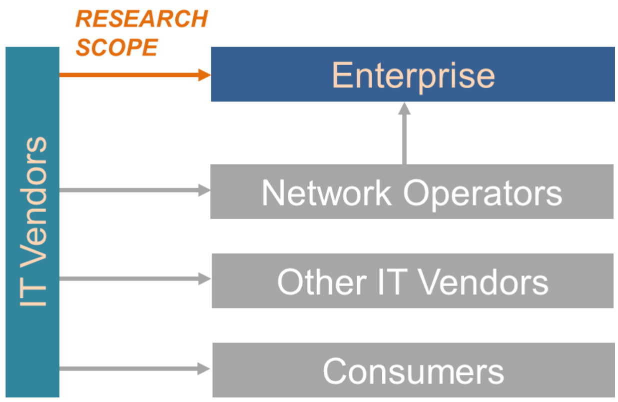

Figure 2: Relationships between IT vendors and buyers in the scope of the research (Source: author).

3.3.5 Content categories

Business and product descriptions were searched in view of the reference to IT-buyers' competitiveness or the competitive advantage that would result from the use of the IT products. In most cases, ITVs describe their competition, their rivals, and their position in the marketplace. These items are of interest to investors when reading an annual report. Thus, the content needed to be carefully checked in order to accurately distinguish the competitive context of enterprises from the competitive context of ITVs.

The procedure was as follows. First, the search string "compete" was used. Second, the sentences and paragraphs around the hits were checked for competitive context (competition among ITVs was ignored). Third, the entire business and product descriptions were studied again to find more connections to IT-buyer competition and to verify the previous search results. The typical and most numerous hits of the search string were "competition," "competitive advantage," and "competitiveness." Some hits were similar expressions such as "competitive agility" and "competitive differentiators." In addition, phrases that clearly indicate competitiveness but do not literally express it were considered, e.g., "give our clients a distinct advantage" and "to grow and win in the market." The latter procedure was more interpretive but still valid.

According to the Mayring's step model (2000) for deductive category application, the definitions of categories should be based on a theory. In terms of value, the customer-value disciplines of Treacy and Wiersema (1995) were chosen as the theoretical ground. As a result, the following categories were defined:

- competitiveness
- customer intimacy

- operational excellence
- product leadership

The analysis of the competitiveness category was separated from the customer-intimacy, operational excellence, and product-leadership categories that constitute the customer-value disciplines. The categories of customer-value disciplines are mutually exclusive and collectively exhaustive, as stated by Chadwick, Bahar, and Albrecht (1984). Each item of coded content is allocated into exactly one analytical category without any intersections, and all categories must cover all codes. As suggested by Mayring (2000), the next stage was the formulation of coding rules for the categories. It began with choosing the units of analysis.

3.3.6 Selection of units of analysis

Units of analysis can be single words or entire articles, and they are coded into the content categories (Prasad, 2008). As units of analysis, I chose from the documents the sentences and paragraphs (context units) that contained keywords (recording units) as displayed in Table 1. This table represents a coding agenda consistent with the ideas of Mayring (2000). As proposed by Berelson (1952), context units are larger objects to be searched in order to describe the recording units more extensively.

Because complete sentences and paragraphs were regarded for coding, interpretations and subjective judgments were necessary to infer meanings in the data. Therefore, latent coding was applied, although the reliability is lower than in manifest coding, which identifies factual objects (Saunders, Lewis, & Thornhill, 2016). Manifest coding ignores context and would have been inappropriate for answering the research question. Many pertinent codes would have been overlooked, while several other hits on keywords would have been irrelevant.

Hsieh and Shannon (2005) showed three different qualitative ways to analyze content: directed, summative, and conventional. The summative analysis was used for the category "competitiveness." That is, keywords were specified during the document study to understand their contextual use through interpretation. In contrast, analysis of customer-value disciplines was carried by directed analysis. Categories and code units were predetermined by a theory. In that case, the keywords for recording units were taken from Treacy and Wiersema (1995). Both of the selected approaches from Hsieh and Shannon (2005) comply with the latent-coding methodology.

3.3.7 Preparation of a coding agenda

The content category "competitiveness," i.e., the definition of coding units and their allocation to content categories, was iteratively developed by studying annual reports and adding keywords as recordings units. Prior to beginning the complete content analysis of all samples, the coding agenda was piloted for all content categories. First, applicability was tested on three annual reports. Second, inconsistencies and inadequacies in the setup were corrected. Third, recording units were adjusted. Table 1 displays the final coding agenda for the examination of the full set of selected annual reports.

3.3.8 Data collection and evaluation

Prasad (2008) and Stemler (2001) recommended frequency as one method of enumeration. Other suggested methods, such as space or direction, were not applicable. Units of analysis were measured in terms of the number of times a context unit was found in the body of a product or business text in an annual report. Detailed data may be requested from the author.

Content Category	Coding units
Competitiveness	- Competitiveness - Competitive advantage - Competition - "Competitive agility", "Competitive differentiators" and similar expressions - Context interpretations, e.g., “give our clients distinct advantage”, “to grow and win in the market”
Customer value: Product leadership	- Best product - Product differentiation - Newness - Innovation - Time-to-market
Customer value: Operational excellence	- Best total costs - Low costs - Operational competence - Process efficiency - Organizational efficiency - Operational efficiency - Productivity
Customer value: Customer intimacy	- Best total solution - Responsiveness - Customization - Problem solving

Table 1: Coding agenda (Source: author)

3.4 Results

3.4.1 Descriptive findings

In order to learn how ITVs present their buyers’ competitiveness and customer value in product and business descriptions, 32 annual reports from world-leading IT suppliers were studied. Eighteen annual reports applied in the Form 10-K, as required by the SEC. Firms applying Form 10-K described their business in *Part I, Item 1* on four pages as a minimum and on 15 pages as a maximum. The average number of pages used for business portrayals in Form 10-K was 10.3. Some firms (Cisco, Accenture) extended Form 10-K with forewords, business charts, figures, and summaries that were not evaluated. Other ITVs, not reporting according to SEC standards (e.g., Atos, Dassault Systèmes, CGI, SAP, and Wipro), made use of enlarged annual reports of more than 150 pages to further build their brand and enhance their attractiveness to investors. Those reports show a higher number of context units than reports with Form 10-K. Table 2 provides an overview of the number of coded context units found according to categories. Figure 3 presents the share of customer-value disciplines.

Half of the sampled documents contained context units for competitiveness (16 out of 32). Most of them (11) contained only one or two context units. At least one customer-value discipline was considered in 27 of the 32 annual reports. Twelve companies mentioned customer-value discipline without codes for competitiveness. All ITVs that mentioned competitiveness also referred to at least one customer-value discipline.

Five ITVs (Apple, Google, Quanta, SanDisk, and Symantec) did not mention either competitiveness or customer-value discipline. When ITVs referred to customer-value discipline, operational excellence was the most used (58%), while customer intimacy (11%) was the least considered (Figure 3). In 71% of the cases in which operational excellence was mentioned, another customer-value discipline was also found. High counts (8–11) of customer-value disciplines in comparison to the average count (4.22) were identified for eight companies (25% of the sample).

			Customer Value Discipline		
IT Product Vendor	**Form 10-k**	**Competi-tiveness**	**Product Leadership**	**Operational Excellence**	**Customer Intimacy**
Accenture	Yes	2	2	4	-
Apple	Yes	-	-	-	-
Atos	No	10	5	5	3
Capgemini	No	2	1	1	-
CGI	No	6	-	3	-
Check Point Software	Yes	-	-	2	-
Cisco Systems	Yes	4	2	1	-
Compal	No	1	1	-	-
CSC	Yes	1	-	1	-
Dassault Systemes	No	3	3	3	4
EMC	Yes	4	2	4	-
Fujitsu	No	2	2	1	-
Google	Yes	-	-	-	-
HCL Technologies	No	-	2	6	-
Hewlett-Packard	Yes	-	-	2	1
IBM	Yes	1	2	5	1
Infosys	No	1	-	2	-
Lenovo Group	No	-	1	-	-
Microsoft	Yes	-	-	4	-
Motorola Solutions	Yes	-	2	2	-
NCR	Yes	-	-	1	-
NetApp	Yes	1	1	5	-
Oracle	Yes	-	-	7	1
Quanta	No	-	-	-	-
SanDisk	Yes	-	-	-	-
SAP	No	2	2	6	3
Seagate Technology	Yes	-	-	1	-
Symantec	Yes	-	-	-	-
Tata Consultancy S.	No	1	2	1	-
VMWare	Yes	-	4	5	-
Wipro	No	2	6	6	2
ZTE	No	-	2	-	-

Table 2: Number of hits of context units in annual reports (Source: author).

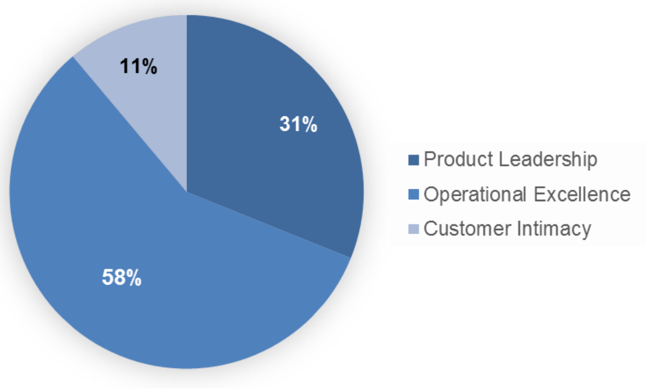

Figure 3: Percentage shares of customer-value disciplines (Source: author)

3.4.2 Correlation of content categories

Correlation coefficients of the sampled data were computed by the aid of R Studio software to determine the strength of associations between variables. Table 3 displays the results of multivariate statistical analysis (Cohen et al., 2003).

	Competi-tiveness	Product Leadership	Operational Excellence
Product Leadership	0,4849**		
Operational Excellence	0,2804	0,4964**	
Customer Intimacy	0,4676**	0,5416**	0,4733**

** Correlation is significant at the 0.01 level (two-tailed)

Table 3: Correlation coefficients r of content categories based on the number of codes in samples (Source: author).

The linear relationship between competitiveness and operational excellence is weak and uphill (r = 0.2804; not statistically significant). All other relationships are moderately positive and statistically significant ($p < 0.01$).

To check internal consistency, Cronbach's alpha was calculated (Cronbach, 1951). The average inter-item correlation (the mean of the correlation coefficients r in Table 3) is rtt = (0,4849 + 0,2804 + 0,4964 + 0,4676 + 0,5416 + 0,4733) / 6 = 0.4574. This value was corrected by the Spearman-Brown formula (1) to compute the standardized Cronbach's alpha.

There are four k-items (competitiveness, product leadership, operational excellence, customer intimacy), so k = 4 was inserted the equation.

$$\frac{k \cdot r_{tt}}{1 + (k-1) \cdot r_{tt}} = \frac{4 \cdot 0.4574}{1 + 3 \cdot 0.4574} = 0.7713 \qquad (1)$$

Cronbach's alpha values greater than 0.7 are acceptable (Nunnally, 1978). Spearman's rank order rho was also worked out. Results between 0.9551 and 0.9859 show monotonic relationships for all combinations.

Besides the data in the correlation matrix, a weak negative relationship between Form 10-K usage and the number of codes for competitiveness was found (r = - 0.3308; the two-tailed significance level of 0.1).

In addition to the previous descriptive interpretation of the results, the consistency-tested correlation matrix indicates moderate positive relationships of content categories. Linearity and homoscedasticity are assumed, i.e., the relationship line between the values is straight, not curved. The distance between the line and the values in a scatter diagram should look like a tube, not like a cone.

3.5 Discussion

3.5.1 Operational excellence is the predominant customer-value type

The investigation of annual reports from ITVs was conducted to gain a more profound understanding of the context of IT products and business strategy. The first research question raised was "What types of customer value do ITVs consider?" As reflected in the literature analysis, there is a consensus among scientists that the notion of value creation still needs more clarification (Gandelman, Cappelli, & Santoro, 2017; Lieberman, Balasubramanian, & Garcia-Castro, 2018; Singh & Paliwal, 2012). In his analysis of IT business values, Tallon (2007) applied Treacy and Wiersema's (1995) customer-value disciplines for the formulation and testing of hypotheses. The content analysis as presented here shows that those disciplines (operational excellence, product leadership, and customer intimacy) are suitable for categorizing IT values. Of the investigated documents, 84% included coding units of customer-value disciplines. Three out of four annual reports contained coding units for operational excellence; it was the most frequent customer value (58% of coding-unit hits), followed by product leadership (31%). The following conclusions may be drawn: a major reason for investments in IT products is to increase operational competence and process efficiency in order to lower costs, which provides monetary advantages to customers. Another important driver for IT products is differentiation by delivering innovative and beneficial functions to customers. The observations and conclusions perfectly fit the value definition of Porter (1985), which was cited previously in the literature review.

3.5.2 Customer-value creation is the key to competitiveness

In addition to the matter of customer-value types, another question looked at competitiveness in the context of customer values. According to Dranove and Marciano (2005), value creation is the key to competitiveness. Many renowned scholars have maintained that IT products deliver value and provide competitive advantage consequently (Clemons & Row, 1991;

Drnevich & Croson, 2013; McAfee & Brynjolfsson, 2008; Peppard & Ward, 2004, 2005; Venkatraman, Henderson, & Oldach, 1993), but they have not provided empirical evidence of that claim. Accordingly, another objective was to search coding units for competitiveness in the annual reports of ITVs to answer the second research question: "Do ITVs consider the competitiveness of enterprises?" Content analysis showed that half of the sampled annual reports from ITVs mentioned the competitiveness of their enterprise buyers. If ITVs referred to enterprise competitiveness, they also mentioned one or more customer-value disciplines. In other words, ITVs that consider the competitiveness of IT buyers are also pointing out value creation to end customers. Taking the moderate positive relationships between competitiveness and customer-value types into account, it may be suggested that enterprise competitiveness is dependent on customer-value creation.

3.5.3 Additional discoveries

Further outcomes of this study are moderate positive correlations among customer-value disciplines. It is possible to hypothesize that ITVs support multiple customer-value types rather than focusing on a single customer value.

From the negative relationship between Form 10-K usage and the number of codes for competitiveness ($r = -0.3308$), it can be inferred that ITVs applying Form 10-K tend to include fewer codes than vendors not obliged to report in 10-K format due to the annual report's limited extent.

Few companies that pointed to customer intimacy are strong competitors in the same market segment (Oracle vs. SAP in the software market for enterprise resource planning; Hewlett Packard vs. IBM for the supply of data-center infrastructure and server solutions).

The data also support an idea suggested by Han, Kuruzovich, and Ravichandran (2013), who argued that hardware products need little customization, whereas software customizations must match the business processes of customers. "Customization" is a coding unit of the content category of customer intimacy. Besides Atos, the most codes for customer intimacy were found at SAP and Dassault Systèmes; both are software vendors.

The frequencies of single keywords (search strings) within the context units for customer value (Appendix A3) were examined to infer further implications. Table 4 displays the keywords in descending order of their frequency. The words in italics are part of the codes (Table 1). It is not surprising that these terms appeared in the context units because they were a part of the search. These were not considered.

The high frequencies of the words "customer," "clients," "performance," and "value" reflect that the context units found refer to customer value. Numerous terms (strings) with medium to low frequencies are attributable to IT planning/IT architecture ("application," "infrastructure," "integrate," "model," "platform," "strategy," "requirements," "plan," "standards," and "architect"). This observation indicates that IT planning and IT architecture are significant for customer value creation. The strings for the RBV expressions resources, capabilities, and assets were sparsely detected. One may conclude that the RBV has minor significance for customer value generation. Further, the search string for digitalization ("digit") was found 28 times. This observation indicates the importance of digitalization for customer value. In addition, current market trends like cloud computing (19 hits) became apparent. In contrast, the outsourcing hype (three hits) appears to be over. Software products/services (22 hits) are of greater significance than hardware for value creation.

Keyword	Frequency
customer	92
business	83
service	65
client	49
efficien	44
cost	42
solution	42
innovat	39
operation	33
enterprise	32
product(s)	31
digit	28
process	27
application	26
data	26
transform	25
optimiz	23
experience	22
software	22
organization	20

Keyword	Frequency
cloud	19
design	19
develop	18
performance	18
value	18
infrastructure	14
system	14
integrat	13
model	13
platform	11
agil	10
competitive	10
effecti	10
productiv	10
management	9
strateg	9
flexib	8
user	8
automat	7
relationship	7

Keyword	Frequency
advantage	6
analy	6
benefit	6
marketing	6
plan	6
capabilit	5
change	5
govern	5
modern	5
requirements	5
asset	4
hardware	4
owner	4
architect	3
combine	3
consulting	3
outsourcing	3
standards	3
transition	3
decision	2
resource	2

Table 4: Keywords in context units (Source: author)

3.5.4 Limitations

In this investigation, there are potential sources of error that impact reliability. Although the data collection aimed at objectivity, researcher bias influenced the search for codes. Latent content analysis calls for minor interpretations of codes, which therefore may reflect the subjective views of the researcher. Also, researcher errors exist due to unconscious altered interpretations of codes. Codes could also have been misunderstood or overlooked.

Although the sample size has previously been justified as being appropriate to the purpose, the sample size is viewed as a limitation, as the samples do not represent the whole population of ITVs.

Another restriction is that content analysis is not suited to explaining causality (Saunders, Lewis, & Thornhill, 2016). Correlations among content categories do not imply cause-and-effect relationships.

As a primary research method, content analysis is constrained for the synthesis of meanings. The counting of the hits of codes does not necessarily mirror the importance of the phenomenon (Dixon–Woods et al., 2005). For example, from the high number of counts for operation excellence (78 hits) as compared to the low frequency for customer intimacy (15 hits), it may not be concluded that operational excellence is significantly more important than customer intimacy.

Another weakness of this study is the use of secondary data from the documents since the annual reports are not produced for research; they lack the details that would allow in-depth answers to the research question (Bowen, 2009).

3.5.5 Future research

To enhance the generalizability of the findings, sample size can be increased, e.g., by including medium-sized ITVs in the scope of research or by inspecting the annual reports of the same vendors from other years. The coding agenda could also be applied to other types of vendor documents, such as brochures, manuals, and the Internet sites of ITVs (web-content analysis). In addition, inter-coder reliability could be proven to increase stability and reproducibility (Stemler, 2001). Another coder could take the same samples and determine whether the units were placed in the same categories (Stempel, 1989).

The results of this research offer a foundation for additional studies. In subsequent deductive research, the presented propositions might be hypothesized and proved or disproved by conducting empirical tests. Additionally, the perspective could be changed from the supplier to the buyer side. Semi-structured interviews with strategists and IT executives from enterprises would extend knowledge of the phenomenon. Investigations of the causalities of the described relations offer great opportunities for more contributions to theory and practice.

Further research might investigate relationships between type of customer value and type of ITV. For instance, system integrators, consultancy firms, and outsourcers that work in close cooperation with enterprises might focus more on customer intimacy than on any other customer-value type. Finally, new research questions can be framed on the relations between types of IT products and types of customer values.

3.6 Conclusions

The goal of this article was to broaden the understanding of the relation between IT products and business strategy with respect to competitiveness and customer value. Codes for competitiveness and customer-value disciplines were searched for in the product and business descriptions of annual reports from world-leading ITVs. These ITVs consider the competitiveness of their buyers and the customer value from their products. IT products increase the competitiveness of enterprises by providing value to end customers.

This exploratory study detected patterns and moderate correlations between competitiveness and customer-value disciplines. The customer-value disciplines as described by Treacy and Wiersema (1995) are applicable for classifying customer values from IT products. Operational excellence is the most prevalent value discipline. It refers to the process efficiency and cost-effectiveness, resulting in monetary benefits for customers. Another substantial customer-value type is product leadership that is about innovation and functional benefits. I recommend that IT managers plan their investments in IT products by their contributions to customer value.

Future research may evaluate data from newer annual reports or from other types of documents. Yet, the main limitations of this work are the use of secondary data and the lack of causality. In order to counter this, the propositions can be hypothesized and quantitatively be tested by collecting primary data from surveys. Causality regarding customer value and IT products can be investigated by interviewing executives from ITVs and IT product buyers. This study opens various paths for further examinations. I hope to inspire more research on the phenomenon.

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ARTICLES PART II

Types of IT Architects and their Connections to Portfolio / Project Management

Article 4: Types of IT Architects: A Content Analysis on Tasks and Skills

Article 5: Connecting Enterprise Architecture and Project Portfolio Management: A Review and a Model for IT Project Alignment

Article 6: Collaboration of Solution Architects and Project Managers

4 TYPES OF IT ARCHITECTS: A CONTENT ANALYSIS ON TASKS AND SKILLS

Abstract

IT architecture is an essential element of an enterprise's strategy and impacts competitive advantage. The management of IT architectures is unexplored in theory and confused in practice. In particular, the roles of IT architects are interpreted in various ways. The purpose of this study is to explore the roles of IT architects by investigating the required activities and skills demanded in the human resources market. In-depth content analysis was applied on job advertisements. Categories were inductively developed by allocating meaning units until saturation: 2438 meaning units were assigned to 37 task categories and 49 skill categories. As a result, three types of architects with distinctive profiles were identified. In addition to technological expertise, all architects must provide outstanding social and methodological skills. Knowledge of particular frameworks is rarely required. Skills and architect types from The Open Group Architecture Framework (TOGAF) were disproved in parts. Attributes specific to e-commerce architects were elaborated. The found task and skill categories may be used as catalogs for recruiting purposes in practice.

4.1 Introduction

Enterprise architecture (EA) is a developing management discipline (Gøtze, 2013) that is receiving growing attention in industry and science. EA comprises and organizes all pertinent elements and processes of an enterprise (Kaidalova, Sandkuhl, & Seigerroth, 2017, p. 526). The scope of EA includes strategy, decisions, planning, human resources, assets, tasks, design processes, results, etc. (Body of Knowledge and Curriculum to Advance Systems Engineering (BKCASE), 2018, p. 644). EA management guides the evolution of enterprises and strives to enhance IT-business alignment (Buckl, 2011, p. 152). IT architecture is an element of the strategic alignment process along with IT strategy, business strategy, and the organization (Baets, 1992). IT is an instrument for achieving and sustaining competitive advantage (Mentzas, 1997, p. 85) used to empower the business strategy (Luftman, 2003, p. 15). The IT architecture is a source of differentiation among competitors and can translate into a business advantage (Feeny & Ives, 1990, p. 37). Thus, managing enterprise and IT architectures is a momentous capability for competitive advantage and has notable strategic importance.

EA describes IT, processes, individuals, procedures, projects, and their relationships (International Institute of Business Analysis (IIBA), 2015, p. 445). It attempts to integrate, align, and administer various components of an enterprise to exploit synergies in accomplishing enterprise goals (Rajabi, Minaei, & Seyyedi, 2013, p. 2). Numerous frameworks, for example, Department of Defense Architecture Framework (DODAF, 2010), The Open Group Architecture Framework (TOGAF) (The Open Group, 2018), Enterprise Architecture Body of Knowledge (EABOK) (Site 2), Enterprise Information Technology Body of Knowledge (EITBOK) (Site 3), try to translate the EA complexity to make it manageable for practical use. However, those EA frameworks are too general and abstract and consequently, not applicable by practitioners (Buckl, 2011, p. 5). Furthermore, multiple comprehensive frameworks exist for other IT-related management disciplines, such as business analysis (IIBA, 2015), project management (Project Management Institute (PMI), 2017), and system engineering (BKCASE, 2018). These frameworks describe processes and elements of IT management from different views but are isolated from other frameworks.

Diverse studies on EA management have been conducted. Most research subjects are strategies, processes, principles, and drivers for putting EA into effect (Kaidalova, Sandkuhl, & Seigerroth, 2017, p. 526). However, the role of the enterprise architect is unclear in theory and practice (Thönssen & von Dewitz, 2018). TOGAF (The Open Group, 2018, p. 472) notes the very poor definition of IT architects in the industry. Olsen (2017) conducted a case study on EA in the Norwegian health sector and found that the EA role was not understood at all. That circumstance resulted in confusion regarding the enterprise architect's involvement in projects. Interestingly, even the enterprise architects themselves were not clear about their roles. The role of IT architects in e-commerce projects is particularly blurred, since e-commerce architecture subject is being researched across diverse IT areas (Aulkemeier, Schramm, Iacob, & van Hillegersberg, 2016, p. 28).

Little academic research on the IT architects' role has been carried out (Gøtze, 2013). Gallivan, Truex, and Kvasny (2004) analyzed contents of job advertisements to understand the trends in demands for IT professionals between 1988 and 2003. This study did not present any architect jobs, although ideas on IT architecture were published previously (Zachman, 1987). Gore (2003) complained that too little attention had been given the architect role and suggested further studies on it, specifically the system architect.

The purpose of this paper is to explore the roles of the IT architect by investigating the market demands for human resources. IT architects' activities and skills are examined by analyzing job advertisements. Types of IT architects are identified; characteristics of e-commerce projects relevant to IT architects are worked out. This study answers the following research questions: What are the tasks of IT architects? What skills are required for IT architects? How can IT architects be categorized? What are special features for IT architects in e-commerce projects?

To address the research questions, content analysis was carried out by identifying and allocating meaning units. Categories for tasks and skills were created based on the data and iteratively readjusted. This research provides catalogs for architect tasks and skills and suggests a typology of IT architects founded on task focus and derived from the evaluated data. The outcomes are discussed with challenges that IT architects must master in e-commerce projects and in the digital transformation. This paper contributes to theory by defining three main categories of IT architects based on their competences and activities. The findings of this study partly refute the skills and the EA types in the leading architecture framework TOGAF (The Open Group, 2018). This research adds substantially to our understanding of the role of the IT architect in various contexts.

The paper is organized as follows. The literature analysis inquiries into the notions of IT/enterprise architecture and presents architect tasks and skills by reflecting dominant IT frameworks and influential academic publications. Then, the chosen methodology is described in detail. The finding section introduces a typology for architects and displays tables of skills and tasks for three types of IT architects. Subsequently, the discussion elaborates on e-commerce/digital architects' characteristics, reflects limitations, and proposes paths for future research.

4.2 Literature review

4.2.1 Definitions of IT architecture

To understand the role of IT architects, the general idea of IT architecture must be illuminated. Definitions from various institutions and their standards help capture the sense of

IT architecture. The different descriptions do not contradict but supplement each other to gain a holistic picture.

TOGAF (The Open Group, 2018, p. 22) displays architecture as a "structure of components, their interrelationships, and the principles and guidelines governing their design and evolution over time" and refers to the standard from the International Organization for Standardization/International Electrotechnical Commission/Institute of Electrical and Electronics Engineers (ISO/IEC/IEEE, 2011), an international architecture standard for systems and software. This standard describes system architecture as "fundamental concepts or properties of a system in its environment embodied in its elements, relationships, and in the principles of its design and evolution" (ISO/IEC/IEEE, 2011, p. 2). Examples of systems are software, data, hardware, services, processes, procedures, facilities, materials, and humans (ISO/IEC/IEEE, 2011, p. 3). EABOK (Site 2) refers to the same definitions for architecture and adds "overall design of a building, structure, or system that unifies its components or elements into a coherent and functional whole." The Project Management Institute standard (PMI, 2016, p. 65) designates architecture as "a method to describe an organization by mapping its essential characteristics, such as people, locations, processes, applications, data, and technology." Thus, IT architecture may be regarded as a methodology for structuring and governing various connected technical components to coherent systems in accordance to resources and capabilities of an enterprise.

4.2.2 Definitions of enterprise architecture

There is no generally accepted glossary for EA; terms and definitions vary over a large range (Korhonen & Halén, 2017, p. 351). Some publications distinguish EA from component or system architectures. The Business Analysis Body of Knowledge (BABOK) (IIBA, 2015, p. 441) defines architecture as "the design, structure, and behavior of the current and future states of a structure in terms of its components, and the interaction between those components." An extra specification is given for EA: "A description of the business processes, information technology, people, operations, information, and projects of an enterprise and the relationships between them" (IIBA, 2015, p. 445). According to the System Engineering Body of Knowledge (SEBOK) (BKCASE, 2018, p. 221), architecting involves designing a system structure that can be applied by system engineers to a system, a product, or a service. In contrast, EA describes the structure of an organization.

The EITBOK (Site 3) does not provide its own definition for architecture but characterizes the perspectives via role descriptions. Similar to the SEBOK (BKCASE, 2018) and the BABOK (IIBA, 2015), there is a differentiation between EA and components/system architecture. The EITBOK (Site 3) designates the *enterprise architect* as "designer of a conceptual blueprint that defines the structure and operation of an organization," whereas the *enterprise IT architect* is "responsible for the design of a computing system and the logical and physical interrelationships between its components. The architecture specifies the hardware, software, access methods, and protocols used throughout the system." The *enterprise IT architect's* responsibility may be related to a physical architecture that is a layout of system components and interfaces to deliver the solution design for a product, service, or enterprise. Physical architecture meets requirements, complies with logical architecture, and can be implemented through technologies (Site 10).

Architecture definitions are dominated by standards and frameworks. Few academic papers deal with those definitions; two are highlighted here. A seminal publication in EA science from Zachman (1987, p. 276) outlined architecture as "logical construct for defining and controlling the interfaces and the integration of all of the components of the system."

Smolander (2002) interviewed 19 IT professionals in software organizations to examine the meaning of architecture in practice. He proposed four architectural metaphors as the outcome. First, *blueprint* denotes a high-level description of future systems for implementation by engineers and designers. Second, *literature* means documentation of the technical structure of an as-is solution or a historical collection of the past structure and solutions. Third, architecture provides a *language* for communication among stakeholders to understand systems and structures. Fourth, architecture is a foundation for *decision*s regarding strategies, resources, and system implementations.

The framework Control Objectives for Information and Related Technology (COBIT) (Information Systems Audit and Control Association (ISACA), 2012) claims to connect different frameworks does not elaborate on the notion of architecture but presents good practices for service capabilities. In that context, architecture principles turn up (ISACA, 2012, p. 108). These principles are general guidelines for governing IT-related resources in implementation and use, for example, re-use of common components, make-or-buy decisions, simplicity, agility, or open industry standards. Turning from the concept of architecture, those who are responsible for it are discussed.

4.2.3 Tasks of IT/enterprise architects

The term 'IT architect' is generic for every architect acting in the IT realm. There are various names for architect roles in the literature that are inconsistent and must be sorted. IT architecture is not a one-size-fits-all subject; several contextual and organizational factors influence the architect role that might be tailored accordingly (van den Berg & van Vliet, 2016). Therefore, the descriptions of the work that IT architects undertake are diverse. In the following, I discuss the architect tasks that comprise views from scholars, from a widely used framework, from a standard, and from an IT industry leader.

Feeny and Willcocks (1998) regarded the 'design of IT infrastructure' as one of three squares that encompasses five of nine IT capabilities and that intersects with the 'business and IT vision' and 'delivery of IT services'. The authors described the role of the 'architectural planner' that performed the following tasks:

- formulate associated policies that ensure integration and flexibility in IT services
- shape the IT infrastructure
- develop the vision for an appropriate technical platform
- create a coherent blueprint for a technical platform that responds to current and future business needs
- build relationships with users and business stakeholders
- take leadership role in robust business/IT relationships
- support sourcing of IT products and services
- support implementation of technology

Strano and Rehmani (2007) performed a qualitative multiple-methods study of the role of the enterprise architect. The data showed that this role appears multi-faceted. The researchers suggested five broad categories (Strano & Rehmani, 2007, p. 385):

- change agent driving IT strategy toward business objectives
- communicator among various IT and business roles in decision making and executing plans
- leader of the team and director for strategic needs
- manager for team organization and resourcing

- modeler of links between components

Each category interacts with various other roles. Thus, the enterprise architect is an information-broker between many roles that act as sources or destinations for information.

Buckl (2011, p. 153) discussed EA activities from an international German bank as follows:

- create and adjust IT strategy based on the enterprise business strategy
- collect and analyze needs from business and their importance
- develop and update architectural guidelines, standards, and principles
- develop and update architecture artifacts
- check architecture conformity within projects

TOGAF (The Open Group, 2018) is the most widely used and best-known framework (Hanschke, 2012, p. 48). It categorizes architects with different responsibilities for design and documentation (The Open Group, 2018, p. 474):

- *enterprise architects* are at highest level and focus on business functions and leadership
- *segment architects* focus on technical solutions for a specific business segment in the value chain
- *solution architects* concentrate on products, components, systems, and technologies for a subject matter, for example, security, data management, or networks

This structure is hierarchical for breaking down the holistic business perspectives into detailed solutions designs. The TOGAF framework (The Open Group, 2018) describes only the EA role and its key characteristics specifically and neglects the activities of segment and solution architects. The following tasks are deduced from the description of the EA role and its characteristics in TOGAF (The Open Group, 2018, pp. 472–475):

- produce designs, including requirement analysis, technology selection, and configuration
- operate the infrastructure across distributed systems and various platforms
- ensure the completeness (fitness for purpose) and integrity of the architecture
- hand over the design to the project implementers
- make decisions and work with the project management team
- lead the team (e.g., segment/solution architects) and communicate to stakeholders
- guide IT strategically and proactively by recognizing trends and optimizing processes
- drive and manage the architecture as the ‘agent of change’
- create and improve models for components or solutions and technical references

The ISO/IEC/IEEE standard (2011) does not explicitly describe the architect role but explains architecting during system life cycle and uses of architecture descriptions that contain tasks for an IT architect. The architecture description is a work result from architecting activities (ISO/IEC/IEEE, 2011, p. 8). Architecting is defined as “process of conceiving, defining, expressing, documenting, communicating, certifying proper implementation of, maintaining and improving an architecture throughout a system’s life cycle” (ISO/IEC/IEEE, 2011, p. 2).

Cisco Systems offers a global certification program that is highly recognized within the IT industry. Certifications for individuals can be acquired over five qualification levels. At the highest level is the architect certificate CCAr® that has been granted to only ten design engineers throughout the world (Site 5). These architects provide world-class in-depth technology expert knowledge, but their responsibilities are closely linked to business and leadership:

- understand the business and the impact on architecture, design, and operation
- decompose a business problem into component parts and determine interaction
- lead teams consisting of architects in other disciplines (e.g., application and data center) and other roles (e.g., business, financial, facilities, and marketing) to understand the applications and services required to meet the business goals and to specify the properties of the network to support those applications and services
- define the strategy and priorities for infrastructure, services, and applications

As the role of IT architects is blurry in theory and practice, one cannot expect a uniform view of IT architects' tasks. I presented six examples (three studies, one framework, one standard, and one practice case) that point three facets of the IT/enterprise architect. One facet connects to identifying future business needs and to driving the strategy accordingly. Another facet relates to social tasks such as leading, communicating with stakeholders, and relationship-building. As expected, the technology facet is central (infrastructure, components, products, etc.) and may comprise different activities in linked fields, e.g., product sourcing, project implementation. In the discussion section the tasks in the literature will be compared with the collected data.

4.2.4 Skills of IT/enterprise architects

The skills requirements for a professional depend on the type of tasks. If the tasks are unstructured, then the skills are unclear. Thus, it is not surprising that the skills of the IT architect are uncharted.

IT architecture, scope, and design as strategic resources constituting core IT capabilities have been considered (Feeny & Willcocks, 1998, pp. 18–19). These capabilities are characterized by high technical skills, medium interpersonal skills, and low to medium business skills. Architect skills embedded in the General Enterprise Architecting (GEA) research program (Site 6) that defines architecture roles in its own way (EA manager, EA strategist, EA designer, EA program architect, and EA administrator) were examined (Wagter, Proper, & Witte, 2012). A matrix that matches competencies to tasks was also presented (Wagter, Proper, & Witte, 2012), although the tasks were based on the GEA program (Site 6). The processes and products were decoupled from other well-known frameworks. Most competencies were personal traits, individual behaviors, and attitudes (e.g., flexibility, creativity, ambition, stress resistance, and analytical ability). These skills are soft, hard to measure, and of limited usefulness. The methods, standards, social skills, and types of technical and business knowledge required were more relevant.

The Skills Framework for the Information Age (SFIA) (Site 8) defined 102 IT skills of which 11 skills relate to architecture. Nine skills denote design, one skill is 'solution architecture', and one skill is 'enterprise and business architecture'. However, the presentation of those skills includes role and task descriptions over multiple levels.

Similar to the GEA program (Site 6), some authors classified architects in their own way. For instance, Woods (2014) subdivided architects into three groups: enterprise, application, and infrastructure. In addition to characterizing enterprise, segment, and solution architects, TOGAF (The Open Group, 2018) introduced the roles EA manager, EA technology, EA data, EA applications, etc., in the skill framework section. The TOGAF architecture skill framework (The Open Group, 2018) defined four levels of proficiency: 'Background' should be provided, if required (level 1), 'Awareness' for understanding issues, implications, and further steps (level 2), ‘Detailed knowledge’ for professional advice and ability to integrate in architecture design (level 3), and ‘Expert’ knowledge and experience (level 4). TOGAF (The Open Group, 2018) also defined seven skill areas, each consisting of five to 17 specific skills. TOGAF (The Open Group, 2018) provided comprehensive maps by assigning a proficiency level to each role and to a specific skill. To better capture the skill requirements for each role, average proficiency values were calculated over all skills within one skill area. Table 1 exhibits mean proficiency values for the different types of architects. The skill sets EA technology, EA data, and EA applications are not significantly different. The EA manager role seems to be quite far from reality because this profile plots a universal expert or a genius.

Skill area	**No. of skills**	**Enterprise Architecture**			
		Manager	Technology	Data	Application
Generic (lead, communication,...)	8	4.00	3.63	3.63	3.63
Business, strategy, organization,..	11	3.64	3.27	3.36	3.36
Enterprise architecture	17	3.82	3.53	3.47	3.82
Program / project management	5	3.60	3.00	3.00	3.00
General IT knowledge	17	3.24	3.59	3.59	3.47
Technical IT skills	13	3.00	3.92	3.38	3.31
Legal environment	5	2.60	2.40	2.40	2.40

Proficiency level: 1 - Background, 2 - Awareness, 3 - Detailed knowledge, 4 - Expert

Table 1: TOGAF proficiency levels for enterprise architects (mean values over all skills per area) (Source: author).

In addition to the proficiency level tables, TOGAF (The Open Group, 2018, pp. 474–475) describes enterprise architect skills as follows (summary):

- skills for producing designs and solutions, including requirement analysis
- deep technology knowledge in one or several subjects and profound technology knowledge over a wide range of platforms and systems
- knowledge of enterprise architecture methods
- project experience from design, development, test, implementation and operation
- communication, relationship building, leadership, and negotiation skills
- business processes skills from one or more industries

The latter bullet points roughly fit to the facets of the IT/enterprise architect that were summarized in the previous subsection. Nevertheless, these are shown on high level lacking detail. Thus far, theoretical elaboration has provided a better understanding of IT architecture as a discipline and of the types, tasks, and skills of IT architects. However, those considerations are diverse and have apparently not arrived in the real world yet. To understand what detailed tasks and skills are demanded in practice, I asked the following research questions: What are the tasks of IT architects? What skills are required for IT architects? The breakdown of skills per TOGAF skill area (The Open Group, 2018, pp. 468 – 471) was used as coding scheme to validate its closeness to practice.

4.3 Methodology

4.3.1 Assumptions and approach

Philosophical assumptions underpin the strategy and methodology of a researcher (Saunders, Lewis, & Thornhill, 2016). The focus of this study was the usefulness of future practice in the domain of IT architecture. Pragmatist ontology, epistemology, and axiology focus on improving practice and on supporting action (Saunders, Lewis, & Thornhill, 2016, p. 152). In this study, pragmatist methods and techniques were applied as they fit the purpose (Creswell, 2013, p. 28). In addition, data collection and numerical evaluations sought objectivism, whereas interpretivist philosophy was adopted when the meanings were discussed and the context extended.

In this study, the research approach was inductive. As the study was exploratory, propositions were developed and theories were built after the data collection and analysis (van de Ven, 2007, p. 24). This research explored significant roles in view of enterprise IT planning by analyzing the content of job descriptions. As there were no previous studies on this phenomenon, inductive content analysis was an appropriate methodology (Elo & Kyngäs, 2008, p. 107). The purpose of content analysis is to provide explanations and to create categories by exploring textual data in inductive ways (Pope, Ziebland, & Mays, 2000, p.114).

Document content analysis is a means to systematically and objectively assess written data to describe a phenomenon. Inferences about intentions and context may be made (Downe-Wamboldt, 1992, p. 314). The context is the conceptual environment of a text and encompasses the researcher's knowledge that she or he applies to the investigated text. The context might take various forms, such as scientific theories or argued propositions (Krippendorff, 2004, p. 51). In the present study, the data were coded and categorized, characteristics of the content and their significance were identified. The texts of the tasks and skills within the job advertisements were evaluated with an open mind to recognize meaningful subjects that help answer the research questions (Bengtsson, 2016, p. 10).

4.3.2 Content analysis of job descriptions

Although classified as secondary data, job descriptions are the best data source for gaining an understanding of job requirements. Job descriptions express the thought-out expectations that managers and human resource experts have for new hires. Tasks and skill requirements are frequently collected in collaboration with other experts and are aligned to the enterprise's recruiting principles. Thus, codes from job ads are richer than primary data from interviews of individuals who probably do not bear in mind the whole extent of their job role at the time of an interview.

To set the parameters for the content analysis design, I searched for similar studies as reference points. Surprisingly, few content analysis studies have been carried out on job ads. I found 11 comparable content analyses that were published within the last 15 years that refer to competencies of various job roles within the fields of IT management. Table 2 provides an overview of those studies. The main attributes of those studies are the sample size, geographic job market, data sources, ways to code, development of categories, and number of categories.

The number of analyzed job ads varied broadly from 56 to 2297. Many studies with large sample sizes applied content analysis software and focused on counting keywords and phrases. Ten of the 11 studies concentrated on the job market within one country. In addition, the number of data sources was limited. Most studies relied on one source, for example, a public job website. Printed job ads have widely been substituted by postings on Internet job portals; thus, paper-based job ads did not appear in recent studies. Another feature of job content analysis is the number of job categories to which the hits were allocated. Eight studies were in the range between seven and 24 categories; only one was far higher (64). Two studies did not provide categories at all but presented their results in different ways, one as patterns and the other as exemplary job descriptions. The way category tables were built is interesting. They may have been taken from literature analysis or developed from data that had been gathered, or from a combination of the two.

Author(s)	Year	Roles	Sample size	Countries	Data sources	Coding	Number of categories	Development of categories
Gallivan, Truex III, & Kvasny	2004	IT professionals	2297	USA	Three print media, monster.com	Manual (single)	7 non-technical skills	Literature
Kennan et al.	2004	Early career IT graduates	400	Australia	Online (not specified)	Software	17, six subcategories	Literature, data analysis
Park & Lu	2009	Metadata professionals	107	USA	AutoCAT	Software	22 responsibilities; 18 qualifications / skills	Pre-study, literature, authors
Park, Lu, & Marion	2009	Digital cataloging	349	USA	AutoCAT	Software	21 skills	Pre-study, literature, authors
Sodhi & Son	2010	Operational research	1000	USA	Monster.com, Hotjobs.com, OR/MS Today	Software	11 top-level skills, 49 sub-categories	Data analysis
Ahsan, Ho, & Khan	2013	Project managers	762	Australia / N. Zealand	seek.com	Manual (single)	Top 10 competences	Literature, data analysis
Steinmann, Voigt, & Schaeffler	2013	Construction engineers	60	Germany	VDI job portal	Manual	64 competences	Literature
Brumberger & Lauer	2015	Technical communicators	914	USA	Monster.com	No info.	18 professional competencies	Literature, data analysis
Carliner et al.	2015	Performance consultants	56	Canada	Recruiting partner	Manual (team)	Patterns were presented.	Literature
Chen & Zhang	2017	Data professionals	70	USA	Five online job lists	Software	Exemplary job descriptions created	Data analysis
Gardiner et al.	2018	Big data professionals	1216	USA	Indeed.com	Software	24 concept categories	Data analysis (pile sorting)

Table 2: Studies within the last 15 years that applied content analysis to technical job ads (Source: author).

4.3.3 Sampling

There is no general rule for sample sizes in content analysis. Determining sampling strategy and size is up to the researchers as they assess adequateness for purpose (Sandelowski, 1995). The sample size should be sufficient to make analytical conclusions from results (Brislin, 1979) to present outcomes for new insights (Sandelowski, 1995) or to meet information requirements to solve the research problem (Bengtsson, 2016). The aim is to gain deeper understanding of the architect role by analyzing task and skill descriptions from job ads. I was interested in the types and accumulation of responsibilities and skills. Thus, sampling was purposeful; that is, the sample was selected on job portals to best answer the research questions (Saunders, Lewis, & Thornhill, 2016, p. 301). In qualitative research, sampling may stop at saturation, the point at which new information no longer emerges in the data collection (Site 4). After several thorough iterations with continually optimized coding schemes, the saturation point was reached. In the last cycle, no categories needed to be added, as all meaning units were unequivocally allocated to reorganized categories. Moreover, patterns were detected based on frequencies per category. Finally, meaningful skill categories were grouped from aggregation (Hsieh & Shannon, 2005, p. 1279)

The first sample was retrieved from stepstone.de, ranked by Germany's leading economy newspaper *Handelsblatt* as among the top five digital brands in Germany (Site 9). On 24 September 2018, stepstone.de displayed 301 job ads with the search term 'Architect' in the title. The country search options were 'All Germany', 'All Switzerland', 'All Austria', 'All Western Europe', and 'All Eastern Europe'. The language of the job ad was 'English'; the category was set to 'IT'. In the output list of 301 items, the job titles changed, and the search term 'Architect' was not included after 74 job ads. Therefore, the demarcation point of sample A was determined.

Sample A from stepstone.de was limited in two ways. One idea was to cover perspectives on architects' roles from several countries, but the sample mainly included firms based in Germany. Of particular interest was the role of the enterprise architect, but only five job titles contained the string 'Enterprise Architect'. Therefore, because of those constraints, another sample (B) was downloaded on 1 October 2018 from www.totaljobs.com, a leading job portal that is hosted in the United Kingdom (Site 11). I searched for the exact sequence 'Enterprise Architect' in the job titles. The portal responded with 1640 job ads, but the title changed after 51 job ads.

Both samples, A and B, comprised 125 job ads from which I excluded 13. Seven were duplicates, and two job ads were project managers from the description although the titles contained the term 'Architect'. I found the same effect in two ads for programmers. Finally, I removed one job ad because it was written in German, and another ad redirected to the company's own job portal, which was empty. From remaining 112 job ads, 13 were for contractors and 99 for permanent employees. Seventy-seven jobs were directly advertised by firms that wanted to engage the architect, while 35 jobs came from agencies. In addition, 29.5% of the job ads originated from IT vendors or IT service providers; they take the seller perspective. The 112 examined job ads provided 2438 meaning units that were assigned to 37 task categories and 49 skill categories bundled in seven skills category groups.

4.3.4 Coding

The units of analysis were descriptions of the skill requirements and the tasks within the downloaded job ads. I started with the directed content analysis approach (Hsieh & Shannon, 2005) and took codes from literature before the data analysis. I selected skill definitions from TOGAF as the coding foundation (The Open Group, 2018, pp. 468–471). I abandoned this approach after tests with 16 job ads. Forty-eight of 76 skills from TOGAF (The Open Group, 2018) were not matched at all. In addition, much information from jobs ads could not be allocated to the predetermined coding scheme. Thus, the skill set from TOGAF (The Open Group, 2018) was insufficient to reflect the real demand. As an alternative, I changed the coding approach to conventional content analysis that derives codes from data. Starting from scratch without any code, I established the new coding scheme during data analysis as codes emerged until saturation (Hsieh & Shannon, 2005, p. 1286). In contrast to a priori coding that uses categories from theory, emergent coding develops categories out of data (Stemler, 2001, p. 2). I followed the step model from Mayring (2000) for developing inductive categories. I developed categories from observation during analysis of the first 40 job ads (sample A) and then refined and applied the categories to the rest of sample A (74 job ads in total). For consistency, I reapplied the reworked coding scheme to the first 40 job ads from sample A. By analyzing sample B, the coding scheme was extended. Again, I reorganized the coding scheme to sharpen the codes for activities (e.g., architecture vs. design, technical vs. organizational, and high level vs. detailed design). All job ads (112) were reanalyzed on the final coding scheme.

The trade-off between reliability and level of interpretation was discussed in relation to ways to code, either latent or manifest (Downe-Wamboldt, 1992; Graneheim & Lundman, 2004; Saunders, Lewis, & Thornhill, 2016). The researcher can select between these approaches prior to data analysis (Vaismoradi, Turunen, & Bondas, 2013, p. 401); both ways deal with interpretation (Graneheim & Lundman, 2004); there are no strict boundaries. The manifest way could be positivistic and highly reliable by counting fixed keywords but would neglect information that is valuable to better understand the role and skills of the architect. My approach could be designated as latent with little interpretation or as manifest with high interpretation. To explore the roles of IT architects, I allowed for lower reliability for the sake of interpretation. However, I claimed to cover every meaning out of a context unit that were bullet points or sentences within the task or skill descriptions. By interpreting them, I covered relevant synonyms. They are not only single words but also diverse expressions. For example, the context units "You verify that the software architectural design maps relevant requirements on to software components" and "Verify technical solutions with stakeholders such as Network or Security team…" were recorded in the category "Ensure quality", because verification of requirements is a quality measure in project management (PMI, 2017). As other examples, "writing codes" was a hit for the task category "Programming", and "Identifying technical solutions based on.... required capabilities" was recorded in the task category "Define/specify requirements".

A single context unit may contain one or more meaning units. The meaning units were allocated to categories. Each meaning unit must be allocated to exactly one category. For instance, the task "Align the solution being recommended with the client strategic direction, managing exceptions, and effectively communicating solutions and their justification to relevant stakeholders" includes several meanings and fit four categories: "Communicate….", "Align with other units/departments", "Ensure compliance with business/business strategy", and "Support customer".

Ideally, tasks and responsibilities should fully correspond within job ads. In many cases, they did not match or only in parts. I did not make conclusions from tasks to skills and versa. It would have required too much interpretation and would have distorted the results as a whole. In some ads, skills were presented in the task/responsibility section, and in other ads, tasks were listed under skills. Those meaning units were recorded because they did not need to be interpreted; they were just placed in the wrong section of the job ad.

I wanted to find out the *essential* skills of IT architects. Therefore, I did not consider *optional* skill requirements that were expressed in different terms, such as "is a plus", "bonus points", "preferred", "is an advantage", or "are beneficial". I also skipped requirements for personality (e.g., style, cognitive abilities, and work attitudes). Individual traits like flexibility, result orientation, commitment, resilience, creativity, and so on are expected anyway. Skill descriptions were sometimes strange, such as "Ability to understand detailed impact while keeping the eye on the big picture as well as to balance what is right with what is realistic" Regarding tasks, I ignored bland, expressionless items such as "Help shape the future", "Create something new", "Be innovative", etc.

4.4 Findings

To better understand the ambiguous role of the IT architect, the contents of job advertisements were investigated by identifying meaning units in skill and task descriptions and allocating them to categories. As the categories were developed from the collected data, the category tables for architect tasks and skills are key outcomes and responses to research question 1 (subsection *Architect tasks*) and research question 2 (subsections *Architect skills in detail* and *Architect skills on aggregated level*).

In addition, the frequencies of the job ads for a category were evaluated. Frequency is a recommended technique for content analysis (Prasad, 2008; Stemler, 2001). Frequencies are presented in the percentage of job ads that contain at least one meaning unit for that category. The quantities indicate the magnitudes and sizes of the categories and may be expressed relative to a sample (Krippendorff, 2004, p. 103).

4.4.1 Job titles of architects

The sampled IT architect ads had various titles that reflect the inconsistency of the IT architect's role in general. The search term "Architect" provided 59 different titles out of 66 samples in sample A. However, some groups of architects were recognized based on common parts in titles, namely, enterprise architects, software architects, solution architects, system architects, data architects, and security architects. After comparing the tasks and skills, I subsumed the latter three groups under the type 'Solution Architect'. Roughly speaking, those architects pursue similar goals, in essence designing IT solutions, but focus on different technologies and systems. Thus, 46 architects were assigned to one of three groups. The remaining 20 samples could not be assigned based on their titles. These samples required examination of the job descriptions for allocation to the appropriate type.

From those examples and from the exclusions mentioned previously, it can be concluded that the titles of architects alone are not only insufficient but also misleading for capturing the particular architect role. All architecture assignments of the samples were reviewed, and the samples were reassigned if necessary. Decisive for allocation of samples to types were the task descriptions in the job ads, not the titles. For example, job ad no. 51 from sample B with the title 'Data Architect – Database Enterprise Architect – Information' describes responsibilities for appropriate architecture and for design of end-to-end solutions. Therefore, this job was assigned to the solution architect group. Table 3 shows the allocation of the samples to the architect types. Tables in Appendix 4 provide overviews of all sampled jobs and their allocation to architect types.

Set	Architect type	Number	Total
A	Enterprise	9	54
B	Enterprise	45	
A	Solution	13	43
A	Solution (Data)	7	
B	Solution (Data)	1	
A	Solution (System)	7	
A	Solution (Security)	4	
A	Solution (Other)	11	
A	Software	10	15
A	Software (Other)	5	
			112

Table 3: Number of job ads per architect type within sample A and B (Source: author).

4.4.2 Architect tasks

Thirty-seven task categories were defined from the data collection and iterative reorganization. Percentage shares of job ads, which contained meaning units for those categories, were evaluated for each architect type. Thus, the main emphasis for each architect type became more transparent. The solution architect was selected as the reference task profile to compare deviations of percentage shares with tasks profiles for enterprise architects and solution architects (Table 4). The tasks in Table 4 were sorted based on the percentages for solution architect in descending order. To better detect the key differences among the architect types, I marked deviations of greater than 15% with a dark blue cell background and differences greater than –15% with a bright blue cell background.

Architect tasks	Enterprise Architect	Solution Architect	Software Architect
Collaborate with other roles / organizational units	40.7	62.8	73.3
Create / propose designs, developments,solutions, products, applications, SW	29.6	58.1	40.0
Counsel / consult / advise stakeholders	46.3	55.8	20.0
Lead team / function	48.1	51.2	26.7
Support projects	50.0	46.5	13.3
Create / propose / manage architecture	44.4	46.5	**73.3**
Define / specify requirements	29.6	46.5	40.0
Ensure compliance with business / business strategy	**57.4**	41.9	26.7
Create / review / enhance / maintain architecture strategy, framework, approaches, methods, governance, policies, principles, rules, processes, tools	**61.1**	37.2	40.0
Support implementation / deployment / roll-out	20.4	37.2	20.0
Integrate (software, systems)	9.3	32.6	40.0
Create / review / enhance / maintain design or development guidelines, best practices, concept, standards, rules	31.5	30.2	33.3
Research market / technology / trends / product	16.7	30.2	40.0
Optimize / improve efficiency (beyond architectural concepts)	27.8	25.6	26.7
Ensure quality	20.4	25.6	33.3
Communicate...	18.5	25.6	13.3
Support customers	24.1	23.3	6.7
Review (assess, validate,....) / Decide designs, developments, solutions, products, applications, software	25.9	20.9	20.0
Document (create, update), artifacts	14.8	20.9	20.0
Provide training / presentations	3.7	20.9	6.7
Develop / maintain roadmap / product strategy / IT strategy	**51.9**	18.6	20.0
Align with other units/departments	22.2	18.6	13.3
Create / maintain / enhance platforms	14.8	18.6	20.0
Moderate workshops / meetings	3.7	16.3	13.3
Ensure consistency / alignment / adherence / compliance to standards	22.2	14.0	13.3
Identify and report risks and issues; maintain risk logs	5.6	14.0	6.7
Support operation	5.6	14.0	0.0
Support sales, support proposals	7.4	11.6	0.0
Test solution	0.0	11.6	6.7
Define reusable items: blueprints, building blocks, patterns, templates, generic HW, applications, references	**29.6**	9.3	13.3
Create models	**29.6**	9.3	6.7
Research architecture, prototype	14.8	9.3	6.7
Support transformations	14.8	9.3	6.7
Purchase / procure / source, e.g., infrastructure, assets, tools; manage vendors	13.0	9.3	0.0
Plan migration / implementation	11.1	7.0	13.3
Manage life cycle	3.7	7.0	0.0
Build / maintain relationships	7.4	4.7	**26.7**

Difference between Enterprise / Software Architect and Solution Architect > 15.0 % (dark blue)
Difference between Enterprise / Software Architect and Solution Architect > -15.0 % (bright blue)

Table 4: Tasks that were listed in job ads (in percent) (Source: author).

Social	Teamwork, interpersonal skills	51.8
	Communication (general)	40.2
	International work / cultural awareness / intercultural cowork	25.9
	Leadership, coordination	25.0
	Documentation / technical writing	16.1
	Presentation (explain, make understood)	14.3
	Customer (value) delivery / facing / relationship	13.4
	Interdisciplinary / cross-functional	11.6
	Moderation	8.9
	Stakeholder management	8.0
	Influencing	5.4
	Relationship building	4.5
	Negotiation	1.8
Technical knowlegde	System knowledge / technologies	70.5
	Programming, -kits	37.5
	Specific IT processes / frameworks	26.8
	Product knowledge (incl. services)	21.4
	Industry-specific IT concepts / models / systems	19.6
	Platforms, operation systems	4.5
	Technology standards	3.6
	Security	1.8
	Other	13.4
Methods	SW / product development / engineering / design	50.9
	SW / system / solution architecture	38.4
	Agile development	32.1
	Standards, principles, design patterns, methods, best practices	30.4
	Tools	20.5
	Project / program management / transformation	18.8
	Requirements management	18.8
	Operations	14.3
	Testing	13.4
	Quality	13.4
	Enterprise architecture	9.8
	Implementation / deployment	7.1
	Integration	4.5
Standards / Frameworks	Project management, e.g., PMI	8.0
	Architecture management, e.g., TOGAF	6.3
	IT management, e.g., ITIL	4.5
	Other	17.0
Business	Business / strategy	22.3
	Process management / design / modeling	10.7
	Cost, quality, performance, metrics, planning, organization, decision-making....	10.7
	Market / product / technology trends	9.8
	Presales / vendor selection / consulting	9.8
	Industry-specific (non-IT)	4.5
	Business case	2.7
Certifications	Methods	3.6
	Vendor certifications	8.0
Legal / regulatory		6.3

Table 5: Percentage of job ads containing meaning units for skills (Source: author).

4.4.3 Architect skills in detail

Forty-nine skill categories were identified and arranged in seven skill category groups. Table 5 shows the number of job ads matching the respective category (with at least one meaning unit) relative to the total sampling size as the percentage. Of all samples, teamwork (51.8%) and communication (40.2%) are the most dominant social skills. Profound knowledge of systems and technologies are in high demand (70.5%). In comparison, knowledge of vendors' products and services is of secondary importance (21.4%). Methods for development, engineering, and design are more often stated (50.9%) than methods for architectures (38.4%). There is low demand for frameworks for architecture management, project management, or IT management (< 10% each). Meaning units for business and strategy knowledge were included in 22.3% of the job ads. The significance of legal and regulatory knowledge is low (6.3%).

4.4.4 Architect skills on aggregated level

Similarities among skills categories were sought to help to describe the observed phenomena by second-order analysis (Gioia, Corley, & Hamilton, 2012, p. 20). Skills were aggregated up to the skill category group level (second-order themes) and compared between architect types. Table 6 exhibits the relative numbers of job ads that contained at least one meaning unit per skill category group (samples A and B; per architect type). All types of architects must provide social, technical, and methodology skills. However, the profile of the enterprise architect differs in three ways. First, business skills and knowledge of frameworks and standards are more often in demand. Second, the need for legal/regulatory knowledge is noticeably beyond the average. Third, requests for social skills are lower than for the solution architect (-16.6%); the difference between both types in terms of technical knowledge is even greater (-18.1%).

Skill category group	All Architects (112)	by Architect type		
		Enterprise (54)	Solution (43)	Software (15)
Social	82.1	74.1	90.7	86.7
Technical knowlegde	89.3	79.6	97.7	93.3
Methods	91.1	90.7	88.4	93.3
Standards / frameworks	28.6	38.9	20.9	20.0
Business	39.3	51.9	34.9	20.0
Certifications	8.9	11.1	7.0	6.7
Legal / regulatory	6.3	11.1	2.3	0.0

Table 6: Percentage of job ads that contained meaning units for skill categories groups (Source: author).

4.5 Discussion

4.5.1 Tasks and skills from architecture frameworks are disconnected from practice

The collected data reflect the confusion about IT architecture roles. Titles, tasks, and skills within job ads were numerous and did not adhere to any framework or standard. However, patterns were recognized, and types of architects were identified whose attributes are in line with suggestions from the literature. Many standards and frameworks present EA processes, roles, and definitions in useful ways. But there are too many competing frameworks, most of which are very comprehensive comprising several hundred pages. In addition, terms and concepts are not aligned to IT frameworks that take business or project perspectives. Consequently, IT professionals struggle to apply EA frameworks, which was also reflected in this study. Although methodology skills were in very high demand, only a few jobs required knowledge of or certificates for a particular framework, such as PMBOK (PMI, 2017) or TOGAF (The Open Group, 2018). The study also showed that the widely used TOGAF framework (The Open Group, 2018) does not mirror the roles as searched on labor markets. Segment architects were not requested at all. The job types EA manager, EA data, EA technology, and EA application were neither advertised nor echoed in the contents. Even the set of 76 skills in TOGAF (The Open Group, 2018) was not suitable as the coding scheme for analyzing the job ads.

4.5.2 Typology of IT architects

As displayed in the findings section and supported by the literature, three types of architects are proposed: enterprise architect, solution/system architect, and software architect. The following paragraphs summarize their key attributes.

The *enterprise architect* has a strong strategic orientation. This role is key for IT-business alignment by defining appropriate IT strategies and developing technology roadmaps. Moreover, governance of architecture is central by creating and managing frameworks, policies, processes, guidelines, standards, etc. More than any other role, *enterprise architects* are dedicated to modeling and defining re-usable blueprints, building blocks, and templates. Enterprise architects are leaders who collaborate with various roles and consult stakeholders. An enterprise architect can also create and design solutions and specify requirements but at a higher level and to a lower extent than the solution architect.

Solution/system architects create detailed designs and develop solutions by collaborating with diverse roles and by advising various stakeholders. These architects take on leadership and support projects. In contrast to enterprise architects, solution architects are more oriented toward specifying requirements, supporting implementations, and integrating systems. Solution architects also provide more training and presentations. The two terms, *system* and *solution*, describe technical segments of the overall architecture; they can be used interchangeably.

Social activities, such as cooperation, teamwork, and relationship building, are essential for *software architects*, but leadership, consultancy, and customer/project support were mentioned less frequently. Links to strategy and implementation are not essential. The focus of software architects is creating and managing the software architecture within the development team and liaising with other organizational units.

This typology is compatible to various frameworks. For instance, Schekkerman (2011, pp. 5–6) applied identical categories for IT architects. The BABOK (IIBA, 2015) distinguishes enterprise architecture from other architectures in the same sense. The hierarchical EA model from the EITBOK (Site 3) also fits the suggested types: business architecture and information architecture can be assigned to the enterprise architecture role, data architecture and system architecture match the solutions architect role, and software application architecture is self-explanatory. The SEBOK (BKCASE, 2018, p. 221) relates EA to the structure of the organization, while system architects and engineers deal with product and services. Finally, the DODAF (2010, p. 15) portrays EA as strategic at the departmental level, whereas systems architecture is closer to implementation and operation.

4.5.3 IT architects in e-commerce projects

Characteristics of e-commerce architectures

Business services are progressively turning into electronic services and e-commerce is decisive this way (Chang, 2010, p. 575). E-commerce markets are growing above average in contrast to conventional retail business (Aulkemeier et al., 2016). By reason of e-commerce significance, the discussion is extended to specific features of e-commerce architecture and to according skills and tasks.

E-commerce denotes product-related transactions over networks between the enterprise and its customers, suppliers, and partners (O'Brien & Marakas, 2010, p. 674). Electronic inter- or intraorganizational exchanges are facilitated by dedicated technologies (Rayport & Jaworski, 2001). E-commerce systems integrate several electronic methods for information display, transmission, and processing (Qin, 2009, p. 79, p. 271). These e-commerce systems enable dealing via the Internet (Stevens & Timbrel, 2003) by using web sites (Addison, 2003).

As the Internet is providing innovative ways to make business, novel job descriptions appear such as the "web architect" (Addison, 2003, p. 29). However, the role of the e-commerce architect has not been defined in practitioner frameworks yet. TOGAF (The Open Group, 2018) presents numerous architect roles but none for e-commerce. TOGAF (The Open Group, 2018) and SFIA skill framework (site 8) do not even mention e-commerce as a skill type, although special skills are required for planning of e-commerce solutions. The literature neglects the e-commerce architect as well. For example, Papazoglou and van den Heuvel (2006) described a design/development methodology for service-oriented architectures (SOA) without including the architect role; just designers and developers were considered.

The tasks of IT architects in e-commerce context are worth to be investigated because e-commerce developments distinguish from other kinds of IT projects. Stevens and Timbrel (2003) displayed differences between conventional IT developments and e-commerce projects from reviewing the literature. The authors noted the subsequent key differences:

- stakeholder groups are broader and skills are more diversified
- requirements and scope are more volatile
- life cycles of applications and development timeframes are shorter
- development processes are less rigor and methods are more iterative

In the following, three more attributes of e-commerce, relevant to IT architects' tasks and skills, are highlighted: multi-tier architecture, hybrid development approach, and service paradigms. The e-commerce architect role was compared to previous architect types by aid of extra samples.

Multi-tier architecture

The literature and some IT vendors suggested to view e-commerce architecture on distinct levels. Yet, the levels are defined in various ways. Gutierrez and Martinez (2000) viewed e-commerce architecture on three tiers to cope with complexity of the enterprise's IT infrastructure. These tiers comprise the clients' computer systems, the backend with software applications, and the intermediate level for business transactions. Mouratidou, Lourdas, Chatzigeorgiou, and Georgiadis (2010) described multi-tier e-commerce applications based on the Java platform consisting of the client tier (e.g., for HTML support), the middle tier (i.e., Java server), and the back-end tier (i.e., enterprise database server). Khalifa (n.d.) extented the stack of layers for e-commerce applications to six in total, including network, security, and data brokerage. Kögler (2015) also took the idea of information brokerage, i.e., inter-application communication, in a three-level concept for IT architectures in e-commerce enterprises. The other two levels refer to SOA for seamless integration of manifold IT components and to cloud computing for flexible services. IBM's e-commerce reference architecture (site 7) displays the cloud as core domain between the public network and the enterprise network. The design guide from Cisco Systems (Wilkins, 2012, p. 121) defined e-commerce as a module in the overall architecture consisting of servers, security devices, and switches for data transport. So, e-commerce architecture is mostly subdivided into three distinct domains or levels. I go along with the layer model from Aulkemeier et al. (2016, p. 42) that concentrates on e-commerce architecture to mirror requirements for IT resources. The business layer represents enterprise functions by aid of models and process descriptions; the technology layer contains hardware, network, infrastructure, cloud, middleware, basic services, etc.; the application layer relates to software development.

Hybrid development approach

The e-commerce architect must oversee all three architectural layers and manage the development towards an integrated solution. Development approaches differ by layer. The building of IT infrastructures on the technology layer typically uses the traditional predictive approach (Gellweiler, 2019), whereas software developments on the application layer use agile methodologies such as scrum (site 1). Tailoring of scrum methodology for e-commerce software development may even improve quality and shorten project duration (Hong, Yoo, & Cha, 2010). The hybrid approach combines agile and predictive methods (PMI, 2017, p. 19) and must be aligned with project management (Grushka-Cockayne, Holzmann, Weisz, & Zitter, 2015).

Service paradigms

E-commerce architecture is often regarded in context with service paradigms such as SOA and cloud computing (Aulkemeier et al., 2016; Kögler, 2015; Site 7) that an architect must understand and incorporate if needed. "SOA is an architecture style that views IT solutions essentially as a collection of services" (Josyula, Orr, & Page, 2012, p. 139) applied in software applications development (Demirkan et al., 2008). Cloud computing provides ways to source IT capabilities as different bundles of services from external vendors. Thereby, resources are shared and delivered in various service models that differ in ownership and their operation. Cloud computing and SOA constitute perspective changes from functional IT components to service descriptions. These trends seem to simplify management of IT delivery, but architectural deliberation is still crucial (Martin, Dmitriev, & Akeroyd, 2010, p. 7). Interoperability between platforms, languages, cloud infrastructures, etc. must be carefully considered. Integration could span over several providers, domains, platforms, and technology components (Khasnabish et al., 2015) that may make architectural design complex.

The e-commerce architect

The title 'e-commerce architect' is not established in practice. Only one job ad from investigated samples A and B included both keywords (commerce, architect) in its title. Other dedicated searches on these keywords on 24. January 2019 provided only six hits on totaljobs.com and just three on stepstone.de (sample C). This time, I included German job ads on stepstone.de, since English job ads were not found there. After excluding one job ad for mobile commerce on Android smartphones, eight job ads remained for exploring patterns in their task descriptions. Each task was allocated to one of three architect types as presented before. None of the job ads indicated tasks typical to the software architect. Seven out of eight job ads contained tasks from both the enterprise architect type and the solution architect type. The other job ad contained items that exclusively referred to the solution architect type. From 60 tasks, 77% were allocated to the solution architect type and 23% to the enterprise architect type. From these few examples, one may propose that e-commerce architects combine enterprise architecture and solution architect tasks with main emphasis on the latter role. This observation is in line with Martin, Dmitriev, and Akeroyd (2010, p. 6), which stated that IT architects operate on two major levels: the enterprise level for flexibility, integration, and re-use, and the solution level for reliability, performance, and interoperability.

In summary, e-commerce architects create designs that extend over three layers as presented by Aulkemeier et al. (2016). They consider strategic aspects on the business layer like an enterprise architect and perform tactical tasks like a solution architect on the infrastructure layer. Although, the e-commerce architect does not actively engage in software developments, she or he aligns activities and objectives on the application layer to the business and the infrastructure layers. These alignments need to combine and manage predictive and agile development methodologies to the hybrid approach. Table 7 displays the mapping of architect types to e-commerce architecture layers and shows the combinations relevant to e-commerce architects. Finally, service paradigms applied in e-commerce, such as SOA or cloud computing, enhance IT efficiency in total but do not reduce architectural sophistication and demand.

E-Commerce Arch. Layer	Architect Type	Architect View	Development Approach		*E-Commerce Architect*
Business	Enterprise	Strategic	N/A	→	*Tasks and skills combination*
Technology / Infrastructure	Solution	Tactical	Predictive		
Application	Software	Tactical	Agile	→	*Hybrid approach*

Table 7: Combinations of architect attributes for e-commerce projects (Source: author).

4.5.4 The upcoming evolutionary step: The digital architect

Digital entrepreneurship is an emerging field in research and practice. Main areas of digital entrepreneurship are the generation of new business and the organization of digital innovation (Fang, Henfridsson, & Jarvenpaa, 2018). Digital innovations go beyond network-based transactions from e-commerce, which concentrates on economic benefits (Pigni, Piccoli, & Watson, 2016). Digital innovations utilize user data from sensors, take advantage from social trends, and create or modify business systems (Gellweiler & Krishnamurthi, 2020). Digital innovations provide new values between professional stakeholders and consumers based on user-generated content (Suseno, Laurell, & Sick, 2018). Creation of value for customers are central for services that found on digital technologies (Baird & Raghu, 2015; Blitz, 2016; Pigni, Piccoli, & Watson, 2016; Trabucchi, Buganza, & Pellizzoni, 2017).

The utilization of digital chances and the management of digital innovations necessitate enhanced organizational IT capabilities (Tumbas, Berente, & vom Brocke, 2018). Organizations engaging in digital transformations require new leadership roles and 'digital skills' to cope with environmental changes (Nadeem, Abedin, Cerpa, & Chew, 2018). For example, the new role of the *chief digital officer* (CDO) is different from the traditional function of the chief information officer; it concentrates on digital innovation. The CDO is placed between IT and marketing; he or she acts close to customers with pronounced value orientation. The CDO concentrates on projects with digital technologies; the aim is to generate novel revenue streams (Tumbas, Berente, & vom Brocke, 2018). The role of the enterprise architect also needs to be adapted in the digital transformation context. In particular, the enterprise architect should evaluate the creation and the capture of values, and observe technological progress and business trends in real-time (Korhonen & Halén, 2017). *Digital architects* must make effective decisions and enable rapid solution development by employing modular services and components (Korhonen & Halén, 2017, pp. 356–357).

High innovation speed calls for potent architecture and design practices, e.g., by using standards, modules, and platforms (Korhonen & Halén, 2017; Yoo, Boland, Lyytinen, & Majchrzak, 2012). Hierarchy-of-parts architecture and network-of-patterns architecture are suggested complementary architecture approaches to increase the speed for (re)designing digital services and products (Henfridsson, Mathiassen, & Svahn, 2014). Flexibility and adaptivity are critical abilities of enterprise architects in the digital transformation (Zimmermann, Schmidt, Jugel, & Möhring, 2015).

Beside effective methods and techniques for product/service design and the distinct customer value attitude, digital architects must lead and govern digital innovations (Henfridsson, Nandhakumara, Scarbrough, & Panourgias, 2018; Korhonen & Halén, 2017; Yoo, Boland, Lyytinen, & Majchrzak, 2012). Recombination of technologies and opportunities for value creation are centerpieces of digital innovation. Design recombination means connecting digital resources to create value (Henfridsson et al., 2018). "New opportunities can be seized by connecting smart devices, modifying business systems, and/or exploiting social trends" (Gellweiler & Krishnamurthi, 2020, p. VI).

Six job postings that contained the term "digital" in the job title were found in sample A, B, and C. Three of them were from type enterprise architect, two jobs were from type solutions architect, and one architect job was responsible for software. Four job ads contained terms for digital technologies such as "Internet of Things", "cloud", "big data", "robotics". Valid conclusions cannot be drawn from this data. Further content analyses are recommended to identify tasks and skills that are generalizable. However, from the previous interpretations and the literature presented in this section, propositions on characteristics of digital architects can be outlined.

Similar to e-commerce architects, digital architects combine tasks and skills from enterprise architects and solution architects. They possess deep knowledge on digital technologies, such as networks, sensors, and artificial intelligence. Like CDOs, digital architects are strongly focused on innovation and customer value creation to generate new revenue streams (cost optimization is in the scope of other architects). Creativity is needed for changing business systems by application of digital technologies and by collecting and evaluating user data. To be faster than innovative competitors, digital architects employ sophisticated and advanced design methods (e.g., modularization, recombination).

4.5.5 Limitations and future research

Several limitations must be considered. Searching and interpreting meaning units and allocation to categories were done by a single coder who unconsciously might have impaired the results. Weaknesses mainly stem from coding errors by altering interpretations, misunderstandings, or overseeing the codes. Two or more coders would have increased reliability. Moreover, the sample is not representative enough to generalize it to a population.

Content analysis of job ads using the same coding scheme can be continued in other countries to increase generalizability. Directed content analysis (Hsieh & Shannon, 2005) can be applied by using codes and keywords from the presented schemes. A greater sample size should be chosen for job ads of e-commerce/digital architects to deeper examine these roles and according digital skills. New insights can also be gained by using other methods of qualitative research, for example, semi-structured interviews with IT managers and system engineers. Surveys among IT professionals would also provide useful quantitative data to support or to challenge the conclusions in this paper. Other interesting research questions can be raised about IT architects' co-operation and communication with other key roles, such as business analysts or project managers.

This exploratory and inductive study has built a *nascent theory* by categorization and characterization of IT architects. A subsequent *intermediate theory* study could empirically verify the proposed IT architect typology. Surveys and/or structured interviews among IT professionals would provide useful quantitative data for testing the results from this content analysis (Edmondson & McManus, 2007). Both empirical building and testing of theories provide elevated scientific contributions (Colquitt & Zapata-Phelan, 2007).

4.6 Conclusions

IT architecture provides critical capabilities and is of strategic importance for gaining and sustaining competitive advantage. Numerous rival institutions try to enhance architecture management by publishing frameworks that are not consistent and that are insufficiently employed in the industry. The EA discipline is widely unexplored in theory and is fuzzy in practice. Moreover, previous IT architecture research neglected the role of the architect.

IT architects are decisive resources for the creation of information systems and their management over life cycles. These architects' tasks and skills were examined with job advertisements. From content analysis, three types of architects were induced that are backed by the literature. *Enterprise architects* align IT strategies with business and are responsible for EA methods, governance, policies, principles, processes, etc. They develop roadmaps for IT products and services, define reusable artifacts, and create structural models. *Solution or system architects* specify system requirements and functions as foundations for detailed solution or system designs. These architects specify hardware and software components and the interaction between them. *Software architects* collect and analyze software requirements and design the software accordingly.

E-commerce architecture has miscellaneous aspects. It includes three tiers (business, infrastructure, application), two different development approaches, and various service paradigms (e.g., SOA, cloud). Architects in e-commerce projects combine tasks of enterprise and solution architects, think and act strategically and tactically, and deal with the hybrid development approach. Digital architecture is an evolving discipline that extents the architecture scope on innovation, business modeling, and customer benefits. Digital architects make use of data from sensor-equipped objects that are intelligent and continuously connected via networks. Thereby, development speed and value creation are central.

All IT architects must provide high proficiency in social skills, in particular, verbal and written communication, teamwork, and leadership. In addition, system and technology knowledge is of great importance. A methodological background in engineering, designing, developing, and architecting is crucial, whereas knowledge of specific standards and frameworks is barely demanded. Business and legal knowledge is required mainly for enterprise architects.

This research evaluated data from practice and partly refutes the skills and the EA types in the leading framework TOGAF (The Open Group, 2018). The TOGAF skill set was unsuited for directed content analysis; many EA roles were not reflected in job ads. Stakeholders dealing with IT management can gain more clarity about the core tasks and key competencies of three types of architects. The listed task and skill categories may be used as catalogs. Managers and recruiters may benefit from these catalogs by selecting needed items when creating their job ads. This research was exploratory and lacks representativeness. Directed content analysis of job ads in other countries and semi-structured interviews with architect-facing IT professionals would enhance knowledge and dissolve the fog around IT architects.

Remark: The citation style of the *Journal of Theoretical and Applied Electronic Commerce Research* is very different from APA citation style. In order to stay close to the accepted version of the article, the following website list has not been integrated into the reference list.

Websites List

Site 1: Agile Manifesto https://agilemanifesto.org/principles.html

Site 2: Enterprise Architecture Body of Knowledge http://www.eabok.org/eabok.html

Site 3: Enterprise Information Technology Body of Knowledge

http://eitbokwiki.org/Main_Page

http://eitbokwiki.org/Common_EIT_Roles

http://eitbokwiki.org/Glossary

Site 4: Center for Innovation and Research in Teaching (CIRT) - Grand Canyon University, Arizona

https://cirt.gcu.edu/research/developmentresources/research_ready/qualitative/sampling

Site 5: Cisco Certified Architect

https://learningnetwork.cisco.com/community/certifications/cisco_certified_architect/syllabus

https://www.cciehof.com/stats.html

Site 6: General Enterprise Architecting research program http://groeiplatformgea.nl/

Site 7: IBM E-Commerce Reference Architecture

https://www.ibm.com/cloud/garage/files/ecommerce-high-level.pdf

Site 8: Skills Framework for the Information Age

https://www.sfia-online.org/en/framework/sfia-7/a-to-z-skills-collection

Site 9: Steptone (job search portal for sample A)

https://www.stepstone.de/

https://www.stepstone.de/ueber-stepstone/press/auszeichnung/

Site 10: Systems Engineering Body of Knowledge Wiki

http://www.sebokwiki.org/wiki/Physical_Architecture_(glossary)

Site 11: Totaljobs (job search portal for sample B)

https://www.totaljobs.com/

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5 CONNECTING ENTERPRISE ARCHITECTURE AND PROJECT PORTFOLIO MANAGEMENT: A REVIEW AND A MODEL FOR IT PROJECT ALIGNMENT

Abstract

Enterprise architecture (EA) and project portfolio management (PPM) are key areas when it comes to connecting enterprise strategy and information technology (IT) projects. Both management disciplines enhance business capabilities, integrate skilled resources, and govern affiliated processes and functions. A skillful comprehension of the links between these managerial areas is essential for effective IT planning. This paper elaborates on the common grounds and structural attachment of EA and PPM, showing the substantiated relations between them and demonstrating their cohesiveness. From strategic planning to solution delivery, a conceptual model for *IT project alignment* integrates these IT management disciplines over two levels. EA ascertains the *technical* goals and constraints, whereas PPM determines the *organizational* goals and constraints. EA and PPM analyses also include requirements, feasibility, value, risks, and dependencies. The results from both sides are combined to jointly propose, select, prioritize, and schedule IT projects. Roadmapping is a suitable approach to bring EA and PPM together.

5.1 Introduction

Information technology (IT) increases a company's competitive advantage by lowering costs and/or by differentiating from rivals (Porter, 1985, pp. 166–172). Enterprises must build and constantly enhance their IT capabilities to survive in the marketplace. Since the late 1970s, the planning of IT capabilities has been strategically significant; indeed, IT planning strives to merge project planning with strategic business planning (Robson, 1997, pp. 100–101). Yet, the mechanisms regarding how IT is strategically aligned to business are still unclear in practice and are subject to numerous theoretical discussions, particularly the alignment of IT and business dominate diverse academic considerations that take various notions, such as fit, linkage, integration, or bridge (Ullah & Lai, 2013). Business-IT alignment is defined in many ways and has been discussed for three decades (Chan & Reich, 2007). This alignment phenomenon is still of growing relevance, and researchers have proposed a great deal of tools, methods, and techniques (Aversano, Grasso, & Tortorella, 2012, p. 162). However, the roles and functions in the enterprise IT area are confusing and inconsistent because there is no authoritative source that defines the knowledge across the whole enterprise (IEEE & ACM, 2018). This article illuminates enterprise architecture (EA) and project portfolio management (PPM) functions and according managerial roles that perform and coordinate strategic IT planning activities.

Definitions and standards for EA have been inconsistent for more than 35 years (Halawi, 2018, p. 1). EA is viewed, on the one hand, as an IT topic, and on the other hand, it is seen as a business model and strategy subject, particularly in management science literature (Syynimaa, 2018). The Open Group Architecture Framework (TOGAF) presents EA as a generic methodology, but the descriptions of EA skills clearly stress IT competencies (The Open Group, 2018, pp. 470–471). In real life, EA almost always includes IT (Walrad et al., 2014, p. 43). EA creates links between business architectures and IT architectures and verifies their integrity (Helfert, Doucek, & Maryska, 2013, p. 73); it also identifies business processes, applications, data, and technology (Strano & Rehmani, 2007, p. 392) and is a means for organizational change (Sousa et al., 2011). Indeed, EA supports executives regarding optimal strategy, providing the direction on what is needed to achieve business goals.

PPM is embedded in the organization's overall strategy to accomplish objectives and realize the strategies of an enterprise (PMI, 2013, pp. 5–7). These objectives concern all the primary and support activities of an enterprise's value chain, including IT "since every value activity creates and uses information" (Porter, 1985, p. 168). PPM takes a holistic view, covering all organizational changes, and every organizational change affects IT. Effective PPM increases the business value from investments (PMI, 2013, p. 10). A portfolio represents the total investments for strategic change initiatives (Axelos, 2014, p. 2). PPM allocates budgets assets, and human resources to projects based on strategic analyses and choices. Projects denote investments (Axelos, 2014, p. 3) in strategic change initiatives to build or extend capabilities and assets to gain a competitive advantage.

Both EA and PPM enable a structured realization of IT solutions that effectively meet business requirements (Office of Management and Budget, 2013, p. 149). Both IT management disciplines enhance business capabilities, integrate skilled resources, and govern affiliated processes and functions. A skillful comprehension of the links between these managerial areas is essential for effective IT planning. The relatedness of these IT planning capabilities is highly significant, because both disciplines bear responsibility of value generation from IT solutions. However, too little attention has been on the connectivity of EA and PPM in theory and practice.

The purpose of the current conceptual paper is to explore the coherence of EA and PPM and their functional alignment to the business and to IT projects. More elaboration is needed to comprehend the dependencies between both IT planning functions and to set the appropriate organizational structures. The present paper answers the following research question: How do EA and PPM connect and align in strategic and tactical ways? The current paper investigates in the coherence of EA and PPM and extends the views on their strategic and tactical alignment.

This paper starts with a literature review on connectivity of EA and PPM and their alignment to the business. The review includes the nascent notion of *IT project alignment*. Then, the strategic and tactical levels of EA and PPM are theoretically illuminated. For both disciplines strategy concerns alignment, whereas tactical management affects governance. Connections between EA and PPM are elaborated; the concept of IT project alignment integrates EA and PPM by aid of the roadmapping technique. Finally, the key statements are summarized, and future directions of research are proposed. The present work contributes to the literature by a concept and a model that connect EA and PPM; practitioners may apply this model as a foundation for governance in their IT organization.

5.2 Literature review

5.2.1 The connectivity between EA and PPM is underestimated

EA and PPM have rarely been seen in connection. The work from Luftman and Brier (1999) described the strategic IT alignment process; here, architecture is one of the 12 strategic alignment components, while project management is the means to implement strategies. However, the connections between architecture and project management have not been analyzed. O'Brien and Marakas (2011, pp. 491–492) noted three main elements of business IT planning: strategic development, resource management, and IT architecture. The planning process should mutually accommodate setting the objectives and prioritization, which both require business insights and feedback. Chief information officers (CIOs) and general managers must manage strategy development to have the business and IT areas work together. However, the authors neither mentioned PPM nor EA.

Cuenca et al. (2014) presented a strategic alignment model that highlighted IT architecture but did not mention PPM. In the same way, Bhattacharya (2018) omitted PPM in his elaboration of the strategic alignment model that uses EA. Similarly, Zhang, Chen, and Liu (2019) suggested an approach for resource allocation and portfolio analysis that concentrates on EA methods but leaves out PPM.

In contrast, some authors reflect PPM in strategic planning/alignment but fail to include EA. Marcos, Mezcua, and Crespo (2007) presented a model that contains portfolio management, IT strategy planning, and alignment, but they did not consider architecture. Kumar, Ajjan, and Niu (2008) regarded applications, infrastructure, and projects as interrelated parts within IT portfolios. Architects were just allocated to the infrastructure sub-portfolio but not to the applications and project groups. Hansen and Kremmergard (2014) even separated IT architecture from IT PPM scope. In their mind, IT architects do not concentrate on the development of IT solutions, but on the operation of IT infrastructures. Benaija and Kjiri's (2014) proposition for strategic alignment left out the IT architecture; they did not consider IT at all. Kaiser, Arbi, and Ahlemann (2015) theorized project selection by PPM from cases in the construction industry without any architectural aspect. El Hannach, Marghoubi, and Dahchour (2016) disregarded EA in their project prioritization process. Bondel, Faber, and Matthes (2018) showed the business capability map as an EA tool for business-IT alignment. Portfolio management was displayed as a business capability on the top level, but links to EA were not demonstrated.

According to Gartner Inc., EA and PPM should build relationships and integrate because both disciplines benefit from each other (Bittler, 2012). Foorthuis et al. (2010) carried out an online survey and found that conformance of EA and projects provide benefits in view of project quality, risks, and business-IT alignment. Another survey from Shanks et al. (2018) also showed benefits to projects when using EA services for IT or business changes.

Few academic publications have recognized the relations between PPM and EA to realize these benefits. According to Quartel, Steen, and Lankhorst (2012, p. 193), EA is essential to identify and analyze the links within a portfolio. In their model, both EA and PPM relate to the business strategy and business requirements. Cameron (2005, p. 404) stated that the IT architecture team belongs to the bodies and stakeholders that manage the portfolio. The involvement of IT architects in PPM is also supported by Aier and Schelp (2010), who examined EA in six companies and reported that EA contributions in IT projects were long-term key success factors in all the cases. Simon, Fischbach, and Schoder (2013) discovered the importance of the PPM-EA connection; they identified some differences and similarities between EA and IT portfolio management from the literature and suggested integrating IT portfolio management into EA management. In their model, EA scope comprises IT and business, while PPM scope is IT only. The Body of Knowledge and Curriculum to Advance

Systems Engineering (BKCASE; 2018, p. 641) connected EA and PPM by looking at resource allocations and budget decisions. These activities are founded on the recommendations from PPM and on the objectives from EA, and they must be brought into line. Investment decisions and the preceding evaluations need inputs from both roles, that is, portfolio managers and architects (Lankhorst & Quartel, 2010, p. 14). A technical value analysis from the EA side should be combined with a monetary value analysis from the PPM side. However, the literature is unclear, how EA contributes to decision-making on IT investments (van den Berg et al., 2019).

Even TOGAF (The Open Group, 2018), the leading reference for EA, does not provide distinct directions to PPM. TOGAF indicates a "structured direction" between EA and PPM and said that PPM is a supplier of pieces that must fit into the EA puzzle (The Open Group, 2018, p. 62). Yet, TOGAF neither presented nor worked out the appropriate processes or methods for "structured puzzling."

Some recent papers indicated links between EA and PPM, but they did neither present sufficient theoretical arguments nor empirical data. Ugwu (2017) pointed out the complementary functions of EA and project management and the need for their alignment by bi-directional data exchange. Yet, the statements from Ugwu (2017) were not scientifically substantiated; his article only referred to the PMBOK (PMI, 2017) and seven online references, thereof two wiki websites and one blog. Sousa and Carvalho (2018) emphasized the need to align EA and PPM and to integrate information flows between both functions for project prioritization, project planning, and risk assessment. A research methodology was outlined, but data has not been presented yet. Schomburg and Barker (2019) compared the entities IT project management office (supporting portfolios and projects) and EA in the public sector. They concluded that these entities have different but complimentary views on IT projects and are critical to project success. Yet, their paper described perceptions and lacked valid research methods

5.2.2 The nascent notion of IT project alignment

The literature has not clearly denoted "alignment" as a state, degree of fit, or process in a business/strategy context (Ullah & Lai, 2013). Yet, alignment theories in IT/IS research concentrate on the business-IT interface. The notion of *IT project alignment* is emerging; researchers have given different meanings to it, which are summarized as follows.

Juiz, Gómez, and Barceló (2012) presented a case where the strategic and tactical IT objectives were aligned to the business, with approved IT plans coming out as the result. However, the authors concentrated on objectives and processes but let down functions and organizational structures. The authors left the notion of IT project alignment unexplained, even though it was part of the title. Not to mention, their theoretical framework lacked proof; their paper only refers to seven sources.

Wolf, Beck, and Vykoukal (2010) delivered a model for IT project alignment that has diverse levels. The vertical direction connects the strategic level to tactical level, whereas the horizontal dimension refers to the external environment. Wolf et al. (2010) omitted IT architecture functions in their model. Bardhan, Krishnan, and Lin (2007) related IT project alignment to the ways information systems are used as tools to perform project management (e.g., file sharing, collaboration systems, planning applications, etc.).

Nilsson (2015, p. 29) observed IT project alignment in practice and showed the context among strategy, EA, PPM, and project management, associating 13 assumptions with this context. The relationships between EA and PPM were not examined; instead, a model was compared with previous research and a set of assumptions was discussed. Nilsson (2015) placed the IT project in the center surrounded by skilled stakeholders that all need to understand the project essentials. IT project alignment, in Nilsson's sense, is relationship management between the IT projects and the stakeholders.

The term "information system project alignment" was presented by Jenkin and Chan (2010), but their research addressed the compliance of project outcomes to project objectives and assumed that IT had already been strategically aligned. Beyond strategic IT alignment, Jenkin and Chan (2010) gave their alignment view on IT deliverables that must be in line with IT project goals; their research related to the tactical results from projects. The influence of IT architecture on project alignment was not examined but suggested for future research.

Previous research on IT project alignment has failed to address the strategic relationship between EA and PPM. The author uses the phrase IT project alignment to connect these functions in the model that is presented later (Figure 1).

The literature review has shown that the connections between EA and PPM and their alignment are essential but inconsistent in theory. In the following section, key aspects of both disciplines are illuminated on two levels: one strategic, one tactical. Thereafter, a model is presented that integrates EA and PPM for aligned IT planning.

5.3 The strategic level: business alignment

Business-IT alignment contributes to value generation from IT investments (Henderson & Venkatraman, 1993), and the concept of business-IT alignment is one of the most examined topics in academia and real life (Ullah & Lai, 2013). EA is considered to be an effective methodology for business-IT alignment (Bhattacharya, 2018), which deals with the interrelationship of IT and business to attain strategic goals (Ullah & Lai, 2013) and to create business value (Mosthaf & Wagner, 2016). Early and influential research on strategic IT alignment perceived architecture as a substantial element for that purpose (Ross, 2003). Architects select, define, and integrate IT infrastructure components (e.g., hardware, software) that must align to organizational goals (Henderson & Venkatraman, 1993; Luftman & Brier, 1999). According to Wieringa, van Eck, and Krukkert (2005), business-IT alignment is an essential driving force for IT architecture. Zhang, Chen, and Luo (2018) found more than 40 academic publications for achieving business-IT alignment by applying EA methods. However, a general definition of business-IT alignment related to EA does not exist. In the context of these previous EA role descriptions, the author considers EA as a strategic function for both business and IT that connects these concepts together; here, EA is the key for business-IT alignment. Business architecture designates the enterprises' operations in terms of its capabilities, organization, processes, tasks, and so forth (The Open Group, 2018, p. 78) to achieve a common understanding (Business Architecture Guild, 2017, p. 590). Business architecture describes the enterprise's current and future conditions and is "used to align the enterprise's strategic objectives and tactical demands" (Business Architecture Guild, 2017, p. 590; IIBA, 2015, p. 442). Thus, the business architecture is sender and receiver for business-IT alignment and constitutes a foundation for the enterprise architect.

The alignment of project management to business strategy is also a bidirectional relationship. In proper alignments, project management supports businesses that pursue cost leadership or differentiation strategies (Porter, 1980); in turn, this affects these businesses from a project feedback perspective (Milosevic & Srivannaboon, 2006). "PPM advances *organizational* capabilities" (PMI, 2014, p. 1). Projects align to the business by meeting organizational goals and by considering organizational constraints (Chaudhry, 2015). PPM should evaluate these constraints to make rational investment decisions. Indeed, "strategic decisions are based on a clear understanding of costs, risks, impacts on business as usual, and the strategic benefits to be realized" (Axelos, 2014, p. 2).

5.4 The tactical level: governance

5.4.1 EA governs solution architecture

IT alignment appears to be multidimensional (Chan & Reich, 2007). However, the research on IT alignment has mainly addressed strategic topics, leaving out their integration in tactical directions; previous studies have underrated the meaning of tactical management (Wolf et al., 2010). The empirical research outcomes from Wolf et al. (2010) indicated the complementation of the strategic and tactical management levels. These management levels correspond to the two main IT architecture levels from Martin, Dmitrieva, and Akeroyd (2010, p. 6): the EA level and the project/solution level. Architectures must be designed so that they perfectly match each other on each of these levels (Wieringa et al., 2005). Enterprise architects link the strategy level to the tactical level by governing solution architects in supporting business-IT alignment (Ullah & Lai, 2013).

On the tactical level, solution architects support projects (Gellweiler, 2019) to implement the strategies and act from previously made strategic decisions and policies (Robson, 1997, p. 17). Enterprise architects control the efficiency and adequacy of the IT architecture (Helfert et al., 2013) and guide solution architects throughout projects. Frameworks, policies, and standards are the tools used to govern solution designs within projects. Governance by EA is crucial to guarantee architectural involvement in projects (Shanks et al., 2018, p. 147). Here, governance includes the introduction and monitoring of the principles and standards for maintaining the consistency of architecture. These standards and policies provide guidance for decision-making in projects (Löhe & Legner, 2014, pp. 105–106), that is, they still allow for autonomy (Robson, 1997, p. 21).

5.4.2 PPM governs project management

Besides the strategic level of business-IT alignment, PPM comprises the tactical level for governance and feedback. The tactical level concerns projects over their life cycle (Milosevic & Srivannaboon, 2006). Thus, PPM must bridge the business on the strategic level to projects on the tactical level. PPM should organize the information flows and make decisions between both levels.

Portfolio managers maintain a consistent delivery of changes (Axelos, 2014, p. 12), that is, PPM controls and monitors projects. Project governance within portfolio functions provides efficiency by giving a definition and application of the tailored frameworks, policies, guidelines, rules, templates, and so forth. Standardization, process homogeneity, planning consistency, and learning curve effects accelerate project management tasks and avoid the costs of failure. Concurrent projects may transparently be controlled, and their dependencies may be managed more efficiently.

Projects can be thought of as business change initiatives that compete for resources and monetary funds; these demands must be monitored and decided if deviations from the cost baselines occur as projects progress. Therefore, portfolio management must constantly gauge all running projects to resolve capacity conflicts regarding the achievement of strategic objectives. For the purpose of resource decision making and for efficiency reasons, projects must be governed from a higher level, that is, portfolio management, and, if needed, via programs as intermediate management level for controlling bundles of interrelated projects.

Portfolio management goes beyond strategic alignment and project/program governance. It also oversees the values that should be realized from the deliverables in use (PMI, 2013, pp. 7–8). In the case of IT, value is delivered from solutions that have gone into production. Thus, portfolio management not only controls IT project performance, but also evaluates the delivered IT solutions in the company's day-to-day operations to verify the achievement of strategic objectives and the fulfillment of business requirements. Therefore, portfolio management is a permanent function. It covers all the solutions from their emergence until their end of life.

5.5 Towards a model integrating EA and PPM

5.5.1 Technical and organizational goals and constraints

For the design of enterprise networks, Wilkins (2011) distinguished organizational goals and constraints from technical goals and constraints; this differentiation helps in comprehending the complementation of analytical contributions from EA and PPM.

Technical goals, as suggested by Wilkins (2011, pp. 71–72), correspond to IT requirements. All technical goals—and, accordingly, the IT requirements—depend on the business architecture. Functional IT requirements are specified to develop new IT services that provide value. Non-functional IT requirements must be defined or reviewed along with any functional changes. Some examples are the scalability to prepare future expansions, service availability for business continuity, performance, manageability, security for data protection and accessibility (Cater-Steel, 2009, p. 129). EA must define the technical goals and analyze the company's limitations. Some examples of *technical constraints* include legacy equipment, solution life cycles, provider contracts, platform compatibility, interoperability (protocols, interfaces), or other technical dependencies such as bandwidth (Wilkins, 2011, p. 72). In short, EA strategically aligns IT to business by translating business architectures into technical goals and IT requirements. EA also takes any technical constraints into account. The implementation of strategically planned changes is carried out on a tactical level by solution architects governed by EA.

Organizational goals encompass all the strategic endeavors, such as geographical expansions, new product introductions, structural redesigns, acquisition of firms, location moves, outsourcings, changes in supplier or partner relationships, and so forth. These must be evaluated based on the requirements, scope, and added value, that is, a benefit realization perspective. PPM strives for optimal resource and budget allocations and preschedules projects to best accomplish the organization's goals (BKCASE, 2018, p. 628; Cooper, Edgett, & Kleinschmidt, 1999, p. 334). This requires a thorough project analysis from PPM while keeping in mind goal setting and value delivery. The selection and prioritization of projects depend on how these projects support strategic goals (Martinsuo & Lehtonen, 2007). The resources and budgets are allocated accordingly. Furthermore, PPM must schedule projects based on priorities, cash and resource availabilities, and project interdependencies. *Organizational constraints* impact project implementation. In the worst case, they can prevent projects from starting. The limiting factors here are budget, human resources, skills, assets, and risks. These must be analyzed, for example, by a capability analysis (PMI, 2013, p. 74) and must be preplanned. Furthermore, internal and external dependencies must be taken into account, such as supplier conditions, lead times, policies, contractual obligations, and logical dependencies from and to other projects. Laws and regulations are also aspects to be considered.

Table 1 depicts scopes of EA and PPM. Both functions strategically align to the business and control subordinate functions on the tactical level to maintain consistency for future changes. While EA concentrates on IT projects, PPM encompasses all major changes of the enterprise. Both sides analyze potential projects based on their needs. These analytical outputs need to be exchanged and discussed between EA and PPM to achieve a joint way forward.

	Enterprise Architecture (EA)	Portfolio Management (PPM)
Strategic scope	- Technical goals and constraints - Business-IT alignment - Technology life cycles	- Organizational goals and constraints - Project prioritization aligned with the business - Fund and resource allocation
Tactical scope	- Consistency of IT architecture - Monitoring and controlling of solution design - Definition of reusables, guidelines, principles,…	- Consistency of project delivery - Monitoring and controlling of programs/projects - Definition of frameworks, guidelines, principles,…
Project focus	- IT projects (infrastructure changes, application development,...)	- All projects (organizational restructuring, process reengineering, mergers, acquisitions, outsourcing, new sites, moves, new products,…)

Table 1: Scope and focus of EA and PPM (Source: author)

5.5.2 Connecting EA and PPM

Decision-making approaches are imperfect, if analyses and judgments are made within EA and PPM silos and, if important aspects from the other silo remain unconsidered. EA lacks organizational views (Nilsson, 2015, p. 28), which are needed to capture the business-IT relations (Luftman & Brier, 1999), whereas PPM lacks the technical perspectives required to implement the IT strategies (Luftman & Brier, 1999). Plans from PPM need alignment with plans from EA. On the EA side, EA states strategically relevant IT change undertakings within the project portfolio (Ross, 2003, p. 43; Öri, Molnár, & Szabó, 2018, p. 727). On the PPM side, each project and organizational change affect IT, which must be taken into account by EA. For example, Langermeier and Bauer (2018) drafted an EA planning method for architectural compliance in projects in order to achieve EA goals; this method integrates project proposals into the domain architecture.

Requirements management is another concrete example that calls for collaboration of EA and PPM. According to Buckl (2011, p. 153), the requirements from IT and the business must be identified, evaluated, and prioritized by EA. Yet, some project-related requirements cannot be described and managed by EA (Apelt et al., 2017). Requirements management should be integrated with processes, such as goal setting, business processes, project management, enterprise architecture, or solution design (Hiisilä, Kauppinen, & Kujala, 2016). Boness and Harrison (2015) suggested a method for requirements modeling and goal setting using the EA tool ArchiMate (The Open Group, 2017); it supports project managers in scope definition and stakeholder alignment. Werewka (2017) mapped project management concepts (PMI, 2017) to the EA language of ArchiMate (The Open Group, 2017) and suggested alignment of EA and project management notions for developing the governance.

The presented strategic alignment and tactical governance aspects reflect the structural similarities of EA and PPM. Both functions are permanent, are connected to enterprise strategy, and must analyze the business: enterprise architects focus on business architecture and IT, while portfolio managers concentrate on organizational objectives. The technical goals and constraints from EA must regularly be aligned with organizational goals and constraints. Then, project proposals can jointly be evaluated, selected, and prioritized. Interdependencies can be uncovered, and timelines for projects can be drawn. The author denotes this horizontal process between EA and PPM as *IT project alignment*, which ensures that the information and strategic plans between IT and other organizational endeavors match (Figure 1).

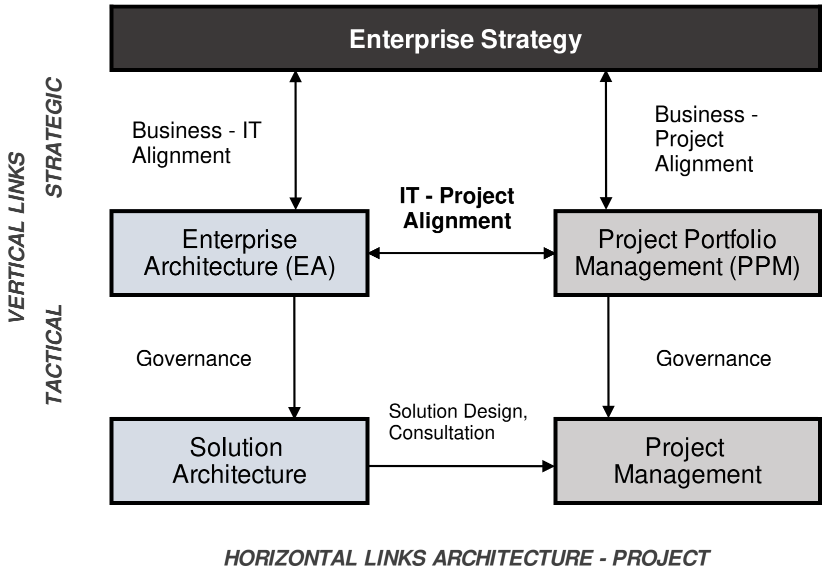

Figure 1: The model of IT project alignment (Source: author)

The results from IT project alignment are inputs to the tactical level, that is, to solution design and to project planning. Solution architects consult with project managers when designing and implementing solutions; they also report to enterprise architects to meet EA goals (Schekkerman, 2011, p. 6). Enterprise architects and portfolio managers serve as governance bodies for solution architects and project managers (Figure 1). Governance provides planning efficiency in both ways and allows for the control of resources and outcomes. Governance embraces all the solutions from project selection to the phase-out of solutions. Thus, portfolio managers and enterprise architects are permanent roles within an organization and control requirement fulfillment in projects, and here, subordinate tactical roles also closely cooperate in view of requirements analysis and solution design (Gellweiler, 2019). On demand, intermediate organizational levels can be incorporated in both vertical paths. These can be domain/segment architects or program managers, respectively.

The suggested model for IT project alignment defines the overall alignment as designing and implementing IT solutions by projects that meet the requirements from strategic *technical* goals and from strategic *organizational* goals. Projects must fit into the strategic purpose. The tactical links in Figure 1 deal with efficiency, that is, time- and cost-efficient project implementation, or doing the projects "right." The governance of solution architects and project managers from EA and PPM, respectively, strives for consistency with strategy, efficiency of planning and execution, and achievement of project objectives. The upper, strategic links in Figure 1 refer to effectiveness by selecting and prioritizing the "right" projects. The roadmapping technique is presented for this aim.

5.5.3 Roadmapping as the technique for IT project alignment

Roadmapping provides flexible and useful ways for project planning and architecture structure (Lee & Park, 2005, p. 576); it coordinates and improves the evaluation of IT projects regarding their relations to business requirements (McCarthy, 2003).

From an architectural perspective, roadmaps are based on strategic changes in the business architecture (IIBA, 2015, p. 420), and they present the current state and a direction to future architecture (IIBA, 2015, p. 420). Architects must "align with business architecture and roadmap" (Cater-Steel, 2009, p. 140). From a project point of view, roadmapping is a methodology that associates projects to strategy and determines the dependencies, risks, and gaps (Office of Management and Budget, 2013, p. 12). Here, a dependency analysis includes resources, finance, and quality. The roadmap also comprises strategic objectives, a cost-benefit analysis, prioritization analysis, milestones, and challenges (PMI, 2013, pp. 61–66); it integrates technologies and market strategies (Vishnevskiy, Karasev, & Meissner, 2016).

Roadmaps make planning transparent and raise awareness within the enterprise, enabling collaborative planning across organizational units (Office of Management and Budget, 2013, p. 12) and promoting communication between the planners (Office of Management and Budget, 2013, p. 94). Roadmaps are the results of a cooperative planning approach that combines planners from various areas (e.g., architects, program managers) to develop a cohesive plan for projects (Office of Management and Budget, 2013, p. 65). Roadmaps link technology to business and enable communication between functions. Building roadmaps combines EA and PPM views and integrates technology strategy and planned organizational initiatives (Phaal, Farrukh, & Probert, 2007, pp. 3–4). Sousa et al. (2011) presented the Serasa case, which strived for the integration of views from IT architecture, IT projects, and IT governance. Thereby, the roadmaps for long-term planning of projects and IT architecture can be linked. Indeed, roadmaps combine planning information from diverse sources, contain current and future architectures, and update project progressions. Strategic planning finishes with a roadmap and a project portfolio to achieve the architectural objectives (Langermeier & Bauer, 2018, p. 98).

Roadmapping is the proposed technique for the reconciliation of strategic plans from EA and PPM; roadmaps integrate each discipline's plans into a joint plan. The EA and PPM planners document data and draw plans to achieve a common understanding and analysis. Both areas develop their schedules, which need to be matched, although these are already aligned with the enterprise's strategy. The schedule from PPM contains parts that are not on the EA schedule (e.g., geographic expansion), whereas the EA schedule covers elements that are not covered in the PPM schedule (e.g., life cycle-driven system replacements). Technical goals and constraints must be discussed with organizational goals and the constraints from PPM.

Thus, EA and PPM should create a collective plan. This joint schedule—referred to as a roadmap—covers all the pieces from both sides, harmonizes priorities, considers interdependencies, and places projects accordingly on a timeline. Roadmapping, that is, the process of alignment between EA and PPM, which the author calls IT project alignment, closes the strategic alignment loop between business-IT alignment from EA and business–project alignment from PPM. The main result—the roadmap—provides a common and reasoned master plan (Figure 2). The integrated roadmap may be approved by an authorized executive role or by a governance body (Office of Management and Budget, 2013, p. 94) and it needs to be constantly reviewed to respond to dynamic forces. By using this roadmapping idea, the author defines *IT project alignment* as the process of harmonizing strategic plans between EA and PPM into a collective roadmap to the meet organizational and technical requirements in projects that deliver IT solutions for value creation.

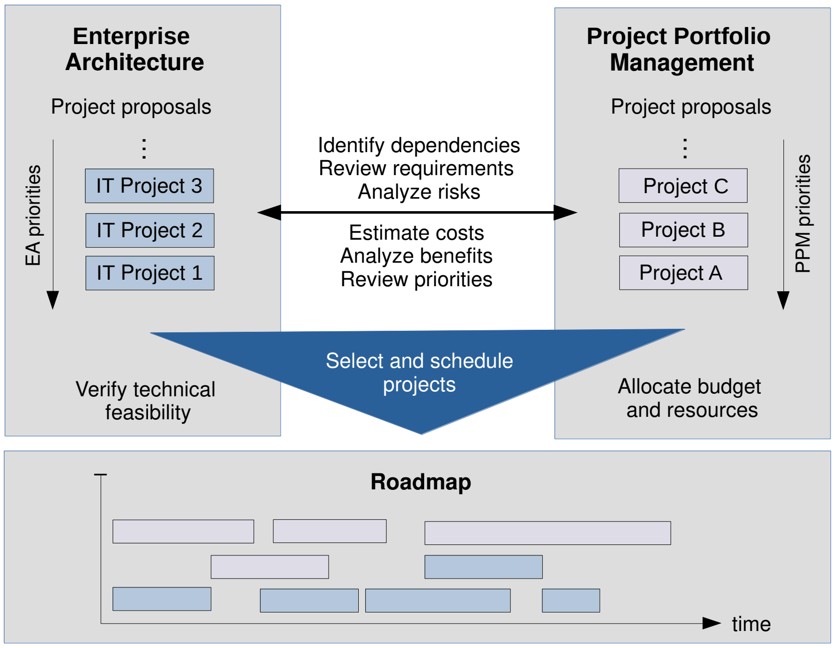

Figure 2: The process of IT project alignment (Source: author)

5.6 Conclusions

The current paper has given the reasons for the coherence of EA and PPM by detecting connections, structural similarities, and common grounds from both areas. Both functions are connected to business strategy when it comes to selecting and prioritizing projects. Thus, the EA scope is on IT, while PPM considers *all* the projects affecting the organization. Both functions also connect to the tactical level and provide governance through frameworks, policies, and principles to guide solution architects and project managers, respectively. The strategic links can enhance effectiveness (choosing the "right" projects at the "right" time), and the links to the project level improve efficiency (the "right" detailed planning and implementation).

The present article has detected the need to harmonize EA and PM plans and proposed a way for alignment between both strategic key functions. EA means business-IT alignment and includes long-term services, overall design, and structures from business architecture. EA also defines the technical goals and constraints (e.g., from legacy solution) and describes target and intermediate IT architectures. PPM concentrates on organizational goals (e.g., acquisitions, geographic expansions, etc.) and is central in investment decision making. Based on business priorities, resources and budgets are allocated to projects. Within the enterprise, all strategic change initiatives should match; plans from EA need to be brought into line with plans with PPM. The technical goals/constraints from EA and organizational goals/constraints from PPM need to be analyzed to determine gaps and interdependencies. Decisions on future investments can then be jointly taken. EA and PPM may choose and prioritize projects together and can roughly schedule them by applying the roadmap approach. This strategic process is referred to as an *IT project alignment,* which closes the strategic planning loop between business-IT alignment and portfolio planning.

Previous research underrated the necessity to link EA to PPM. Simon et al. (2013) detected cohesiveness but their interpretation of the scopes of EA and PPM were inadequate. The current article introduces an opposing viewpoint; it defines scope the other way; that is, EA concentrates on IT, whereas PPM serves the whole strategic change spectrum.

The present paper contributes to theory in three ways: first, by demonstrating the connectivity between EA and PPM; second, by reviewing and redefining the emerging notion of IT project alignment; and third, by presenting a two-dimensional alignment model that integrates EA and PPM. The propositions from the current work also provide ways for practical application. Enterprises may modify their organizational structures and processes to be in tune with the IT project alignment model. Also, the ideas from the current paper can be used as a blueprint for regular alignment between EA and PPM. For example, EA and PPM stakeholders may periodically carry out planning meetings to jointly update the roadmap.

The suggestions from the present conceptual paper are, in some ways, limited because they are found on theory without any data from practice. Future qualitative research is recommended. First, case studies would be beneficial because little is known about the EA-PPM connection in the industries. The case studies can be used for testing the concept of IT project alignment (Myers, 2013, p. 75). Multiple case studies on the cooperation between EA and PPM can be carried out in enterprises by interviewing enterprise architects, portfolio managers, CIOs, and general managers. In addition, analyses on existing documents within enterprises, such as internal guidelines or planning handbooks, would help in exploring this topic. The applicability of IT project alignment can be verified by participatory action research (Whyte, 1991) to examine the phenomenon in real-life settings. Finally, agile methods for the displayed EA-PPM linkages are recommended topics for upcoming research; several articles on EA and *agile* portfolio/project management showed ideas and findings for further elaboration (Canat et al., 2018, Hanschke, Ernsting, & Kuchen, 2015; Horlach, Schirmer, & Drews, 2019; Werewka & Spiechowicz, 2017).

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6 COLLABORATION OF SOLUTION ARCHITECTS AND PROJECT MANAGERS

Abstract

If IT projects are to be successful, they must meet business requirements, and they must be efficiently managed. IT projects need methodological skills to manage resources as well as technical capabilities for architectural planning and solution design. Project managers and solution architects represent two highly qualified leadership roles in IT projects, both of which analyze requirements and both of which are responsible for supplying IT solutions. In predictive IT infrastructure projects, solution architects' technology skills complement project managers' organizational competencies. The combination of those skills improves requirements elicitation that is the key for IT project achievement. Project managers and solution architects closely collect and evaluate requirements and specify the scope in the planning phase. The relationship between these roles is examined by the IT management literature and established practitioner frameworks. Finally, suggestions for collaboration are derived and presented in the IT solution life cycle model.

6.1 Introduction

Information technology (IT) solutions facilitate the attainment of enterprise goals by offering information services to human resources, partners, and customers and by automating business processes. IT solutions should not be viewed as isolated "technology" outcomes (Information Systems Audit and Control Association (ISACA), 2012, p. 76); instead, they must align with the business (Buckl, 2011, p. 152; Luftman, 2003). IT architecture and project management enable a structured supply of IT solutions that effectively meet business requirements (Office of Management and Budget, 2013, p. 149). Both IT architecture and project management are understood as crucial management disciplines for IT project success.

The notion of architecture is poorly understood outside the civil engineering field (Josyula, Orr, & Page, 2012, p. 35). In the IT realm, architecture is an immature, evolving management direction that is establishing its place among diverse IT methodologies. The role of the IT architect is vague in the literature and in practice (Ameller et al., 2012, p. 11; Olsen, 2017, p. 641; Thönssen & von Dewitz, 2018, p. 409). Architecture in IT is wide-ranging; it is multi-dimensional and comprises various levels of detail. Enterprise architecture comprises strategy, organization, processes, assets, resources, etc. (Body of Knowledge and Curriculum to Advance Systems Engineering (BKCASE), 2018, p. 644), striving to align IT with business (Baets, 1992; Buckl, 2011, p. 152). Architecture may also focus on solutions, systems, and components from technology segments such as security or networks (The Open Group, 2018, p. 474) or on software applications. Architecture is synonymous with the structural design of components, their features, and integration in present and future conditions (International Institute for Business Analysis (IIBA), 2015, p. 441). Architectural works must be planned, developed, implemented, and maintained, which extends to include governance (The Open Group, 2018, p. 23). Purposeful organizational implementation of IT architecture vastly enhances efficient planning and effective design of IT structures.

In contrast to IT architecture, project management is a matured methodology and with established and accepted frameworks. For example, the guide to the *Project Management Body of Knowledge* (PMBOK) includes the standard approved by the American National Standards Institute (Project Management Institute (PMI), 2017, pp. 539–635). Project management is applied in almost all industries, especially for significant IT endeavors. IT projects convert business objectives into project objectives (Kendrick, 2018) and are linked to enterprise strategy either directly or via portfolios and programs (PMI, 2013).

Both IT architecture and project management are associated with strategy, processes, and delivering results (i.e., IT solutions). People, processes, technology, and data are interconnected (Institute of Electrical and Electronics Engineers Computer Society and Association for Computing Machinery (IEEE & ACM), 2018). However, there is no clarity how managing projects and IT architecture relate to each other in practice. The linkages between both management areas and the collaboration between the relevant roles remain undiscovered. There is currently a gap in both the IT management theory and practical business contexts.

The purpose of this paper is to gain a better understanding of IT architecture and project management and to better comprehend the linkages between corresponding roles. This article explicates IT architecture and project interrelatedness and illuminates the key players in predictive IT projects from two management practices: the project manager and the solution architect. The skills and tasks of these roles are investigated, comparing and discussing their attributes regarding skill complementation and work organization. Technology skills from solution architect complement planning and organizational skills from project managers for accurate requirements and scope definitions. In addition, this paper enters into features of software projects to distinguish agile from predictive approaches and their impacts on roles.

This conceptual paper broadens the scope of thinking by bridging theories on fundamental IT management disciplines into an integrated model for collaboration over an IT solution life cycle (Gilson & Goldberg, 2015, pp. 127–128). Finally, further research directions are suggested and key points are summarized.

6.2 Relations between project management and IT architecture

Early influential scientific works about architecture did not find connections between project managers and architects (Feeny & Willcocks, 1998; Mentzas, 1997). Mentzas (1997) missed out the role of the architect. He described an approach for implementing strategies for information systems by emphasizing their link with a business and the participation of the business' management and team. He proposed planning actions to implement IT architectures (e.g., budgeting, scheduling, human resources, migration), but he did not identify the role of the architect in this scenario. Technical teams coordinated by a project manager plan logical architectures (functional and organizational needs) and technical architectures (detailed specifications of physical hardware, software, and development efforts). In Mentzas' proposal, even the business architecture (the processes and models of logical and technical architectures) was not the dedicated responsibility of an architect. In contrast, Feeny and Willcocks (1998) underrated the role of the project manager. They excluded project managers from architecture planning and characterized architectural planners by their high technical skills and low-to-medium business skills. These authors saw project management not as a core IT capability, but as an organizational capability related to the business.

The linkage between architects and project managers is more apparent in practitioner frameworks and standards dealing with IT management. Frameworks enable standardized views and help to develop architectural descriptions by using methods and models or more informal means such as pictures or tables (BKCASE, 2018, p. 636). Frameworks deal with practices, precepts, and rules describing architectures with specific purposes (International Organization for Standardization/International Electrotechnical Commission/Institute of Electrical and Electronics Engineers (ISO, IEC, & IEEE), 2011a, p. 2).

The *Enterprise IT Body of Knowledge* (EITBOK) (IEEE & ACM, 2018) depicts architecture and project management frameworks as the roots of an organization, among other standards that are foundational for furnishing enterprise IT. It shows architectural planning and projects on two different sides of the organizational tree impacting IT operations. A requirement analysis connects project portfolio management and enterprise architecture. Alignment with enterprise architectures and adherence to portfolio management priorities are used as success metrics for requirements. The requirements analysis examines four main categories that require various skills and include project management and solution architecture: business, stakeholders, solution, and transition. Outputs are defined as requirements documents and solution design documents, both of which must contain sufficient information to enable the project team to build the solution.

According to ISO, IEC, and IEEE (2015), architecting is carried out within organizations and/or by temporary projects that supply products and services as per specified resources and requirements. The project/organization must provide detailed information about the architecture (ISO, IEC, & IEEE, 2011a, p. 12); then, architecture frameworks can be used for processes, communication, and interworking over various projects and/or organizations (ISO, IEC, & IEEE, 2011, p. 10). Thus, ISO, IEC, and IEEE display two links between architecture and project management—one refers to contributions on a project basis, and one is strategic regarding framework application.

The Open Group Architecture Framework (TOGAF) (The Open Group, 2018) describes itself as a generic framework for defining architectural deliverables and the relevant methods. TOGAF's (The Open Group, 2018, p. 20) methods may be tailored and combined with methods from other IT frameworks such as *Control Objectives for Information and related Technology* (COBIT) (ISACA, 2012), the *IT Infrastructure Library* (Axelos, 2011), and the PMBOK Guide (PMI, 2017). Architecture professionals participate in projects, portfolios, and in the entities that govern them (The Open Group, 2018, p. 18). Project management frameworks are used to plan and build deliverables in structured ways. Enterprise architects and project portfolio managers commonly govern solution developments, which plan, create, and supply IT components as part of the projects and in accordance with IT architecture. Project management methods define how changes are managed within an enterprise (The Open Group, 2018, pp. 61–63). TOGAF points out the enterprise architect's responsibility for the design and hand-over of projects for implementation. TOGAF also stresses decision-making with project managers, which requires the architect's experience through all phases of the project (The Open Group, 2018, p. 475).

The *Federal Enterprise Architecture Framework* (Office of Management and Budget, 2013) presents five reference models. One of them, the business reference model, is meant to find opportunities for cost reduction and new capabilities to facilitate strategic goals. Strategic planning is supported by enterprise architecture as well as portfolio and project managers, the former of whom facilitate the alignment of IT projects to enterprises' business needs. Project managers examine existing business capabilities and verify their fit to IT projects. Their responsibility includes aligning the project with the business architecture.

COBIT denotes itself as an integrator of management frameworks for overarching governance (ISACA, 2012, p. 31). Among others, COBIT takes architecture and project management frameworks into account. TOGAF (The Open Group, 2018) and the PMBOK Guide (PMI, 2017) are depicted side-by-side as supplements without intersections in the context of four management domains (ISACA, 2012, pp. 79–81). The core of TOGAF is allocated to the management domain "align, plan, and organize," along with portfolio management, whereas program and project management processes belong to the domain "build, acquire, and implement."

The *Business Analysis Body of Knowledge* describes business architecture as a discipline of the entire enterprise used to identify stakeholder concerns and support transformation. Results from business architecture deliver inputs to requirements analysis, project planning, and high-level solution design. Project managers, solution architects, and other stakeholders collectively use business architecture models to govern changes within the enterprises they oversee (IIBA, 2015, pp. 408–413).

As reflected in several frameworks and industry standards, IT architecture and project management are connected. Both roles are concerned with strategic alignment, governance, frameworks, planning, and stakeholder communication. A content analysis of job advertisements for IT architects (Gellweiler, 2020) empirically confirmed relatedness to project management. Fifty-eight percent of examined job postings included relation to project management in skill or task descriptions.

In the succeeding sections, the roles and tasks of IT architects are examined in view of complementation with project management tasks. Prior to that, the two fields' cohesiveness is elaborated by considering the technology skills within IT projects.

6.3 Technology skills within IT projects

IT projects need profound technology knowledge and related experience. There are controversial standpoints in the literature regarding whether project managers or other project team members should provide technological skills. The different views are displayed below.

Ramazani and Jergeas (2015, p. 46) explored directions in project management education and emphasized the need for project managers to possess both technical and leadership competencies, especially in IT and engineering projects. Ahsan, Ho, and Khan (2013) found that technical expertise was the third most cited competency in the project management literature and the second most frequent code in their analysis of project management job advertisements. However, their study did not reveal the depth of the technical knowledge that was demanded.

In contrast, the list of 18 IT project manager skills created by Jiang, Klein, and Margulis (1998) did not contain any items referring to technology—instead, they concentrated on behavioral skills. According to El-Sabaa (2001), project managers' human skills, followed by conceptual and organizational skills, mattered most for project effectiveness, whereas technical skills were the least influential. Liikamaa et al. (2015) investigated businesses' reasons for replacing IT project managers and found that poor social skills and personal skills were the second most common cause for substitutions—lack of technology skills was not listed.

Napier, Keil, and Tan (2009, p. 266) found the top five skill categories for project managers to be the following: planning and control, general management, leadership, communication, and team development. The top five skills for IT projects that Keil, Lee, and Deng (2013, p. 403) recognized also do not surprise: leadership, verbal communication, scope management, listening, and project planning. What was astonishing in their study was that technical skills for IT system development did not even appear in a table consisting of 19 various skills. The researchers followed up on this issue by interviewing the participating project managers, who argued that they concentrated on management and leadership activities and employed technically skilled people within their team; these experts were critical to project success and needed to be available. Further, Harison and Bonstra (2009, p. 287) reasoned that IT project managers did not need to study technology in depth because technical tasks were delegated to technical specialists who found appropriate solutions. However, an IT project manager must possess a basic technical understanding in order to communicate with experts (Keil, Lee, & Deng, 2013). In the same sense, Napier, Keil, and Tan (2009) defined a project manager skill category of "systems development" to refer to understanding and managing technical complexity for quality control and for the sake of planning; eight of the 19 research subjects fulfilled this category.

Napier, Keil, and Tan (2009, p. 274) also presented four archetypes of IT project managers that differed in the extent to which they possessed the nine skill categories essential to successfully managing IT projects. A combination of all four archetypes (i.e., general manager, problem solver, client representative, and balanced) made for an ideal IT project manager. The problem-solver archetype added competencies in systems development and planning and offered technical expertise. Thus, this archetype corresponded to IT architects that complemented a project manager's skill set by adding technology and system development skills.

TOGAF's skills framework (The Open Group, 2018, pp. 467–471) reflected lower technology skill demands for project managers and indicated the complementation of architect and project management skills. TOGAF defined 76 different skills allocated to seven groups. Per skill and per role, TOGAF assigned proficiency levels on a four-point integer scale (1 = background, 2 = awareness, 3 = detailed knowledge, 4 = expert). Table 1 depicts the calculated mean proficiency values of the skills per TOGAF's skill categories for enterprise architect technology vis-à-vis the project management role. The dark gray cells in Table 1 mark joint skill areas; both roles must provide high levels of general management skills. Light gray values show the expert categories of each role. In these skill sets, project managers and enterprise architects supplement one other.

Categories of skills	Enterprise Architect Technology	Project Manager	Examples
General	3.63	3.75	Leadership, teamwork, communication
Business	3.27	3.27	Strategic planning, business processes/cases
Program/project management	3.00	3.60	Methods and tools, business change management
Legal environment	2.40	3.00	Contract law, data protection law
Technical IT	3.92	2.00	Engineering, data management, security
IT general knowledge	3.59	2.06	System knowledge, service levels, migration planning
Enterprise architecture	3.53	2.35	Modeling, building block design, process design

Proficiency levels: 1 - Background, 2 - Awareness, 3 - Detailed knowledge, 4 - Expert

Table 1: Mean proficiency levels per skill category from the TOGAF skill framework (Source: author).

The literature is disunited regarding IT skills of project managers. However, the comparison of mean proficiency levels from according TOGAF roles shows complementation of skills.

This leads to the proposition: the project manager specializes on planning and managing the work to change the business, while the IT architect possesses deep and broad technological knowledge for solution development. IT architects' technology skills complement project managers' methodological skills. The project manager does not need to study IT in depth.

Skills should correspond to tasks. Next, the tasks of project managers and IT architects are regarded separately. Then, their complementation is discussed in dependence from agile and predictive approaches.

6.4 Tasks of project managers

Major change initiatives in enterprise IT, such as the implementation of new services, equipment installations, or upgrades, require project management (IEEE & ACM, 2018). Project managers have to achieve the objectives of a temporary undertaking in order to establish a unique outcome by means of applying skills, techniques, and tools to meet project requirements (Pinto, 2016, p. 550). Roughly speaking, they manage the work through every phase, from initiating, planning, and execution to closing. Thereby, they plan, monitor, and control the constraints (scope, cost, time, quality, resources, and risks) (IIBA, 2015, p. 18; PMI, 2017). Their tasks also include stakeholder management, communication, and identification of project requirements (PMI, 2013). Beyond this, IIBA (2015, p. 18) denoted a project manager's responsibility to provide solutions according to business requirements. IEEE and ACM (2018) considered project management in the context of enterprise IT and stress project managers' responsibilities for planning, acquiring, and coordinating resources, especially people. Human resources are central since they have the greatest impact on costs and schedule (IEEE & ACM, 2018). Project managers are also responsible for implementing technological strategies (PMI, 2017, pp. 8–9); they produce future architecture and must therefore collaborate with architects.

6.5 Tasks of IT architects

Tasks and responsibilities of IT architects depend on their role. There are various types of IT architects that contribute differently to IT projects. Using the enterprise architecture tool selection guide (Schekkerman, 2011, pp. 6–7) and content analysis of job advertisements (Gellweiler, 2020), three types of architects are found with specific objectives and who render tasks accordingly.

First, *enterprise architects* align IT solutions with businesses and act strategically. They model IT architectures along with business architectures and draw product roadmaps to meet long-term business strategies. They also govern all issues related to IT architectures within an enterprise, take the lead over other subordinated architects, and they advise stakeholders from both the IT and the business side on technology matters. Architecture governance comprises approaches, techniques, methodologies, processes, patterns, etc. to create and sustain the organizational "platform" for architectures and define "reusables" such as blueprints, references, functional blocks, and generic hardware. It provides the toolbox, the workbench, the frame, and the rules for solution architects to work efficiently and consistently. It may also propose logical and physical solution designs that are central outcomes for solution architects.

Second, *solution architects*, also referred to as system architects, focus on functional sections within the overall architecture and require more detailed technological knowledge such as data storage, networks, workplaces, and security to design solutions. These architects must collect and analyze the functional and non-functional requirements for detailed solution designs, which include specifications for hardware, operations systems, interfaces, software versions, protocols, flow charts, use cases, etc. to integrate solutions into the overall architecture. Solution architects support projects not only in the planning phase, but also during the execution phase when the solution is deployed and tested.

Third, *software architects*' needs are different from the previous two types (Schekkerman, 2011, p. 6). Software development applies adaptive life cycles. The agile approach was invented for software development (Beck et al., 2001); it defines its own role concept. The characteristics of agile software projects are explicated as follows.

6.6 Agile software projects

Software projects may select various methods that are fundamentally different from IT infrastructure projects and that may include or exclude project managers and architects. On the one hand, software projects can be managed as other endeavors; on the other hand, there are aspects specific to software engineering that must be taken into account. These relate to software development life cycles (SDLCs) and to their effective and efficient hand-over to stakeholders (Bourque & Fairley, 2014). The SDLC includes processes for specifying requirements and facilitating their transformation into software product delivery (Bourque & Fairley, 2014). Depending on the fitness of a project life cycle, four diverse approaches are available that differ in view of requirements (fixed vs. dynamic), activities (once vs. repeated), delivery (single vs. frequent), and goals (cost, quality, time, customer value). On the one end is the predictive approach with fixed requirements, little changes, and single delivery, and on the other end is the agile approach that allows for flexibility in view of requirements changes via multiple corrections and frequent small productions. In agile software developments requirements may change dynamically in "short iterative planning and execution cycles" (PMI, 2017, p. 666). Requirements and scope are defined and reworked through all project phases (PMI, 2017, p. 133), resulting in a greater number of release versions.

The roles of project managers and architects are unclear in agile developments. Scrum, a framework for implementing agile methods (Scrum Alliance; 2018) and presumably the best-known method for agile developments (IEEE & ACM, 2018), mentioned neither project managers nor architects in its guide (Schwaber & Sutherland, 2016). The role of the "scrum master" is sometimes compared to the project manager (Bourque & Fairley, 2014; Sutling et al., 2015). However, from the agile alliance perspective, scrum masters are process experts and coaches (Agile Alliance, 2017).

PMI admits that the role of project managers is not known in agile settings, and that due to self-organizing teams, the need for project managers is not recognized (Agile Alliance & PMI, p. 37). In contrast, Pinto (2016, p. 390) portrayed scrum as agile project management. Regarding architecture, TOGAF, one of the most popular architecture frameworks, is not clear in how it positions itself and its roles within agile environments. There is no explicit reference to agile approaches and their relation to architects, not even in the latest edition (9.2 from 2018). Instead, a blog entry on the Open Groups website interpreted some generic parts of TOGAF as adaptions for agility (Lambert, 2018).

Since the project management role in agile software developments is not clear, the software architect type is not followed up in this paper but suggested for future research. In contrast to the agile approach with high requirement flexibility, the predictive approach with solid requirements need intensive planning supported by solution architects.

6.7 Requirements elicitation in predictive IT projects

The predictive approach, also referred to as linear development (Bourque & Fairley, 2014) or a waterfall approach (IEEE & ACM, 2018), corresponds to traditional project management phases and frameworks. It can be applied to IT infrastructure projects that can include physical equipment, virtualizations, services, applications, and combinations of these (Josyula, Orr, & Page, 2012). In predictive projects, all requirements are collected, analyzed, and then fixed as a basis for the scope baseline, the cost plan, and the project schedule (PMI, 2017).

Requirements express needs and are defined as the "usable representation of a need" (IIBA, 2015, p. 15) or as the "condition or capability that is necessary to be present in a product, service, [or] result to satisfy a business need" (PMI, 2017, p. 719). Future IT solutions are developed based on technical requirements that are derived from business requirements, as-is analysis, and other inputs (e.g., organizational constraints and legal frame conditions).

Requirements are central to IT projects, relevant to all stakeholders, and decisive for the success of predictive projects. A major cause of project failure is inaccurate requirement gathering (PMI, 2018, p. 25). Both solution architects and project managers must understand and manage requirements. Solution architects create IT solutions that meet explicit business requirements and translate these into requirements for IT engineering (Josyula, Orr, & Page, 2012, p. 37). Determination of actual requirements is the key capability for an IT architect (Teare & Paquet, 2005, p. 6). Requirement management is the nucleus of TOGAF's architecture development method, and it is processed throughout all nine TOGAF phases. Project managers bear the responsibility for requirement collections (i.e., "the process of determining, documenting, and managing stakeholders' needs and requirements to meet project objectives") (PMI, 2017, p. 129). So, project managers must closely align themselves with solution architects in order to collect detailed technical requirements.

Requirements are diverse and can be classified in many ways. ISO, IEC, and IEEE (2011b) 29148, section 9.4.2.3 presented the following requirement types: service or functional, operational, interface, environmental, human factors, logistical, maintenance, design, production, verification requirements, validation, deployment, training, certification, retirement, legal, regulatory, environmental, reliability, availability, maintainability, design, usability, quality, safety, and security requirements. Pataki, Dillon, and McCormack (2003) distinguished between the functional requirements impacting business processes, the technical requirements affecting the system infrastructure, the operational requirements impacting support and operations, and the transitional requirements needed for implementation. PMI (2017, p. 148; 2016, p. 27) suggested the categories exhibited in Table 2. The first four classes can also be found in IIBA (2015, p. 16).

Cisco architects create designs after analyzing business requirements and transform them into technical requirements (Cisco Systems, 2018). Business requirements answer the "what" and "why" questions from a business point of view and concern, for example, use cases or legal/regulatory constraints. Technical requirements are based on business requirements and answer "how" questions. They describe attributes of the solution to support the use cases. Technical requirements are inputs to the design that specify the components (the question of "with what").

Type of Requirements	Short Description	Project Manager	Solution Architect
Business	Strategic needs of the enterprise	C*	C*
Stakeholder	Needs of individuals, groups, and organizations affected by the project	R	C
Solution	Functional req. (e.g., features, user functions) Non-functional req. (e.g., environmental conditions)	C	R
Transition and Readiness	Integration and migration capabilities from as-is to target state	R	C
Program / Project	Planning, controlling, monitoring, assumptions, constraints	R	C
Quality	Validation and verification of solution, results, and services by tests, proof of concept, and/or pilot	R	C

Legend: R - Responsibility, C - Contribution * responsibility of portfolio manager / enterprise architect

Table 2: Responsibility matrix for requirements (Source: author).

Howsoever requirements are classified, they must be complete, and stakeholders must be able to understand them. Solution architects and project managers must work together to identify and realize all the different types of requirements. Thus, the project manager is dependent on the technical contributions from the solution architect and other stakeholders. Translations from business and stakeholder requirements into functional requirements need technical core competencies on the part of the solution architect, who must collaborate with subject matter experts to realize these. Solution architects' technological skills are also imperative for working out non-functional requirements, including availability, compatibility, functionality, maintainability, performance efficiency, portability, reliability, scalability, security, usability, certification, compliance, localization, service level agreements, and extensibility (IIBA, 2015, p. 302). Consequently, the responsibility for solution requirements lies with the solution architect. His or her expertise is also needed for transition requirements (e.g., describing detailed migration steps or specifying test requirements). Table 2 exhibits the allocation of responsibilities to requirement types for the discussed roles. The collection and analysis of business requirements are the responsibilities of the enterprise architects and the portfolio managers, with the support of solution architects and project managers. Other roles, e.g., IT executives and system engineers, should also contribute to gathering requirements. Finally, dedicated business analysts may also bear the responsibility for business requirements (IIBA, 2015).

6.8 Scope specification in predictive IT projects

Specification of scope is the planning step that follows requirement collection; it describes all the project deliverables and is mainly based on the project goals and detailed requirements it must meet. The total scope of a project may be subdivided into product scope and project scope (PMI, 2017, p. 131).

The *product scope* contains deliverables that are operationalized at the end of a project to benefit the enterprise. It describes characteristics of physical resources, services, results, or a combination of these as a target state, referred to as "to-be" conditions. In IT projects, the product scope is the solution design that satisfies functional and non-functional requirements.

In practice, the term *design* is often confounded with *architecture* (BKCASE, 2018, p. 344; Rivera, 2007). In connection with IT, the notion of *design* is reserved for the *technical solution design* performed by solution architects and developers (IIBA, 2015, p. 394). It includes technologies and detailed specifications for quantifiable hardware models, commercial off-the-shelf software, techniques necessary for developing software, middleware, platforms (e.g., hypervisors and databases), resource-abstracted virtualizations, interfaces, protocols, supporting tools, controls, operational processes, standards, system configurations, vendor services as well as statements of compatibility, compliance, constraints, preconditions, assumptions, and risks. Furthermore, solution design should comprehend functional descriptions such as flow charts, context diagrams, logical and physical topology graphics, and use cases. The components of product scope are verifiable and handed over to operations. The end result is the capability to perform services (e.g., a function that supports a business domain or an e-commerce function for customers). Deep technical and architectural competencies are needed for valid solutions designs. Requirements teams frequently consist of people with various skills, including solutions architecture, project management, and business analysis (IEEE & ACM, 2018). The solution architect is the technical leader in charge of solution design and any underlying solution requirements.

The *project scope* describes the ways and the work to be performed to provide the solution—that is, transition from the current condition ("as-is") to the target state ("to-be"). It must meet transitional requirements and comprise all the tasks necessary to furnish the solution, particularly in terms of project management and system implementation tasks. Examples of project managers' tasks include planning, stakeholder communication (meetings, minutes, status reporting, etc.), change management, leadership, work coordination, and progress monitoring. The work that architects and system engineers undertake is also part of the project scope (e.g., consultancy, system setup, programming, testing, deployment, and rollout). Coordination of the project scope is the project manager's core function; however, he or she is highly dependent on contributions from solution architects' work quality in view of the product scope definition and their support for integration, migration, and quality assurance.

In essence, solution architects concentrate on the product scope—that is, the solution design to meet functional and non-functional requirements; project managers plan and manage the project scope—that is, the work and the resources to accomplish business outcomes (The Open Group, 2018, p. 144). Both scope parts must join together to form a cohesive whole. The variety of tasks in context with architectural complexity and organizational dependencies requires intensive communication and close cooperation between solution architects and project managers.

6.9 Cooperation over an IT solution's life cycle

The cooperation between project managers and solutions architects goes beyond specification of requirements and scope. IT services and their associated solutions underlie life cycles (ISACA, 2012, p. 108). IT architecture encompasses the whole life cycle of an IT solution (ISO, IEC, & IEEE, 2011a, p. 8) and is a continuous function that guides its evolution (Buckl, 2011, p. 152). Beyond planning, the architecture process comprises implementation, maintenance, and continuous improvement (ISO, IEC, & IEEE, 2011a, p. 1). IEEE and ACM (2018) depicted enterprise architecture core functions (i.e., change initiatives, interoperability, security, quality, disaster/recovery, and operations/support) over all the life cycle phases.

Figure 1 illustrates a model with project managers' and solution architects' key activities over a generic IT solution life cycle. It comprises the emergence of the solution as a project, its use in production, and its controlled end of life (i.e., the phase-out). Prior to project initiation, projects must be selected. Project success is incumbent upon selecting the right project, which must be aligned to business/IT strategy and add value to the enterprise. Project prioritization among stakeholders is based on the business architecture (IIBA, 2015, p. 413) and a criterion for IT-business alignment (Luftman, 2003, p. 12). In this early stage, near cooperation between project managers and IT architects are already vital. Enterprise architects, solution architects, portfolio managers, and project managers should collectively agree on priorities and selection based on enterprise strategy, business cases, technical feasibility, and risks. Analysis and decision-making call for various competencies from all these roles (Hanschke, 2012, p. 153; PMI, 2013, p. 7).

Once a project has been selected, the project manager must create a project charter and present it for the management's approval. The project charter formulates the objectives and presents its requirements and scope along with rough costs, a milestone schedule, overall risks, and key stakeholders (PMI, 2017, p. 155). Creating a project charter is the project manager's responsibility; contributions from the solution architect are mandatory. He or she provides technical expertise on high-level requirements, rough design, as well as judgment of risks. In the subsequent planning phase, these items will be further broken down and result in detailed specifications, which remain one of the solution architect's responsibilities.

Expertise from the solution architect is also central in the project execution phase. Based on the scope statement, services and products from IT vendors need to be sourced and implemented. This includes deep technical discussions with IT architects and system engineers from vendors and from the project's organization. Configurations might be changed, added, or refined due to unknown or unexpected system behaviors. The more a project progresses, the more experience is gained on the target solution and its environment. Technical clarifications go on, issues must be solved or decided, design documents must be updated, etc. System engineers need technical leadership from solution architects. Beyond this, architects help to ensure quality via control tests in the lab or in the field. Testing means the evaluation of the IT solution regarding conformance to the requirements specification (PMI, 2017, p. 303). As a result, deliverables are verified and the IT solution is validated for official acceptance (PMI, 2017, p. 305).

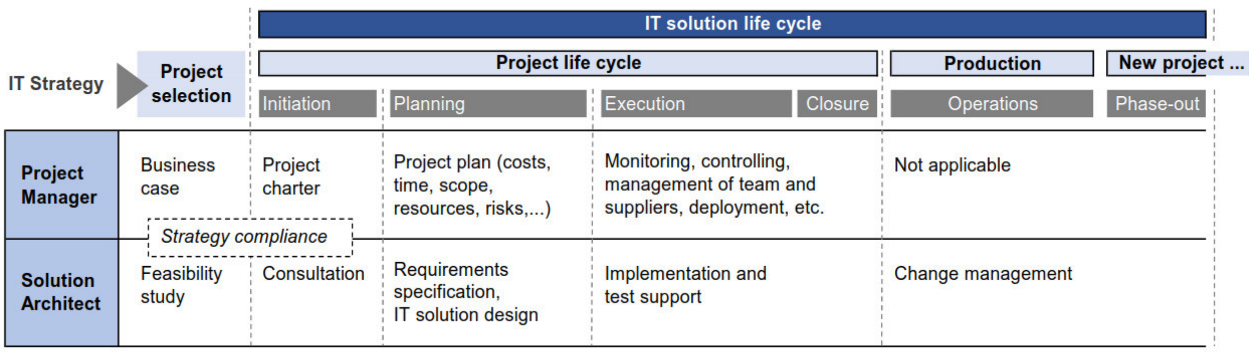

Figure 1: IT solution life cycle model with complementing activities of project managers and solution architects (Source: author).

After successful acceptance and project completion, the solution architect will enter the operation phase and control minor changes (e.g., software upgrades) until the end of an IT solution’s life. The phase-out of an IT solution is part of the subsequent project, which drives the enterprise to the next level of evolution.

6.10 Conclusions

Past research on IT architecture and project management is extensive, but their interaction has been underestimated. In this paper, the connection between these crucial IT management disciplines was explored to augment the value of their collaboration. Relations between IT architects and project managers were discovered in IT management frameworks and standards that academic research has overlooked.

IT architecture and project interrelatedness were highlighted by analyzing solution architects’ and project managers’ tasks and skills. IT architects’ tasks depend on their role. Architecture emphasis may be placed on the enterprise level, or the solution level, or during software development. Collaboration with project managers depends on which development approach is being used. Software projects mainly apply agile approaches that define dedicated roles. The structured interworking of architects and project managers is notably rich in waterfall projects for IT infrastructures that achieve their goals in predictive ways. While enterprise architects focus on business needs, strategy, and methodological governance, solution architects conspicuously complement project managers in predictive projects. They provide skills for technology and architecting that are essential when specifying solution requirements and creating corresponding designs, whereas project managers are skilled in and focused on organizing the work and managing personnel. Beyond technical planning, solution architects are involved in project execution by advising personnel on implementation, integration, and testing—that is, requirement verification. Solution architects also help project managers in the early stages when projects are being evaluated, selected, and defined to ensure feasibility and strategy compliance. Close and structured collaborations between project managers and solution architects enhance IT-business alignment and increase IT projects’ efficiency and effectiveness.

This essay contributes to the literature by indicating the coherence of IT architecture and project management and by demonstrating the complementary of skills from key roles. Furthermore, a model for cooperation between solution architects and project managers over an IT solution life cycle was derived.

For practitioners, this article suggests adaption of role descriptions for solution architects to focus on collaboration with project managers. Solution architects must be clear about their responsibilities for the solution requirements/design and support activities embedded in the project plan. Solution architects must understand themselves as technical leaders on par with project managers. Resource plans should allow for solution architect engagement from project selection to the cut-over of the target solution to production. Even better, a solution architect should remain technically responsible over an IT solution’s lifetime, including decommissioning at the end of an IT solution’s life.

This article raised several questions that need further examination. The strategic relationship between enterprise architects and project managers has not been addressed so far. Also, the roles of software architects and project managers in adaptive initiatives are of interest, not only the architect–project manager connection, but also the links to other roles from agile frameworks, such as scrum master or product owner. Business analysis, another discipline dealing with requirements analysis and design definition (IIBA, 2015, pp. 1–2), seems to overlap with architecture and project management in certain parts—contradictions, coherence, and intersections among these areas and roles might be subjects for further investigations. Foremost, the propositions for collaboration as per the IT solution life cycle model and the requirements responsibility matrix are suggested to be tested. These tests can be carried out via structured interviews or surveys with solution architects, project managers, and near stakeholders such as chief information officers, portfolio/program managers, enterprise architects, and system engineers.

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APPENDICES

Appendix A1 – Acronyms

ACM	Association for Computing Machinery
BABOK	Business Analysis Body of Knowledge
BI	University (BI Norwegian Business School, Oslo)
BKCASE	Body of Knowledge and Curriculum to Advance Systems Engineering
CCAr	Cisco Certified Architect
CDO	Chief Digital Officer
CGI	Firm (IT vendor)
CEO	Chief Executive Officer
CIO	Chief Information Officer
CIRT	Center for Innovation and Research in Teaching
COBIT	Control Objectives for Information and Related Technology
CPCI	Conference Proceedings Citation Index (WoS by Clarivate)
CSC	Firm (IT vendor)
CSV	comma-separated values (file format)
DODAF	Department of Defense Architecture Framework
EA	Enterprise Architecture
EABOK	Enterprise Architecture Body of Knowledge
EITBOK	Enterprise Information Technology Body of Knowledge
EMC	Firm (IT vendor)
ERP	Enterprise Resource Planning
ESC	Enhanced skills and capabilities
ESCI	Emerging Sources Citation Index (WoS by Clarivate)
FA	Flexibility/agility
FEAF	Federal Enterprise Architecture Framework
GEA	General Enterprise Architecting (research program)
GPM	Gesellschaft für Projektmanagement (German Project Management Association)
HTML	Hypertext Markup Language
HW	Hardware
IBM	Firm (IT vendor)
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
IIBA	International Institute of Business Analysis
INCOSE	International Council on Systems Engineering
IOE	Industrial Organization Economics
IPMA	International Project Management Association
IS	Information Systems (see IT)
ISACA	Information Systems Audit and Control Association
ISM	University (Vilnius, Lithuania)
ISO	International Organization for Standardization
IT	Information Technology (here used as synonym for information systems)
ITIL	Information Technology Infrastructure Library
ITVs	IT vendors
NCR	Firm (IT vendor)
NPD	New Product Development

OGC	Office of Government Commerce
OLR	Overarching literature review
PESTEL	Political, economic, social, technological, environmental, legal (analytical method for the macro-environment)
PMBOK	Project Management Body of Knowledge
PMI	Project Management Institute
PMP	Project Management Professional
PPM	Project Portfolio Management
RBV	Resource-based view
SAP	Firm (IT vendor)
SA/SR	Strategic alliances/supplier relationships
SDLC	Software Development Life Cycle
SEBOK	System Engineering Body of Knowledge
SEC	U.S. Securities and Exchange Commission
SFIA	Skills Framework for the Information Age
SOA	Service-oriented architectures
SP/DM	Strategic planning/decision-making processes
SSCI	Social Science Citation Index (WoS by Clarivate)
SW	Software
SWOT	Strength, weaknesses, opportunities, threats (analytical method)
TH	Technische Hochschule (Technical University of Applied Sciences)
TOGAF	The Open Group Architecture Framework
VDI	Verein Deutscher Ingenieure (Association of German Engineers)
WHU	Wissenschaftliche Hochschule for Unternehmensführung (University in Vallendar, Germany)
WoS	Web of Science (scientific database from Clarivate)
ZTE	Firm (IT vendor)

Appendix A2 – Short biography

Christof Gellweiler is IT project management consultant with more than 25 years of professional experience in the financial services industry and the IT infrastructure business in Germany. He holds a diploma in telecommunication engineering from TH Bingen University of Applied Sciences and earned an Executive-MBA from Kellogg-WHU. As doctoral student at BI Norwegian Business School and ISM Vilnius, Christof's research focused on IT planning and IT architecture. He is certified by PMI and Cisco Systems and teaches international project management at various universities in Germany and Lithuania. He can be contacted at christof.gellweiler@whu.edu

Appendix A3 – Recorded context units from IT vendors' annual reports

Company	Competitiveness	Product Leadership	Operational Excellence	Customer Intimacy
Accenture	Page 13: We work with clients to develop and execute innovative strategies, improve operations, manage complex change initiatives and integrate digital technologies designed to help them differentiate themselves in the marketplace, gain competitive advantage and manage their large-scale capital investments Page 14: Accenture Strategy helps clients achieve specific business outcomes and enhance shareholder value by defining and executing industry-specific strategies enabled by technology. We bring together our strategy capabilities in business and technology to help senior management teams shape and execute their transformation objectives, focusing on issues related to digital disruption, competitive agility, global operating models and the future workforce.	Page 12: Examples of our services include helping clients….., create business model innovations, introduce new products and services, and digitally engage and entertain their customers. Page 14: Accenture Digital combines our capabilities in digital marketing, mobility and analytics to help clients provide better experiences for the customers they serve, create new products and business models,	Page 12: Examples of our services include helping clients run cost-effective operations, …. Page 13: We help clients enhance their performance in distribution and sales and marketing; in research and development and manufacturing; and in business functions such as finance, human resources, procurement and supply chain while leveraging technology Page 15: Accenture Operations provides business process services,...We operate infrastructure and business processes on behalf of clients,....., to help improve their productivity and performance. ...Our solutions help clients optimize their IT infrastructures— whether on-premise, in the cloud or a hybrid of the two. Page 15: our global delivery model supports all parts of our business to provide clients with price-competitive services and solutions.	No data found
Apple	No data found	No data found	No data found	No data found
Atos	Page 12: During 2015, Atos helped its customers apply the disruptive forces of mobile, social media, Big Data and Cloud to create competitive advantage, fuel topline growth and reinvent their business models. Page 21: Combining Atos' Big Data expertise and Circuit's high quality enterprise communications software will deliver greater customer engagement and a compelling competitive edge for Atos' clients Page 25: Bull's (note: subsidiary of Atos)world-class capabilities in increasing computer performance will help our customers accelerate their research and innovation and increase their competitiveness." Page 27: Digital technologies are powerful enablers to fuel topline growth and create competitive advantage for businesses, provided they are able to look beyond their day-to-day operations and reinvent business models along digital principles to meet changing customer expectations. Page 27: For any organization, to remain relevant and competitive, it is essential to develop a new mindset and structures to increase flexibility and to unlock the value of digital data Page 29: Leadership in customer experience design is today's primary source of competitive advantage. ... Page 30: To raise the competitiveness of Paderborn Lippstadt Airport in Germany, the airport is investing in Atos cutting-edge thinking and technology. Page 35: Working with Atos, our clients are gaining business advantage from understanding the value of transactional business data, opening new channels to market, redesigning their business models and culture, and rethinking the ways in which they collaborate and innovate with their partners and suppliers Page 35: At the same time, enterprises need to be aware of the rapid changes in the business models of competitors who offer once lucrative services for free, Page 35: Sharpen competitive edge and strengthen market position	Page 22: Worldline's mission is to prepare its customers for this new landscape and help them offer innovative solutions to the end consumer. Page 25: Bull's (note: subsidiary of Atos) world-class capabilities in increasing computer performance will help our customers accelerate their research and innovation and increase their competitiveness." Page 30: To raise the competitiveness of Paderborn Lippstadt Airport in Germany, the airport is investing in Atos cutting-edge thinking and technology. Enterprises now urgently need to turn Cybersecurity, privacy and data protection into key values across their business, increasing consumer trust and using digital innovations to develop new business. Page 35: The digital revolution brings fresh opportunities for flexible and innovative solutions to find new value, new efficiency and effectiveness whilst not destroying existing business models overnight Page 47: Enterprises now urgently need to turn Cybersecurity, privacy and data protection into key values across their business, increasing consumer trust and using digital innovations to develop new business.	Page 14: Atos leadership in hybrid Cloud solutions provides customers with new levels of flexibility, security and efficiency. Page 14: With our know-how in data analytics and the Cloud, we are helping our customer turn their data into new business opportunities and improve the operational efficiency of their organization of their business. Page 27: Atos works daily with our clients to help them create and anticipate disruptive technologies, addressing the four key challenges of Customer Page Experience, Business Reinvention, Operational Excellence Page 41: At the same time, enterprises must also introduce more intelligent secure business processes – especially those processes with high data-intensity. As processes become digital they can be automated and enhanced with near real-time intelligence. Taken together, these opportunities can deliver significant and tangible improvements in operational efficiency. Page 41: To support the digital transformation of our clients' business processes and operations, we deliver 'right fit' infrastructure and application approaches, which include advanced Cloud services to reduce costs, increase scalability and deliver new business opportunities. Atos works with its clients to modernize business applications through full lifecycle services, considering development opportunities, upgrades, management and decommissioning options. As well as using automation and robotics to increase efficiency, manage quality and improve safety, we provide our clients with the tools to apply analytical insight into operational processes to drive optimization and reduce risk	Page 21: Atos intends to combine its expertise as a large-scale IT services provider with Unify's specialism in enterprise unified communications. This boosts Atos' efforts to create innovative solutions for its customers, integrating advanced communication services into business and production processes to enhance customers' digital transformation. Page 29: Across private and public sectors, customer loyalty is more likely to be achieved when organizations deliver personalized, frictionless and trusted relationships. In the digital age, organizations that offer an enhanced customer experience can now strive for customer advocacy: loyal customers who in turn bring in new customers through the powerful medium of social engagement. Page 29: Our expert solutions in digital marketing and services allow our clients to interact with their customers intimately, responding to their mobile, hyper-contextualized and instantaneous behaviors and preferences. Delivering multi-channel engagement and customer relationship management solutions means our clients provide improved services to their customers, whatever their preferred channel.
Capgemini	Page 66: Capgemini believes that insights coming from this data will soon be the most effective driver of business competitiveness. This is why the Insights & Data solution uses an innovative approach, based around guiding principles, to provide our clients with relevant insights to their business and, in particular, ensure they are delivered at the right time to the right decision centers. Page 76: Because one thing is certain: it is that our clients, if they want to increase their growth and improve their competitiveness, have no option but to succeed in the digital world—and that means radically transforming how they work.	Page 1: The new wave of technology and the development of very agile digital competition is radically changing the way companies innovate. With the "Applied Innovation Exchange" program launched in early 2016, Capgemini has made technology integration an asset to help its clients accelerate. It is an innovation that is faster, easier to use, "open", and applicable to the business and sectoral challenges faced by every company.	Page 19: Technological innovation enables us to develop methods and processes that simultaneously contribute to the operational excellence and quality of the services that we deliver to clients.	No data found

CGI	Page 6: Significant business erosion from new competition Page 15: Technology to help achieve a competitive edge. Page 16: In 2015, we conducted face-to-face interviews with 965 clients—business and IT leaders across the industries and countries we serve. The clear takeaway from these discussions is that, for the first time since the global financial crisis in 2008, clients are expanding their business priorities from primarily cost reduction to a focus on funding revenue growth initiatives, including launching new services and products. The motivation for this focus is our clients' quest to become customer-centric digital organizations. To avoid runaway budgets, clients need to adopt a clear division between the contribution of IT toward competitive differentiation and the necessary running of the business. Page 19: Driving this digital transformation mindset are increasing demands from consumers and citizens who expect seamless, omni-channel and personal interaction with businesses and governments. Clients also face intensified regulatory requirements, cybersecurity risks, budget pressures and market disruption from new digital-first competitors. Page 20: CGI is the Official Systems Integration Partner of UK Sport and is working closely with its sport intelligence team in the development of a sustainable data management and analysis capability that allows UK Sport to maintain competitive advantage and enhance the quality of decision-making. (customer citation) Page 26: For the first time, social media and digital customer engagement also are top of mind. Digitally executed manufacturing is required to achieve the agility needed to compete.	No data found	Page 15: As part of our 2015 annual strategic planning process, we conducted 27 in-person interviews with oil and gas clients in 9 countries. In the face of fluctuating prices, geopolitical uncertainty and increasing difficulty in accessing reserves, our clients are seeking to reduce costs, increase the productivity of reserves, make better use of assets, engage in strategic partnering, improve compliance and generate more downstream profits — securely, safely and sustainably.... With a significant drop in oil prices, companies face extreme pressures on revenue generation and cost reduction. To help address these issues and the industry's trends and priorities, CGI is focused on helping clients design, build and deliver an effective response. Page 16: Clients find they are struggling to transform to meet these demands. Their business and IT platforms, which have been built and enhanced over many years, add complexity and cost to their ability to fund and achieve digital transformation. From a cost perspective, 65% of clients cited that they have not been able to reduce costs and adjust their IT spend mix to support change investments. Approximately 18% of clients' Capex budgets are allocated to support digital transformation, with nearly 60% of clients confirming they have digital transformation activities underway. As we support our clients on their digital transformation journeys, CGI is at the forefront of helping clients lower their costs to fund and drive change. Page 19: Through CGI's IT outsourcing and digital business services solutions — along with our best-fit global delivery options — CGI can reduce our clients' IT budgets by 30–40% over time, providing a strong emphasis on IT modernization, the retirement of old applications, and the adoption of automation tools and processes.	No data found
Check Point Software	No data found	No data found	Page3: The systems and services included in this business enable retailers and their suppliers to reduce shrink while leveraging real-time data generated by our systems to improve operational efficiency. Page 6: All participants in the retail supply chain look for ways to operate with maximum efficiency. Many of our products and services, including labels that are fully integrated with EAS and/or RFID capability, help our customers to achieve critical objectives, such as meeting tight delivery schedules and preventing losses caused by tracking failure, theft, misplacement or counterfeiting.	No data found
Cisco Systems	Page 20: These customers look to us as a strategic partner to help them use IT to enable, differentiate or fundamentally define their business strategy and drive growth, improve productivity, reduce costs, mitigate risk, and gain a competitive advantage in an increasingly digital world. Page 21: We see our customers increasingly using technology and, specifically, networks to grow their businesses, drive efficiencies, and try to gain a competitive advantage. In this increasingly digital world, we believe data is the most strategic asset and is increasingly distributed across every organization and ecosystem, on customer premises, at the edge of the network, and in the cloud. The network also plays an increasingly important role enabling our customers to aggregate, automate, and draw insights from this highly distributed data, where there is a premium on security and speed. We believe this is driving them to adopt entirely new IT architectures and organizational structures. We understand how technology can deliver the outcomes our customers want to achieve, and our strategy is to lead our customers in their digital transition with solutions including pervasive, industry-leading security that intelligently connects nearly everything that can be digitally connected. Page 21: Digital Transformation.....We believe these types of transformations create opportunities to deliver better customer experiences, create new revenue streams through business model transformation, and optimize efficiency through workforce innovation. Page 27: Security We believe that security is the top IT priority for many of our customers. We further believe that security solutions will help to protect the digital economy and will be an enabler that safeguards business interests and protect customers and thereby creates competitive advantage.	Page 27: Cloudlock provides additional visibility and control directly in SaaS, platform-as-a-service (PaaS), and infrastructure-as-a-service (IaaS) environments through application program interfaces (APIs) that enable a rapid deployment, and quick time to value for customers. Page 27: Our Other Products category primarily consists of certain emerging technologies, and other networking products. This includes our continued investment in IoT with our acquisition of Jasper. Through this acquisition we intend to leverage new platforms to help our customers increase their volume of business, or otherwise address their most pressing challenges, in the IoT area.	Page 27: Technical support services help our customers ensure their products operate efficiently, remain available, and benefit from the most up-to-date system, and application software that we have developed.	No data found

Compal	Page 80:...strategic alliances with main parts providers in the supply chain to give customers better and more competitive products and services.	Page 80: We will help customers create differentiated products with feasible designs.	No data found	No data found
CSC	Page 6: Information Management: enables clients to integrate, manage and analyze enormous amounts of data from a large variety of sources in order to gain competitive advantage and improve their business outcomes.	No data found	Page 4: The company's business model is built to support two principal goals: helping enterprise clients to become more innovative, efficient and competitive through the application of business insight and IT solutions;	No data found
Dassault Systemes	Page 25: These simulation activities allow manufacturers to better address and shift processes so as to quickly respond to the competition, or to take advantage of new market opportunities. Page 25: It enables customers to build on their competitive differentiators and plan for profit by capturing their operational reality – down to the last significant detail. Page 26: Companies are able to compile, analyze and uncover the value of "product-generated" data, combined with customer information and aggregated data found in any systems that may be used during product support and operations, creating new services and enhancing competitiveness and customer satisfaction.	Page 20: Based on their strong competence in industries and application domains as well as their regional expertise, in conjunction with Dassault Systèmes' products and solutions, these partners help to deliver innovative solutions that customers need for success in their business. Page 26: Companies ...., creating new services and enhancing competitiveness and customer satisfaction. Page 27:...while new, innovative products and services are created.	Page 20: It provides a single source for truth by integrating all data required to improve processes while eliminating costly IT operations, such as database replication. Page 25: This enables customers to integrate supply chain planning and optimization to plan their workforce, manufacturing environment, and logistics operations. Page 27: Processes are optimized while	Page 17: The Company works closely with customers, involving them in many phases of product development. Through these close, long-term working relationships, the Company develops a good understanding of its customers and their most important business values. This level of knowledge enables the Group to develop software solutions more closely attuned to the customers' requirements, highly suited to their industries, and designed to maximize user productivity and experience. Page 17: The Company's brand strategy focuses on providing significant value to end-users with the objective of each brand/product line being a leader within its respective markets. Page 20: The 3DEXPERIENCE platform is a business experience platform. It provides software solutions for every organization within a company – from engineering to marketing and sales – that help clients, in their value creation process, to create differentiating consumer experiences. page 27: Through a customer-facing, programmable dashboard, enterprises can also empower consumers to design their own custom product experiences.
EMC	Page 4: As data centers become more agile, managing information becomes central to our customers' operations. EMC Information Infrastructure provides a foundation for organizations to store, manage, protect, analyze and secure ever-increasing quantities of information, while at the same time improving business agility, lowering cost and increasing competitive advantage Page 4:...We believe this ability to draw on resources from across the federation to offer tightly integrated solutions that can be rapidly deployed while retaining choice for customers seeking flexibility is a distinct competitive advantage. Page 7:The continued growth of data in the digital universe creates a huge challenge for IT departments that must store and manage information, but Big Data also creates huge opportunities for a new generation of applications that help organizations turn massive amounts of data into insight and competitive advantage. Page 9: EMC Global Services ("GS") enables customers and partners to transform IT, realize the agility and efficiency of a trusted cloud and capitalize on the competitive advantage of Big Data.	Page 10: As many enterprises are transitioning to cloud computing and seeing their industries disrupted by smaller, more nimble software-driven companies, these enterprises are seeking to transform their businesses by developing and using next generation software applications to differentiate themselves from their competitors. These applications are designed to.... as well as provide a better customer experience for their products and services. Page 9: VCE Vblock systems accelerate the adoption of cloud-based computing models that .....and increase business agility, enabling customers to transform their IT for faster time to market.	Page 10: As many enterprises are transitioning to cloud computing and seeing their industries disrupted by smaller, more nimble software-driven companies, these enterprises are seeking to transform their businesses by developing and using next generation software applications to differentiate themselves from their competitors. These applications are designed to drive more efficiencies within these organizations as well as ..... Page 7: The ability of our federated businesses to work together results in differentiated solutions, including Enterprise Hybrid Cloud ("EHC") and Business Data Lake, with broad transformational capabilities which allow our customers to maximize their control, efficiency and choice. Page 8: EMC's EHC solutions provide customers with a single platform designed to reduce the cost of delivering mission-critical IT services, while providing the financial transparency, on-demand services and agility that businesses need. Page 9:VCE Vblock systems accelerate the adoption of cloud-based computing models that reduce the cost of IT, simplify operations and	No data found
Fujitsu	Page 12: As an example of how we are developing managed services, we helped a financial services organization outside Japan switch 50,000 PCs to thin client terminals. Through managed services in 20 countries around the world, including consulting on deployment, we are helping to enhance the global competitiveness of this customer. Page 64: For local companies, Fujitsu will offer technology that helps make customers' businesses and products more competitive	Page 7: Existing ICT usage areas for enterprises are expected to contract due to cost-cutting pressures and intensifying competition. However, ICT usage in fields that can directly contribute to customers' sales and profit have become more and more important. Fujitsu will strive to expand ICT usage areas for enterprises by promoting modernization and by driving marketing, work style, and manufacturing innovation through business innovation. page 42: Fujitsu will work together with customers to achieve business innovation, such as enhancing enterprise competitiveness, and social innovation that addresses social issues.	Page 42: We will also offer system integration services that respond flexibly to customers' initiatives to increase business process efficiency, organizational changes, and service expansion.	
Google	No data found	No data found	No data found	No data found
HCL Technologies	No data found	Page 5: IoT WORKS by HCL, the Internet of Things (IoT) services unit of HCL Technologies, allows organizations to adopt IoT functioning in their business context, creating entirely new services that deliver an enhanced experience and measurable business outcomes. These experiences will have an increasing role in differentiating enterprises and positioning them for the 21st century. Page 7: Over the past decade, HCL's engineering services have helped more than 300 organizations develop and launch market-leading products and services across various market segments, which has delivered more than $50 billion in revenues for its customers. Today, it works with more than 50 of the top 100 R&D spenders in the globe. Empowered by a deep engineering heritage, out - of - the - box thinking, and a solid foundation of talent, processes, systems, frameworks, and tools, this group is a preferred engineering partner for global companies with its ability to drive	Page 5: The framework eliminates IT and business waste, reducing cost and driving transformative initiatives across the organization. Page 5: HCL recently introduced the Next-Generation ITO framework to enable 21st Century Enterprises operate with agility, run lean operations, and focus on customer experience Page 5: ...create a modernized workplace that transforms employee productivity, enable internet-optimized highly-available networks and power lean and agile operations through DryICE, Page 7: clients are now seeking partners that can also help them take advantage of emerging technologies and simplify their IT operations, while simultaneously reducing costs and investing in business growth. Page 8: BPO services enable clients to improve organizational processes, reduce costs and create economies of scale. HCL	No data found

		significant business impact and value through accelerated product launches, improved engineering efficiencies, and adoption of new and disruptive technologies.	Business Services offers customized service offerings that translate into flexible and cost effective services of the highest quality for customers. Page 8: HCL's EFaaSTM holistically transforms the clients' enterprise functions while significantly reducing the total cost of operations.	
Hewlett-Packard	No data found	No data found	Page 9: The EG (Enterprise Group) portfolio delivers products and services across servers, storage and networking to reduce cost and continue high performance operations for traditional IT loads Page 10: The Infrastructure Technology Outsourcing group delivers comprehensive services that streamline and help optimize our clients' technology infrastructure to efficiently enhance performance, reduce costs, mitigate risk and enable business optimization.	Page 6:…that bring together infrastructure, software, and services through innovation to enable our customers to create value and solve business problems.
IBM	Page 7: Information Management: enables clients to integrate, manage and analyze enormous amounts of data from a large variety of sources in order to gain competitive advantage and improve their business outcomes.	Page 5: The company's business model is built to support two principal goals: helping enterprise clients to become more innovative, efficient and competitive through the application of business insight and IT solutions; Page 3: Enterprises are benefiting from cloud by using it to transform their information technology (IT) and business processes into digital services. Cloud brings two compelling sources of value: • Innovation: In addition to cloud enabling the sharing of infrastructure, the real promise of cloud is innovation. By forcing greater levels of standards throughout the technology value chain, new products and services, and even entire business models, can be created in weeks rather than months or years.	Page 5: The company's business model is built to support two principal goals: helping enterprise clients to become more innovative, efficient and competitive through the application of business insight and IT solutions; Page 6: Integrated Technology Services: delivers a portfolio of project-based and managed services that enable clients to transform and optimize their IT environments by driving efficiency, flexibility and productivity. Page 6: GBS helps clients use these technologies to reinvent relationships with their customers and realize new standards of efficacy and efficiency in the internal processes, data and applications that they use to run their businesses. Page 7: Smarter Commerce software helps companies better manage and improve each step of their value chain and capitalize on opportunities for profitable growth, efficiency and increased customer loyalty. Page 8: By remaining at the forefront of collaboration tools, IBM's social business offerings help organizations reap real benefits associated with social networking, as well as create a more efficient and effective workforce.	Page 24: The company creates value for clients through integrated solutions and products that leverage: data, information technology, deep expertise in industries and business processes, and a broad ecosystem of partners and alliances. IBM solutions typically create value by enabling new capabilities for clients that transform their businesses and help them engage with their customers and employees in new ways.
Infosys	Page 191: Infosys enables clients in more than 50 countries to stay ahead of emerging business trends and outperform their competition. Our experience gives our clients a distinct advantage.	No data found	Page 191: In addition to transforming their business, we efficiently manage their operations. We deliver business value in global scalability, process efficiency and cost optimization for our clients. Page 84: Consulting and domain expertise: Our specific industry domain, process, and technology expertise allows us to enable clients to transform their businesses with innovative strategies and solutions. Our expertise helps our clients enhance their performance, gain process and IT efficiencies, increase agility and flexibility, reduce costs, and achieve measurable business value.	No data found
Lenovo Group	No data found	Page 45: Lenovo will continue to leverage its innovation leadership to create new and exciting choices for its customers and drive new growth. (~)	No data found	No data found
Microsoft	No data found	No data found	Page 10: Our Commercial segments develop, market, and support software and services designed to increase individual, team, and organizational productivity and efficiency, Page 10: Our server products are designed to make information technology professionals and developers and their systems more productive and efficient. Page 11: We believe our server products provide customers with advantages in performance, total costs of ownership, and productivity by delivering superior applications, development tools, compatibility with a broad base of hardware and software applications, security, and manageability. Page 15. Software assurance also provides support, tools, and training to help customers deploy and use software efficiently.	No data found
Motorola Solutions	No data found	Page 4: We serve our customers with a global footprint of sales in more than 100 countries based on our industry leading innovation and a deep portfolio of products and services. Page 5: We have a history of delivering these products and services by focusing on the following areas: Driving innovation and thought leadership;	Page 4: Our products and services help government, public safety, and commercial customers improve their operations through increased effectiveness, efficiency, and safety of their mobile workforces. Page 5: We have a history of delivering these products and services by focusing on the following areas: Building technology that improves productivity and safety;	No data found
NCR	No data found	No data found	Page 3: Longer term managed service arrangements can help improve the efficiency and performance of the customer's business, and also increase the strategic and financial importance of its relationship with NCR.	No data found

NetApp	Page 6: Converged infrastructure. Due to budget constraints and skill imbalances, our customers need greater support from their technology partners to evaluate, integrate, deploy and sustain the sophisticated solutions they need to stay competitive.	Page 6: Software-defined Storage: Software-defined storage (SDS) is a key component of the software-defined data center, an evolving architecture and set of technologies designed to speed delivery of IT services to application owners within an enterprise.	Page 7: Our data management and storage offerings help improve business productivity, performance and profitability, while providing investment protection and enhanced asset utilization Page 9: NetApp offers a range of software products to protect customers' valuable data and applications. These provide optimal availability and IT efficiency while safeguarding data assets. Page 10: ...It reduces capacity requirements on arrays by more than 35%... Page 10: FlexPod solutions are designed and validated to reduce deployment time, project risk, and the cost of IT. Page 11: Our professional services team and certified services partners have the expertise to assist customers with each phase of their IT lifecycle, from planning next-generation storage systems and deploying new technology to optimizing the operational efficiency of existing infrastructures.	No data found
Oracle	No data found	No data found	Page 7: Provide IT functionality that customers can use to manage critical business functions in a rapidly deployable delivery model with lower upfront customer investment. Page 7: We designed our Oracle Engineered Systems to combine certain of our hardware and software offerings to increase computing performance relative to our competitors' products, creating cost efficiencies, time savings and operational cost advantages for our customers. Page 10: We believe most businesses view big data as a high-value opportunity because effective technologies can leverage big data to allow those businesses to gain new insights into their customers' behavior, anticipate future demand more accurately, align workforce deployment with business-activity forecasts, and accelerate the pace of operations. Page 10: Our software solutions are built on a standards-based architecture that is designed to help customers reduce the cost and complexity of their IT infrastructure. Page 11: Our customers are increasingly focused on reducing the total cost of their IT infrastructure and we believe that our software offerings help them achieve this goal. Page 16: Our storage products are co-engineered with Oracle software and designed to provide performance benefits for our customers in Oracle Database and Oracle Applications environments, as well as to work with multi-vendor application and systems environments to maximize performance and efficiency while minimizing management overhead and lowering the total cost of ownership. Page 16: We have also engineered our hardware systems products to create performance and operational cost advantages for customers	Page 14: Our complete customer experience software solutions—including customer relationship management—are designed to help organizations deliver simple, consistent, and relevant experiences across all channels, touch points and interactions. We provide customer experience solutions for marketing, sales, commerce, service, social, and industry requirements.
Quanta	No data found	No data found	No data found	No data found
SanDisk	No data found	No data found	No data found	No data found
SAP	Page 47: To remain competitive – and create a sustainable competitive advantage – businesses today must become sustainable digital businesses. In fact, experts across industries know that in the new digital economy, only the most adaptive businesses will prevail. SAP provides what is needed to become a digital business. Page 50: Companies in every industry must take a unified approach to managing every aspect of their business, and they need solutions whose innovation matches their own ambitions to grow and win in the market.	Page 48: ….by helping our customers innovate,.., and offer new products and services. Page 52: At SAP, we are helping to lead this transformation through our business networks, which are helping drive innovation in key areas that impact an organization's core operations.	Page 48: As they become digital businesses, our customers are becoming more sustainable organizations by improving how they serve their customers, engaging and developing their workforce, increasing transparency of their suppliers' social performance, using resources more efficiently, and interacting with local communities. Page 48: ….by helping our customers..., run more efficiently,... Page 48: For example, when major manufacturers gain greater transparency into their energy usage and create more efficient supply chains, ... Page 50: Enterprises can now reduce their data footprint and work with larger data sets in one system to save hardware costs, operational costs, and time as well as reduce complexity. Page 51: Customers also have the benefits of efficiency and flexibility through a variety of deployment models. Page 53: AP HANA has vastly increased the efficiency with which our customers can use analytics to drive decision making.	Page 51: SAP S/4HANA represents a huge step forward in simplifying how applications are built, consumed, and deployed. It provides real-time, mission-critical industry-specific business processes across organizations and lines of business. As a basis, enterprises can now support end-to-end operations across key business functions through a fully digitized enterprise management solution named SAP S/4HANA Enterprise Management. A prime example of our innovations is SAP S/4HANA Finance, a comprehensive solution for the office of the CFO. This solution brings enhanced functionality to a range of key areas – from financial planning and analysis to collaborative finance operations. It also provides our customers with seamless flexibility, with deployment either on premise or in the cloud. Page 54: ..., we recognize that we must partner with our customers to help them make the most of these innovations based on their unique needs and goals. Through our worldwide service and support, we guide companies at every stage of their digital transformation. We focus on creating and delivering strategies for our customers' digital journey, accelerating innovation, driving simplification of business and IT, and ensuring that expected business value is realized and continuously optimized. Page 55: As they continue on their path to digitization, we work with large enterprise customers to forge a co-engineering and co-innovation relationship, so that they can influence and shape existing SAP solutions while gaining early access to product innovation.

Seagate Technology	No data found	No data found	Page 8: addition, the economics of storage infrastructure are also evolving with the utilization of public and private hyper-scale storage and open-source solutions reducing the total cost of ownership of storage while increasing the speed and efficiency with which customers can leverage massive computing and storage devices.	No data found
Symantec	No data found	No data found	No data found	No data found
Tata Consultancy Services	Page 69: In the digital era, where customers are looking to TCS to help leverage new technologies to transform their businesses and gain competitive advantage, speed is of the essence, and agility is key. Consequently, new projects use 'Agile' or 'DevOps' by default.	Page 69: In the digital era, where customers are looking to TCS to help leverage new technologies to transform their businesses and gain competitive advantage, speed is of the essence, and agility is key. Consequently, new projects use 'Agile' or 'DevOps' by default. Page 84: To capture the growth opportunities driven by the impact of emerging technologies across the manufacturing industries, TCS is focusing on building innovative solutions and accelerators that help customers address their most significant areas of competitiveness.	Page 15: Banks continue to face a dynamic regulatory environment. They need a single source of truth to make compliance efficient. TCS developed the World's largest cloud cluster (500+ Nodes) to help one of its customers to simplify its Information flows for an accelerated data quality compliance and a significant improvement in data governance.	No data found
VMWare	No data found	Page 5: vRealize Automation—enables customers to rapidly deploy and provision cloud services. vRealize Business—provides transparency and control over the costs and quality of IT services. Page 6: Our solutions provide corporate end users with choice in access to their applications, content and data in a user-friendly environment—all while allowing corporate IT appropriate control over the computing environment with high-quality service, improved availability and scalable performance—either on-premise or in hybrid clouds. Page 7: ....enabling VMware and AirWatch customers to take advantage of "bring your own device" initiatives. Page 7: ...Socialcast, our enterprise social computing solution that allow users to complement their use of email with rich communication in consumer-grade experiences.	Page 4: The benefits to our customers include lower IT costs and… and address a range of complex IT challenges that include cost reduction, operational inefficiencies, … Page 4: We believe that our solutions enable organizations to realize significant operational and cost efficiencies as they transition their underlying legacy IT infrastructure. Page 5: We provide many storage and availability products to offer cost-effective holistic data storage.......provides cost-efficient and simple way.... Page 5: VMware vSphere with Operations Management allows users to optimize capacity and monitor the workload performance of their vSphere environments. Page 6: Our End-User Computing strategy enables IT organizations to efficiently deliver more secure access to data, applications and devices to end users	No data found
Wipro	Page 27: Pressures on cost-competitiveness and an uncertain economic environment are causing clients to develop newer business models. Page 32: Powered by accelerators, metadata extractors and visualization frameworks the BI tools covered by Analytics help decision makers make informed decisions, identify new business opportunities and create sustainable competitive advantage.	Page 28: Our clients are beginning to see the bene t of design and engineering working together to deliver remarkable customer experiences at speed and at scale. Page 29: We offer services designed to help customers integrate digital technologies and remain agile. Page 29: Our solutions like Digital Customer Experience Management ("DCxM") and Encore ("Next Gen Commerce Solution") enable businesses to engage customers, drive sales, enhance customer experience and create an integrated enterprise that delivers a consistent, omni-channel customer experience. Page 31: Testing Services: We deliver functional assurance, better quality and enhanced performance with our offerings like risk-based testing, cloud testing, business assurance, ready to deploy tools such as model based testing and test lifecycle automation and industry point solutions such as Digital Assurance platform. Page 31:...the next generation technologies which can help customers to transform their business and technology landscape in next 1-3 years. The group specializes in technologies like Open Source, Google Enterprise Technologies, Amazon Web Services, Apple technologies, Agile and DevOps, Blockchain and SaaS/PaaS based innovative platforms like Treasury Decision and Analytics, Page 34: Customers can maximize their revenue by leveraging our IoT and connected devices solutions on the one hand....	Page 27: Our strategy thus addresses our clients' Run and Change agenda. The Run Strategy is about Modernizing the Core of our clients' process and technology landscape i.e. help clients achieve significant efficiencies in their core operations through various levers in all of our core markets. Page 27: In integrating services to solve customer's business problems, the unit will consider reference architectures, selection of tools and platform, cost effectiveness of solution and best practices. Page 27:Enterprises are focused on cost reduction with improved quality of service and reliability, coupled with variable pricing arrangements. Wipro's approach to achieve enterprise objectives is to deliver simplification of client technology landscape through consolidation, elimination and automation. Page 27: Our focus is to help clients achieve their 'Run' goals through significant cost optimization in operations by deploying cutting edge platforms and technologies that drive Hyper-automation and achieve industrialization of service delivery. Page 29: Wipro Consulting Services consults and leads organizational and business process transformation to improve performance, increase effectiveness, reduce costs and improve resilience. We introduce leading edge practices and offer business advisory, business and functional transformation, IT consulting and risk and compliance services to many of the world's leading organizations, governments and institutions. Page 34: Customers can ...optimize their operational expenses by using our smart manufacturing solutions on the other hand.	Page 33: Our integrated portfolio of solutions, platforms and services in applications, infrastructure and business process outsourcing enables our clients to enhance engagement with their end customers – the patients and providers by reimagining and redesigning experiences across channels of consumption in this digitized world. Page 34: As an innovative integrated services player, we help clients reimagine customer experiences and deliver them through a unique blend of design and technology.
ZTE	No data found	Page 4: ...we have the flexibility to fulfill differentiated requirements and demands for fast innovation on the part of different carriers and customers in the government and corporate sector around the world. Page 19: The Group worked proactively in the domestic market in support of the network construction plans and application requirements of domestic carriers and government and corporate clients, maintaining quality growth by offering competitive innovative solutions on the back of application of new technologies in various industries.	No data found	No data found

Appendix A4 – Samples from IT architect content analysis

Sample A

Set-ID	Job Ad Title	Advertizer	Architect Type
A-1	Lead Software Security Architect	Wirecard AG	Software
A-2	Software Architect Sensor Fusion Automated	Continental AG	Software
A-3	IT Architect Infrastructre & Network	Altran Deutschland S.A.S. & Co. KG	Solution (Other)
A-4	Global Program Manager & Solution Architect	Merck KGaA	Solution
A-5	Infrastructure Architect	RWE	Solution (Other)
A-6	Software Solution Architect - IoT	Hilti Entwicklungsgesellschaft mbH	Solution
A-7	IT Architect	Sixt Autovermietung	Software (Other)
A-8	Software Architect for Computer Vision	Zeiss	Software
A-9	(Senior) Software Architect	QIAGEN GmbH	Software
A-10	System Architect for SLAM	Bosch Gruppe	Solution (System)
A-11	Solutions Architect	Schrödinger GmbH	Solution
A-12	System Architect	HARMAN International	Solution (System)
A-13	Solution Architect	Configit GmbH	Solution
A-14	(Senior) CRM Data Architect	QIAGEN GmbH	Solution (Data)
A-15	Software Architect IT	Red Bull Media House GmbH	Software
A-16	Integration Architect	E.ON Business Services GmbH	Solution (Other)
A-17	Software Architect Computed Tomography	Siemens AG	Software
A-18	Cloud Solution Architect	Henkel AG & Co. KGaA	Solution
A-19	Lead System Architect DevOps	Kühne + Nagel (AG & Co.) KG	Solution (System)
A-20	Architect — Science Workflow Web Platform	ZEISS	Software (Other)
A-21	Solutions Architect	Nakisa GmbH	Solution
A-23	Solution Architect Dynamics NAV	thyssenkrupp Access Solutions	Solution
A-24	Digital Operations Architect	thyssenkrupp Elevator AG	Solution (Other)
A-25	Solutions Architect - Customer Experience	KANTAR	Solution
A-26	Senior Architect Linux	DNVGL	Solution (Other)
A-27	Big Data Architect	Altran Deutschland S.A.S. & Co. KG	Solution (Data)
A-28	Big Data Architect	Cognizant Technology Solutions	Solution (Data)
A-29	Enterprise Architect	Henkel AG & Co. KGaA	Enterprise
A-30	Digital Delivery Architect	John Deere GmbH & Co. KG	Software (Other)
A-31	Cyber Security Architect - Infiotainment	MBition GmbH	Solution (Security)
A-32	Lead IT Architect	thyssenkrupp Elevator AG	Enterprise
A-33	System Architect	Veoneer Germany GmbH	Solution (System)
A-34	Software Cloud Architect	Haufe Group	Software
A-35	Enterprise Integration Architect	PwC	Software (Other)
A-37	Software Architect (w/m) Virtual validation in	Volkswagen AG	Software
A-38	AI Algorithm Architect for automated Driving	Bosch Gruppe	Software (Other)
A-40	Software Architect in API Design in Bosch	Bosch Gruppe	Software
A-41	PLM Solution Architect	Atlas Copco Energas GmbH	Solution
A-42	Data Architect (m/f)- Performance	Ernst & Young GmbH	Solution (Data)
A-43	System Architect - Infotainment	MBitionGmbH	Solution (System)
A-44	eBusiness and Integration Architect	Trinseo Deutschland GmbH	Solution (Other)
A-45	IAM Solution Architect Flexible	Danfoss	Solution
A-46	Cloud Platform Architect	E.ON Business Services GmbH	Solution (Other)
A-47	Senior Enterprise Architect Transition &	Deutsche Telekom AG	Enterprise
A-48	IOT Architect	Cognizant Technology Solutions	Solution (Other)
A-49	Cyber Security Architect	Daimler FleetBoard GmbH	Solution (Security)
A-50	ERP Solution Architect - Services	GE Power	Solution
A-52	Enterprise Architect Energy Networks	E.ON Business Services GmbH	Enterprise
A-53	IT-Architect Web Solutions	Allianz Technology SE	Solution
A-56	System Architect - Embedded Systems &	Elektrobit Automotive GmbH	Solution (System)
A-57	Data Architect	E.ON Business Services GmbH	Solution (Data)
A-58	ABAP Application Developer and Architect	Knorr-Bremse Services GmbH	Solution (Other)
A-59	Enterprise Architect Technology & Platforms	E.ON Business Services GmbH	Enterprise
A-60	Security Architect	Knorr—Bremse Services GmbH	Solution (Security)
A-61	Information Security Architect	E.ON Business Services GmbH	Solution (Security)
A-62	Network Architect_HCL Technologies	HCL GREAT BRITAIN LIMITED	Solution (Other)
A-63	Senior Software Architect Connected Things	Robert Bosch GmbH	Software
A-64	IT Functional Architect	Boehringer Ingelheim	Enterprise
A-65	Business Technology Architects	Bucher Hydraulics GmbH	Enterprise
A-66	IT Enterprise Architect	Siegwerk Druckfarben AG & Co.	Enterprise
A-67	Senior Mobile Architect	IBM Deutschland GmbH	Solution (Other)
A-68	Architect Online Systems & eCommerce	Nintendo of Europe GmbH	Solution (System)
A-69	DWH Developer / Data Architect	Westwing Group AG	Solution (Data)
A-70	Data Architect	Eurowings Digital GmbH	Solution (Data)
A-72	Solution Architect	Sixt Autovermietung	Solution
A-74	Architecture Lead	StepStone GmbH	Enterprise

Samples B and C

Set-ID	Job Ad Title	Advertizer	Architect Type
B-1	Enterprise Architect	Salt	Enterprise
B-2	Enterprise Architect - Azure	Teck nuovo	Enterprise
B-3	Enterprise Architect - IT Transformation,	La Fosse Associates Ltd	Enterprise
B-4	Enterprise Architect (Application Integration)	Capita Resourcing Ltd (IT	Enterprise
B-5	Lead Enterprise Architect	Jumar Solutions Ltd	Enterprise
B-6	Enterprise Architect (Application Integration)	Capita Sourcing Ltd (IT Resourcing)	Enterprise
B-7	Enterprise Architect	Clinical Professional	Enterprise
B-8	Global Group Enterprise Architect	Marks Sattin	Enterprise
B-10	Enterprise Architect — Birmingham	BCT Resourcing	Enterprise
B-11	Enterprise Architect (Enterprise Architect -	Salt	Enterprise
B-12	Information Enterprise Architect	Shaw Daniels Solutions	Enterprise
B-13	Application Enterprise Architect	Shaw Daniels Solutions	Enterprise
B-14	Enterprise Architect	Capita Sourcing Ltd (IT Resourcing)	Enterprise
B-15	Enterprise Architect — CRM	Verticality Ltd	Enterprise
B-16	Enterprise Architect	Shortliste Recruitment	Enterprise
B-17	Enterprise Architect	Robert Walters Plc	Enterprise
B-18	Digital Enterprise Architect	Shaw Daniels Solutions	Enterprise
B-19	Enterprise Architect Central Birmingham	Oliver James Associates Limited	Enterprise
B-20	Enterprise Architect - Somerset	Redrock Consulting Limited	Enterprise
B-21	Enterprise Architect	Reed Technology Leadership	Enterprise
B-22	Enterprise Architect	CGI Group	Enterprise
B-23	Enterprise Architect	Michael Page Technology	Enterprise
B-24	Enterprise Architect	Shaw Daniels Solutions	Enterprise
B-25	Enterprise Architect	Harvey Nash	Enterprise
B-26	Enterprise Architect	Forsyth Barnes Limited	Enterprise
B-27	Enterprise Architect (Financial Sector)	Jumar Solutions Ltd	Enterprise
B-28	Principal Enterprise Architect	Datasource Computer Employment	Enterprise
B-29	Enterprise Architect	Computer Futures Solutions	Enterprise
B-30	Enterprise Architect	Aviva	Enterprise
B-33	Enterprise Architect	Morson (IT Devision)	Enterprise
B-34	Enterprise Architect (Customer Service)	Dixons Carphone	Enterprise
B-35	Enterprise Architect - Payments	Spring Technology	Enterprise
B-36	Enterprise Architect - Microsoft Transformation	EMBS	Enterprise
B-38	Enterprise Architect	Spring Technology	Enterprise
B-39	Enterprise Architect - Database	Datasource Computer Employment	Enterprise
B-40	Enterprise Architect	Capita Resourcing Ltd (IT	Enterprise
B-41	Enterprise Architect — Telecom/Enterprise	CACI Network Services Ltd	Enterprise
B-42	Tempest Enterprise Architect	Leonardo	Enterprise
B-43	Strategy & Enterprise Architect	The Dining Club Group	Enterprise
B-44	Enterprise Architect	Network Rail	Enterprise
B-45	Enterprise Architect, Digital Technology	HSBC	Enterprise
B-46	Enterprise Solution Architect	Summit Media Limited	Enterprise
B-48	Enterprise Architect	Aviva	Enterprise
B-49	Enterprise Architect	Oblix It Partners Limited	Enterprise
B-50	Senior Enterprise Architect	Managed Solutions	Enterprise
B-51	Data Architect - Database Enterprise Architect -	Reflex Computer Recruitment	Solution (Data)

Set-ID	Job Ad Title	Advertizer	Architect Type
C-1	Solution Architect E-Commerce	dress-for-less GmbH	E-Commerce
C-2	Softwarearchitect (m/w) SAP Hybris Commerce	Westfalen AG	E-Commerce
C-3	Solution Architect E-Commerce	ZEISS	E-Commerce
C-4	Ecommerce Solutions Architect	Experis	E-Commerce
C-5	Digital Solutions Architect - Ecommerce Agency	Savvy Media Group	E-Commerce
C-6	Application Security Architect - E-Commerce	Ventula	E-Commerce
C-7	API Architect - Leading eCommerce Firm	Ventula	Solution (E-Com.)
C-8	Customer Application Architect - Mcommerce	Project people	E-Commerce

This dissertation does not contain declarations of co-authorship because all parts/articles were written without co-authors.

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