Digital Capability
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Investigating Coevolution of IT and Business Strategies

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ABSTRACT

This dissertation investigates the role of information technology (IT) in organizational strategy. Specifically, it examines how organizations can persist in turbulent competitive landscapes characterized by IT innovations. Underlying premises for this dissertation are that: (1) ubiquitous IT implies constant disruptions from digital innovation, (2) IT and practice are becoming fused, and (3) organizational strategies are dynamically linked with practice, i.e. they are reciprocally related through what organizations do rather than have. To investigate such IT strategizing processes, I outline a conceptual framework for analyzing how organizations can generate digital capability, i.e. a collection of routines for strategizing by leveraging digital assets to create differential value. Digital assets here refer to the complement of available resources and competencies for IT design and implementation. Based on the notion of dynamic capability and evolutionary theory, this framework emphasizes the importance of sensing, seizing and transforming abilities for generating digital capability.

As organizational practices are becoming fused with IT scholars have argued that attempting to disentangle them analytically is futile. In a similar vein, organizational strategy is increasingly reliant on available IT resources for both formulation and execution. In the IS field it is widely acknowledged that IT has both enabling and inhibiting consequences for organizations. Drawing on the resource-based view of the firm and theory on organizational capabilities, the notion of IT capability has been widely used as a conceptual tool for analyzing these dual strategic effects of IT. Considering the explosive advances in computing, network and interaction that have resulted in IT being ubiquitous and deeply embedded in contemporary practices, recent research argues for the need to move beyond the functional view of technology implicit in the IT capability notion. A key aspect to address for such broadening of the perspective is the coevolution of IT and business practices, i.e. who (or what) leads, who or what follows, and whether such a causal distinction is meaningful.

Grounded in the outlined conceptual framework, this dissertation examines how organizations can build digital capability to both enable large variation and complexity of feasible competitive actions, and reduce inhibiting effects of IT. The empirical investigation is situated in three distinct domains: boundary spanning IT innovation, transformation of existing IT resources, and hybridization of technology through digitalization of production equipment. These investigations are presented in five research papers.

The dissertation contribute to knowledge of IT strategy by: (1) explicating the construct of digital capability, (2) providing a framework for coevolutionary strategizing processes, (3) presenting an empirical illustration of the coevolution of IT and business strategies, and (4) offer specific insights on design and orchestration of processes for digital capability generation.

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Johan

PREFACE

This dissertation consists of a cover manuscript and five research papers. In writing this manuscript my aim has been to provide a sense-making framework for facilitating understanding and discussion of the role of IT in organizational strategy. Hence, plausibility is favored over accuracy as suggested by Weick (1995, p. 61), *"in an equivocal, postmodern world, infused with the politics of interpretation and conflicting interests and inhabited by people with multiple shifting identities, an obsession with accuracy seems fruitless, and not of much practical help, either"*. Accordingly, the role of the cover manuscript is to support analysis and description of the encompassing topic of IT and strategy, while the papers explore demarcated aspects within this domain. The full research papers[1] are presented after the cover manuscript, in the following order:

Paper 1 Sandberg, J., Holmström, J. Mathiassen, L. and Levén, P. *"A Platform for Open IT Innovation: Knowledge Brokering in Academia-Industry Collaboration"*, currently under review (first round).

Paper 2 Sandberg, J., Holmström, J. Napier, N. and Levén, P. *"Balancing Diversity in Innovation Networks: Trading Zones in University-Industry R&D"*, currently under review (second round).

Paper 3 Sandberg, J. (2010), *"Coping with Complexity: Exploring Modularity and Flexibility in IT Infrastructure Adaptation.",* in Holmström, J. Wiberg, M. and Lund, A. (Eds.), Industrial Informatics Design, Use and Innovation: Perspectives and Services, p. 85-101.

Paper 4 Sandberg. J, Mathiassen, L. and Napier, N. (forthcoming), *"Digital Options Theory for IT Capability Investment"*, Journal of the Association for Information Systems.

Paper 5 Sandberg, J., Holmström, J. and Lyytinen, K. (2013). "*Platform Change: Theorizing the Evolution of Hybrid Product Platforms in Process Automation"*. Platform Strategy Research Symposium. Boston MA.

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[1] Related versions have been presented in proceedings of peer-reviewed and as book chapters, for a full list I refer to section 4.3.

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1 INTRODUCTION

1.1 Research Motivation

The implications of information technology (IT) for value creation are arguably the key strategic concerns in contemporary organizations. IT is no longer only a functional resource, rather it is now integrated into the very fabric of many social contexts. In recent decades IT-enabled innovations have fundamentally disrupted business logics in numerous industries, including media, mobile communication, automobile and finance industries (Mallat et al. 2004; Boczkowski 2005; Svahn 2012; Selander et al. 2013). Examples of landscape-changing innovations include Netflix-streamed media services, the smartphone, digital appliances pioneered by Apple, software used to improve cars' performance and extend their functions, and Internet banking. In fact, it is hard to identify sectors that have *not* been profoundly affected by IT. However, despite high awareness of IT's importance in value creation, practitioners and scholars alike struggle to grasp such processes analytically. In particular, how and why certain organizations seem capable of repeatedly generating and adapting to changes, and the roles of IT in such processes, are poorly understood.

The role of IT in organizational change and performance has been an object of study in the field of information systems (IS) since its infancy in the late 1950's (Leavitt and Whisler 1958). While early accounts often assumed deterministic outcomes of technological and organizational design, IT's implication in organizational change is now mainly considered to be emergent and shaped through interaction and use (Markus 1983; Markus and Robey 1988; Orlikowski 1992; Lamb and Kling 2003; Leonardi 2011). Thus, the focus on IT-implicated organizational change is enduring, but IS researchers are faced with a continuously moving research object (Tanriverdi et al. 2010).

A central argument in this dissertation is that an increasingly important precursor of organizational performance is the ability to develop and sustain adequate digital capability, i.e. *a collection of routines for strategizing by leveraging digital assets to create differential value*. While extant research increasingly acknowledges that organizational strategy and IT strategy coevolve (e.g. Benbya and McKelvey 2006; El Sawy et al. 2010; Bharadwaj et al. 2013), little if any attention has been paid to the generation of digital capability and its activation in practice (Peppard et al., 2014). In particular, while extensive research on alignment of IT with

business processes provides an important body of knowledge on IT as a functional resource, the increasingly salient reciprocal nature of the relationship between IT and business strategies has been largely neglected.

As IT is becoming increasingly ubiquitous, heterogeneous, networked, capable and complex, it is also emerging as a vital driver of strategic change (Jonsson et al. 2008; Lee and Berente 2012; Yoo et al. 2012). Loose coupling of IT architecture and standardization of data allow a high degree of variation and such variation drives rapid evolution. For example, the distribution of music recorded on vinyl records (and subsequently tapes or CDs) for personal enjoyment was confined to users with appropriate players, but recent digitalization of music allows us to enjoy it from diverse streaming services delivered through multiple devices. This is because neither the recorded music nor playing it is confined to a specific hard-wired medium. Accordingly, control over both content and functionality has been gradually dispersed across multiple parties and innovation patterns have changed. Further, impressive advances in computing capabilities have simplified communication and coordination via open innovation processes, provided added functionality to previously non-digital products through convergence, and resulted in digitalization of processes that previously did not leverage IT (Jonsson et al. 2008; Yoo et al. 2009). Taken together, these changes have blurred organizational boundaries and driven rapid, ongoing innovation (Yoo et al. 2010). Consequently, many organizations need to adapt their strategic frameworks and IT resources to new organizing logics (Bharadwaj et al. 2013; Peppard et al. 2014).

In the IS field it is widely acknowledged that IT has both enabling and inhibiting consequences for organizational performance (e.g. Orlikowski and Robey 1991; Hanseth et al. 1996; Woodard et al. 2013). An organization's digital capability enables a specific set of competitive actions for each application, and both the breadth and depth of these actions affects organizational boundaries and the ability to adapt to exogenous forces (Zammuto et al. 2007; Majchrzak and Markus 2012). Both the state of an organization's digital assets and its ability to recognize plausible competitive actions are drivers of enabling competitive actions.

The design of digital assets has been suggested to vary according to the option value and technical debt incurred (Woodard et al. 2013). Option value reflects both the current value of digital assets and the value of potential competitive actions they enable: "At the firm level, option value is a measure of the breadth of opportunities afforded by the

firm's design capital." (Woodard et al. 2013, p. 540). The "technical debt" concept originates in the software engineering domain and refers to "the expected cost or effort entailed in exercising the options embedded in a firm's design capital." (Woodard et al. 2013, p. 540). Such technical debt cumulatively accrues during evolutionary cycles of systems and requires compensation when making future changes to the systems. While most organizations prefer their digital assets to have a high option value and low technical debt, other states may sometimes be advantageous because of the implementation costs associated with maintaining options and technological flexibility. For example, in the IT control of nuclear energy plants there is little to gain from increases in functionality as operations remain stable while risks of technology malfunctioning associated with updates are high. Accordingly, organizations running such plants would probably be wise to choose systems with relatively low option values and high levels of technical debt (i.e. systems requiring major technological leaps when they are modernized). However, for most organizations that heavily rely on IT, maintenance of a large variety and complexity of competitive actions, and low technical debt, provides greater payoff.

While an organization's digital assets enable a certain variety and complexity of competitive actions, the option to exploit afforded opportunities only arises if and when the organization recognizes them (Bowman and Hurry 1993). Capacity for such recognition is an essential element of overall digital capability and can be facilitated by entrepreneurial alertness in terms of strategic foresight and systemic insight (Sambamurthy et al. 2003). Strategic foresight in this context refers to anticipation of discontinuities in the environment or technology while systemic insight denotes the capacity to identify entrepreneurial opportunities in linkages between technology, operations and business models. To remain competitive in a business landscape with rapidly shifting positions through creative destruction, organizations continuously engage in capability-building processes. For example, to maintain a large portfolio of competitive actions, the digital assets must be managed through investments and design-moves that ensure depreciation does not erode capabilities. These capability-building processes are path-dependent and require commitment of resources, strategic foresight and systemic insight (Sambamurthy et al. 2003).

1.2 Problem Statement

The ability of organizations to co-evolve with new technology is crucial for survival and is becoming increasingly important for contemporary organizations as competitive environments are evolving increasingly rapidly (D'Aveni et al. 2010). While the dominant perspective in IS strategy considers IT as a functional level resource that must be aligned with the organization's operational strategy (Sabherwal et al. 2001; Chan and Reich 2007), scholars have recently started to question this perspective and proposed that IT and business strategies are fused in ways that require a holistic perspective (El Sawy 2003; El Sawy et al. 2010; Bharadwaj et al. 2013).

The role of capabilities in dynamic adaptation to strategic change has been examined in great detail during the last two decades, but the coevolution of digital and business strategies has received much less attention. Similarly, the roles of organizational learning and resources in organizational adaptation have been examined in detail, but the nature of digital technology and its fusion with social structures has been neglected. Furthermore, much of the IS research focused on IT strategy has examined structural relationships from the viewpoint of IT alignment, while the continuous coevolution of IT and business strategies in rapidly changing environments has been neglected (Feldman and Orlikowski 2011; Henfridsson and Lind 2013; Arvidsson et al. 2014; Peppard et al. 2014).

Against this backdrop, the aim of this dissertation is to analyze the *generation of digital capability,* in the light of empirical observations regarding the following three main themes.

First, as industries are gradually becoming increasingly interconnected, competitive environments are becoming increasingly complex, unstable and dynamic (D'Aveni et al. 2010; Tanriverdi et al. 2010). To reduce uncertainty and make sense of exogenous changes and trends, organizations engage in extrovert activities. Such activities support sensing abilities (Haeckel 1999; Teece 2007; Westergren and Holmström 2012) and absorptive capacity (Cohen and Levinthal 1990), both key components of strategic foresight. These activities increasingly involve tapping into external sources through participation in open innovation processes (Chesbrough et al. 2008; Westergren and Holmström 2012). While extant research has identified positive outcomes from boundary-spanning collaborations in numerous areas (Levina and Vaast 2005), their management remain undertheorized.

Second, efficiency and flexibility often constitute opposing forces in organizational practices, as illustrated by notions such as ambidexterity

and the underlying tension between exploration-exploitation (Duncan 1976; March 1991; Gibson and Birkinshaw 2004). Ambidexterity here refers to organizations being *"aligned and efficient in their management of today´s business demands, while also adaptive enough to changes in the environment that they will still be around tomorrow"* (Gibson and Birkinshaw 2004, p. 209). IT can both enable and inhibit ambidexterity, for example large standardized enterprise systems provide advantages in terms of scale and scope, but may also impose disadvantageously rigid routines (Davenport 1998; Ross et al. 2006). Similarly, large-scale systems allow re-use of practices and interpretations through standardization, while increases in size and dependencies increase resistance to change as systems grow (Hanseth et al. 1996; Braa et al. 2004; Hanseth and Lyytinen 2010). The extent to which digital assets support appropriately balanced exploration and exploitation is tightly related to their option value and technical debt(Sambamurthy et al. 2003; Woodard et al. 2013). Digital assets can be strategically exploited (in multiple ways), but their state and management are also important prognosticators of digital capability levels.

Third, while a major objective of IT strategists has been to align IT with business strategies, intense competition and frequent disruptions suggest that organizations increasingly need to develop the ability to coevolve with changes in the environment and IT (El Sawy et al. 2010; Tanriverdi et al. 2010). The fusion of IT and practice is obliging organizations to engage in transformation cycles increasingly quickly as the evolutionary rate increases. As effects of digital innovation are becoming deeply intertwined with practices and essential operational IT, life cycles of organizational routines are shortening. Thus, efficiently transforming sociotechnical structures is a key challenge for successful coevolution in the increasingly turbulent environment.

1.3 Research Objective and Approach

Despite the far-reaching implications of IT in organizations, we know little about the management of continuous adaptation of digital technology and practice. Compelling success stories illustrate how IT can provide competitive benefits in organizational settings (Weill and Aral 2006; McAfee and Brynjolfsson 2008; Davenport 2013). However, there are few theoretical and empirical investigations of the increasingly salient coevolutionary dynamics involved with strategizing by leveraging digital assets. This dissertation draws upon evolutionary theory and practice-

based strategy approaches to make sense of these dynamics, aiming to fill a critical gap in the IT strategy literature.

The expected contributions from this dissertation lie primarily within the areas of analysis and explanation, addressing "…*what is, how, why, when, and where*" questions (Gregor 2006). The objective is to elucidate specific aspects of the capability-building process by developing and applying conceptual tools supporting explanation of IT strategies, and analytical approaches for examining the design and implementation of IT-related practices.

To provide such insights, digital capability generation is investigated empirically in three distinct contexts: (1) academia-industry collaboration to create innovation, (2) IT's role in process transformation at the dairy company Norrmejerier, and (3) the evolution and digitalization of ABB's platform for industrial process control over four decades. These research contexts illuminate different aspects of digital capability building. The academia-industry context provides insights from two data sets, one on configuration and orchestration of innovation networks and the other on establishment of a social platform for boundary-spanning innovation collaboration. In the Norrmejerier context the focus is on implementation of an enterprise resource planning (ERP) system and opportunities for IT-enabled process innovation. The focus in the third context is on the coevolution of technology, strategy and environment as ABB's platform for process automation emerged through digitalization.

1.4 Central Argument

The fundamental thread running through the three research domains is the dynamic linkage of: (1) distributed digital innovation, (2) fusion of IT with the environment, and (3) strategy as a process of activities dispersed within and outside organizations' boundaries. The overall argument expounded throughout this dissertation is as follows:

1. Advances in IT capacity are fusing digital technology with social contexts and making it ubiquitous. Accordingly, continuous IT innovation and change are not confined by but are swiftly changing existing organizational structures.
2. Organizational strategies are dynamically linked with practice, i.e. reciprocally related by things organizations *do* rather than have.
3. The fusion of IT and practice suggests that digital technologies are no longer merely functional resources. Rather they are key drivers of strategic change, and IT and business strategies increasingly coevolve.

4. Digitalization affects at least four dimensions of business strategy: scale, scope, speed and sources of value creation and capture.
5. An increasingly important predictor of organizational performance is the ability to develop and sustain digital capability, i.e. *a collection of routines for strategizing by leveraging digital assets to create differential value.*
6. Competitive advantages are increasingly short-lived, and important dimensions of digital capability for organizational performance in this landscape are the variety and complexity of competitive actions it enables.
7. Generation of digital capability can be analytically considered in terms of retaining useful variation through dynamic capabilities to sense, seize, and transform.
8. Sensing involve routines for internal R&D/IT development, tapping into external sources for R&D/IT development, exploiting suppliers' and complementors' innovations, and identifying customer-induced change.
9. Seizing involves routines for enacting competitive actions through new business models/products/services, adapting to IT change, and responding to environmental opportunities/threats.
10. Transforming involves routines for altering the architecture of digital assets, organizing logics and structures, ostensive and performative dimensions of routines, and business models.
11. As capabilities depreciate over time, organizations striving to maintain (or increase) their digital capability need to engage continuously in these capability-generating activities.
12. The extent to which they need to do so depends on the rate of depreciation, turbulence in the environment and the extent to which IT is embedded in (or could potentially improve) operations.
13. Organizations can leverage (at least) four evolutionary strategizing approaches: selection of the fittest, internal or external selction, and adaptive evolution.
14. Creating and retaing proper architectural control points is essential in implementing these evolutionary strategizing approaches.

1.5 Structure of the Dissertation

This dissertation consists of this cover manuscript and a collection of five research papers. The rest of the cover manuscript comprises four sections: firstly, the theoretical foundations and previous research are described (Chapters 2 and 3), secondly the research design is detailed and discussed (Chapter 4), thirdly the research papers are presented (Chapter 5), and fourthly the research contribution is discussed and conclusions are drawn (Chapters 6 and 7). More specifically, Chapter 2 presents a literature review of research on IT strategy and outlines the foundations of digital capability while Chapter 3 outlines the coevolution of IT and business strategies. Chapter 4 outlines the research philosophy and summarizes the methodology applied. Chapter 5 summarizes the research papers, findings are then discussed in Chapter 6 and conclusions are presented in Chapter 7. Finally the research papers are presented in full.

2 DIGITAL CAPABILITY FOR IT STRATEGIZING

The aim of this section is to present theoretical foundations for analyzing digital capability. First I present a review of the literature on IT strategy, then discuss implications of a practice-based approach for analyzing strategy, and finally examine strategizing with digital assets from a capability viewpoint.

2.1 IT Strategy

2.1.1 *Trends in IT Strategy Analysis*

A common theme in the literature on IT strategy is that IT is a functional resource with high potential for increasing operational efficiency. Hence, researchers have often sought to provide normative accounts on accounts on alignment of IT with strategy (e.g. Davenport and Short 1990; Hammer 1990; Broadbent 1998). An important element of this research stream was the business process reengineering movement that sought to establish and implement "best practices" through (for instance) ERP systems. Such endeavors often proved to be more problematic than anticipated, partly because practices and institutional logics within (at least) subdomains of organizations are often incongruent with the system logic (Berente 2009). Other literature streams have stressed that technology is often immersed in settings that are more complex and messy than techno-deterministic accounts suggest, accordingly learning processes and path dependencies are essential aspects to consider when examining the impact of IT on performance (Ciborra 2000; Newell et al. 2000). Furthermore, as IT is gaining increasingly impressive abilities, its role in organizational strategy is shifting, and recent research strongly suggests that the relationship between IT and business strategies is increasingly characterized by reciprocal interactions (Bharadwaj et al. 2013).

Although IT is emerging as a strategic driver in contemporary organizations, for several decades the dominant perspective on IT's role in organizational performance was that of a functional resource to be aligned with strategy and core operations (Chan and Reich 2007). Examining cognitive models of IT in organizations, El Sawy (2003) distinguished between three views: the connection, immersion and fusion views. While still prevalent in IS research (e.g. Benbasat and Zmud 2003), the connection view of IT was mainly formed and shaped

between the 1970´s and mid-1990´s. Informed by characteristics of early systems, this view regards IT as a separable tool for assisting and/or automating existing practices. The immersion view presents IT as an integrated, non-separable component of work and inter-organizational relationships (e.g. Alter 2003), providing interwoven connections across boundaries. Thus, processes and practices need to be re-designed accordingly. The vastly improved connectivity enabled by networks during the mid-1990's fundamentally influenced this perspective. The fusion view emerged in the beginning of the 21st century, when IT started merging with material environments and social practices (e.g. Tanriverdi et al. 2010). This view highlights how IT is becoming increasingly intermingled with our personal and professional lives, and so seamlessly integrated that it is impossible to disentangle it meaningfully. These trends show that focal concerns and approaches in both research and practice have shifted, but previous concerns may still be relevant.

Decisions regarding IT systems were long considered the responsibility of technically-oriented IT staff and the emphasis was on building efficient technical systems. Success stories, such as American Airlines SABRE system, showed that IT could provide major competitive advantages and sparked interest in the application of information systems for strategic purposes. As technological capabilities increased and organizations started learning about the benefits, IT strategy became increasingly important for business managers. In a similar vein, IT researchers' area of concern has expanded, starting from the technology itself and gradually moving towards an application-centric focus including sociotechnical aspects. As IT has evolved and become ubiquitous, so has its position in organizations and research perspectives.

Peppard et al. (2014) identify five phases in strategic perspectives on IT over the last half century[2]. These phases are, naturally, heavily influenced by general trends in strategic management over the period. The starting point of the first systematic approach to managing the IT function was in formal planning. For example, early publications on the topic include two books presented in the mid-1970's dealing with strategic planning and what were then referred to as management information systems (Siegel 1975; McLean and Soden 1977). At that time, strategic management theorists focused largely on planning while

2 Peppard et al. (2014) use the term "IS strategy", this difference is semantic and the area of concern is the same as which I refer to as "IT strategy". Throughout this section I adapt their terminology to the one used in this dissertation.

later authors have regarded planning as a minor component of strategic activities (Peppard et al. 2014).

Success stories in the late 1970's illustrated how IT could affect competitive positions and led practitioners and scholars to rethink perspectives on IT (Hopper 1990). IT's ability to impact business strategy sparked interest in formal methodologies for identifying value-creating opportunities and management of IT was no longer seen as solely the concern of IT staff. As computing and networking capacity developed, IT was increasingly considered a viable tool for improving efficiency in diverse contexts. During the 1990's streams of advocacy of radical transformation of existing practices emerged under names such as business process reengineering. These efforts were grounded in mechanistic understanding of organizations and often failed due to lack of consideration of practice.

As the resource-based view (RBV) gained increased recognition in organizational strategy, IT capability was increasingly promoted as a source of sustainable advantage (in the sense of being difficult to imitate rather than stable over a specific time period, cf. Barney 1991).IT capability is a meta-construct for understanding how rather homogenously distributed and available technologies can be competitive forces. A widely adopted definition of such IT capability is the "*ability to mobilize and deploy IT-based resources in combination or copresent with other resources and capabilities"* (Bharadwaj 2000, p. 171). Examples of IT-based resources are the technology itself, human IT resources (such as technical and managerial IT skills) and intangible resources (such as knowledge assets, customer orientation and synergy). Capability-inspired thinking on IT focused on how top-down approaches to planning and organizational design were achieving limited results and highlighted the importance of organizational context and knowledge.

Recently researchers argue that IT and strategy are rooted in dynamic learning activities involving both exploitation and exploration, regarding strategy as a continuous practice-based process that organizations engage in to leverage situated knowledge. Further, coevolution of business and IT is considered a multi-level activity with strategic, operational and individual dimensions (Benbya and McKelvey 2006). Several scholars have very recently advocated a view fusing IT and strategy more comprehensively under the term "digital business strategy" (Bharadwaj et al. 2013; Grover and Kohli 2013).

Table 1. Trends in IT Strategy and Strategizing (Adopted from Peppard et al. 2014)

IT strategy trends	Praxis	Practitioners	Practices	Description
Ad hoc bottom-up approach to determining IT	Ad hoc approach to determining data processing and computing requirements	IT staff	Most emphasis on building systems rather than strategy	Ad hoc, bottom up, primarily driven by technology requirements.
IT planning	Top-down approach to determining IS needs to meet business goals	IT staff	Planning based on an informal network of a few key individuals	Formal top-down planning, IT plans reactive to business plans and aimed at alignment with business goals
Strategic planning for information systems (SPIS)	Team approach, involving multiple stakeholders, practitioner involvement through feedback in assessing IT planning effectiveness	IT strategy promoted as a business management issue: senior management and IT staff.	Focus on themes, IT plans periodically adapted to changing environments, business value accentuated	Proactively seeking opportunities for competitive advantage from IT.
Building IT capability	IT capability embedded in fabric of the organization	All employees have a role to play	Influenced by organizational culture and information orientation of organization	Having a strategy is only part of what is required. Ability to continually identify opportunities, deploy technology, implement change and use information and IT important
IT strategizing	Cognitive and intellectual dimensions. "The most important direct predictor of alignment in this study was a high level of communication between IT and business executives" (Reich and Benbasat, 2000)	All employees	Coevolution of business and IT strategies.	IT strategy something that organizations do rather than have. Integrating IT considerations into the discourse on business and knowledge strategy. Functional strategies having a digital component; fusion of IS and business strategies – the digital strategy.

2.1.2 Digital Business Strategy

Digital technology is increasingly connected and embedded in products, processes and services. Exponential improvements in IT capacity and cost have created dramatic leaps in (for instance) internet provided IT services, information availability, the structure of supply chains and data analysis. These technological advances are important drivers of change in competitive landscapes and business strategy. For example, to exploit the generative and convergent possibilities afforded by digital technology, strategic moves may involve radical adoption of (or radical amendments to) platform structures, distributed innovation and combinatory technological possibilities (Yoo et al. 2012). As IT has evolved from relatively static systems into loosely coupled digital artifacts that can be re-combined in nearly infinite combinations, business strategy has become increasingly affected by digital organizing logics. Such logics include fluid product boundaries, control through interfaces, distributed product control and knowledge, and generativity (i.e. *"a technology's overall capacity to produce unprompted change driven by large, varied, and uncoordinated audiences"* (Zittrain 2006, p. 1980). Bharadwaj et al. (2013) argue that digital trends and organizational shifts result in a fusion of IT and organizational strategy into a new logic affecting increasing numbers of industries. They contend that digital business strategy is different from non-digital business strategy in terms of: (1) scope, (2) scale, (3) the speed of value creation/capture, and (4) sources of value creation. Each of these dimensions is briefly considered below.

Scope. IT affects the scope of organizations, i.e. the products and services (external and internal) generated by activities that it controls (Bharadwaj et al. 2013). It does so through providing connections across boundaries, architectural properties promoting fluid product boundaries and disrupting existing business structures. IT has long transcended functional boundaries by connecting activities performed in separate functional inter- and intra-organizational areas. As digital technologies are evolving from solely purpose-specific tools for internal information processing to integrated parts of products and services, technological properties are further affecting strategy scope (Bharadwaj et al. 2013). IT is adaptable to diverse use contexts and purposes since its architecture is loosely coupled, reprogrammable and standardized (Yoo et al. 2010). These properties imply that use contexts and purposes of digital artefacts are often fluid and that designs at different layers in the architecture can be recombined in unforeseen ways (Svahn 2012; Nylén et al. 2014). In other words, loose coupling, reprogrammabaility and data homogenization are essential features of the generativity of digital

technology. As IT disrupts business structures, technology becomes such an integrated part of some organizations' service provision that they start offering IT services or engage in IT infrastructure adaptations. Salient examples include Amazon's cloud computing services, Netflix hosting their servers at Internet service providers' sites to reduce traffic, and Google developing hardware solutions. Examples at the more application-oriented end of the spectrum include universities offering web-based courses and so-called MOOCs (Massive Open Online Courses), thereby expanding their services both in terms of what they provide and their customer base. It is no longer certain that a university degree will involve students ever setting foot on a campus, fundamentally challenging previous understanding of the scope of academic organizations.

Scale. Bharadwaj et al. (2013) argue that digital business is distinct in scale in at least four ways: dynamic scaling, network effects, information abundance, and scaling based on alliances and partnerships. First, they suggest that cloud services allow organizations new possibilities for rapidly scaling infrastructure. Improvements in capacity, functionality and modularity of cloud computing services under labels such as "Platform as a service" enable translation into strategic actions. Second, positive network effects, i.e. value generation from increases in numbers of users, is often apparent in IT use. These effects can be either one-sided (related to similar users, such as for social media) or two-sided (related to distinct user groups, such as application developers and consumers in Apple's ecosystem) (Eisenmann et al. 2006). These logics are not exclusive to IT, but as digital technology diffuses and is integrated into new products they are reinforced. Third, as ubiquitous IT generates explosive growth in data, information is increasingly abundant. Sensors, in devices such as phones and glasses, trends toward the "quantified self" and "internet of things", and information production in social media provide ample opportunities for scaling strategic activities. Fourth, the increasing ease of sharing and connecting digital assets is simplifying the formation and disintegration of alliances and partnerships. Accordingly, organizations can leverage platform-like structures with a set of stable modules that compose the organizational core and a set of organizational modules that are allowed to vary.

Speed. Digital business strategies and pervasive connectivity can also boost the rapidity of organizations' execution in four dimensions according to Bharadwaj et al. (2013): product launches, decision-making, supply chain orchestration, and network formation and adaptation. First, digitalization affects product launches both by facilitating distribution

(e.g. enabling the direct distribution of electronic books and improving supply chain management etc.) and through the rapid improvements of functionality in hardware and software (e.g. phones). As control over R&D processes and launches of products associated with each other seldom lie within one organization, digital dynamics create a need for tight coordination. Second, advances and pervasiveness of IT affect the speed of decision-making by providing extensive connectivity and fast access to information on internal operations, and by providing new means of communication with the organization and among customers (e.g. Facebook). Hence IT enables access to real-time information and dialogue, but also imposes demands in terms of responding swiftly and transparently. Third, advances in IT systems for orchestrating supply chains enable rapid realignment of sourcing. Rapid innovations in design and functionality need to be accompanied by the ability to deliver such products before competitors. Further, as pointed out by Tanriverdi et al. (2010), organizations providing rapidly developing products need to disintegrate and reconfigure existing structures to adapt to technical developments external to the supply chain. Fourth, as illustrated by dynamics in digital ecosystems in the mobile phone industry, networks of complementors are rapidly formed and reconfigured. The adaptability of such networks implies that competition over participating actors in ecosystems directly links architectural and governance to competitive positions.

Sources of value creation and capture. Digitalization of business strategy also affects how value is created and seized in at least four ways (Bharadwaj 2013): appropriation of value from information, multisided business models, codependencies in ecosystems, and appropriation of value from architectural control. First, for some organizations the appropriation of value from information changes as actual products become digitized (e.g. newspapers) while for others information on, for instance, customers (or visibility to them) becomes essential. Accordingly, companies such as Google and Facebook can broker access to such information. Second, as digitalization of physical artefacts creates abundant information it enables multisided and multilayered business models, which have consequently flourished in the digital domain. Examples include Google's mobile phones and acquisition of the home automation company Nest. Third, business models in digital ecosystems such as those within the mobile phone industry are nested and dependent. As such ecosystems expand into new domains, coordination of changes that ripple through them is increasingly challenging. Fourth, as digital architecture is increasingly implicated in value creation control

points in this architecture become even more important in value appropriation. Examples include Apple's ability to appropriate rent from content distribution and Microsoft's monopolistic architectural control, for which the European Commission fined the company[3].

Table 2. Implications of Digital Business Strategy (Compiled from Bharadwaj 2013)

Strategy Aspect	Change Introduced
Scope	• Functional boundaries diminished • Fluid product boundaries • Disrupted business structures
Scale	• Dynamic IT scaling enables adaptivity • Platform structures enable network effects and multisided markets • Information abundance, "big data" and the "internet of things" • Scaling through collaborations
Speed	• Product launches • Decision-making • Supply chain orchestration • Network formation and adaptation
Sources of value creation and capture	• Increased value from information • Value creation from multisided business models • Value capture through coordinated business models in networks • Value appropriation through control of digital industry architecture

2.2 Strategy-as-Practice

Practice-based approaches to strategy build on recognition of both emergent and deliberate processes in strategy generation as identified by Mintzberg (1978). A practice-oriented perspective on strategy focuses on how organizations and their strategy emerge and remain through ongoing actions (Weick 1969). Examinations grounded in a practice perspective are often preoccupied with issues such as who is a strategist and *"what they do, how they do it, what they use, and what implication this has for shaping strategy"* (Jarzabkowski and Spee 2009). In this perspective, strategy is considered something organizations do as opposed to have. In particular, strategy is characterized as enacted by the actions that

[3] Microsoft Corp. v Commission of the European Communities, Case number: T-201/04

organizational actors continuously perform. As such, the practice perspective takes a dynamic stance on strategy and considers it a process constantly in the making rather than purely a static plan. To emphasize the enactment of strategy, some scholars refer to it as *strategizing* which Gallers (2011, p. 337) describes as:

> *"the process of strategizing is one of visioning, planning, taking action, and assessing outcomes, all with an eye to changing circumstance and imperatives, and the actions of individuals and groups outside of, or irrespective of, any formal strategy process"*

The notion of practice describes ways of doing things – ways of cooking, communicating or working. Reckwitz (2002, p. 249) defines practices as:

> *"routinized types of behavior which consist of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, 'things' and their use, a background knowledge in the form of understanding, know-how, states of emotions and motivational knowledge"*

Despite being enacted by persons, practice is not confined to individuals. Routinized ways of acting provide frames, but actors can perform them multiple ways. Hence, an observer sharing the practices of a certain culture understands associated actions, descriptions or mental models (Schatzki 1996; Reckwitz 2002).The schematic aspect of practice resides within actors while its enactment depends on how these actors translate it into specific actions. As identified by Feldman and Pentland (2003), the relationship between schematic aspects and the enactment of practice create recurrent opportunities for variation, selection and retention. This relationship implies that practices might not only generate stability but also substantial change. On a similar note, Jarzabkowsi (2004, p. 543) contends that *"there is an ongoing and developmental tension between recursive and adaptive behaviours"*. Further, an essential aspect of a practice perspective is that it broadens the view of who is a strategist, compared to the traditional perspective of strategy as a top-down process. The point is not to abandon examinations of top and middle managers, but rather to acknowledge that actions performed by others (e.g. operational staff, consultants and customers) impact strategy (Whittington 2006).

Examining practice-based research approaches, Feldman and Orlikowski (2011) distinguish between focusing on empirical, theoretical and philosophical issues. Empirical approaches examine the role of human actions at different levels in organizations and consider the significance of agency. Such research often provides insights into the

role of agency in a specific domain by examining *what* happened in a specific context. These studies do not necessarily explicitly connect to practice theory or philosophy. Theoretical approaches instead articulate frameworks based on practice theory and examine *how* dynamics in activity are generated, and operate across contexts and over time. Philosophical approaches address *why* a practice-based approach is useful in examining its relation to ontological concerns. As most research on strategy-as-practice incorporates an explicit practice-based framework, without focusing in detail on ontological implications, it is grounded in a theoretical approach.

While deeply interrelated with trends in organizational science in general, Johnson et al. (2003) suggest that two economic drivers have accentuated the importance of a practice perspective on strategy during the last decade: increases in the efficiency of resource markets (deregulation and rises in labor mobility and information availability) and "hypercompetition". Resource transparency highlights the "inimitable" and "non-substitutable" aspects of competitive impact. Hypercompetition refers to rapid and dynamic competition characterized by unsustainable advantage (D'aveni 1994), decentralization of decision-making in rapidly moving industries (Zenger and Hesterly 1997), reductions in lengths of planning cycles and reinforcement of strategizing as a continuous process. It should however be noted that this perspective can be criticized for having too rosy a view of deregulation, as it permits (or even encourages) the emergence of monopolies and anti-competitive practices.

The strategy as practice perspective emerged from a disconcern with the economics influenced conceptualizations of strategy as planning performed by fully rational managers as it did not adequately explain organizational conventions (Mintzberg 1994; Johnson et al. 2003). Scholars have argued that neglecting agency and black boxing of contextual aspects reduces both the accuracy and relevance of much strategic thinking (Johnson et al. 2003; Jarzabkowski and Spee 2009). A salient example is the emphasis by the resource-based view (RBV) that resources providing advantages should be valuable, rare, inimitable and non-substitutable (Barney 1991). However, resources cannot create value until they are activated in contextual actions. Resources have also been suggested to be mutable in the sense that they are reciprocally related to action rather than being static (Feldman 2004). That is, resources shape and are shaped by actions. The strategy-as-practice perspective emerged from the failure of conceptualizations (inspired by mainstream economic theory) of strategy as planning performed by fully rational managers to

explain organizational conventions (Mintzberg 1994; Johnson et al. 2003).

A recent literature review of the strategy-as-practice field by Jarzabkowski and Spee (2009) identifies performance outcomes and links between levels of analysis as essential aspects of practice-based theorization. To obtain relevant insights, scholars adopting a strategy-as-practice approach should therefore aim to link findings from rich descriptions with theoretical implications for macro or meso levels of analysis (Jarzabkowski and Spee 2009). Further, the overall area of concern for strategic management analysts is organizational performance. In order to address such a discourse and inform both practice and research, the rich insights need to be translated. An important consideration in applying a micro perspective on strategy is the link with macro-oriented phenomena, as localized actions shape and are shaped by context (Carter et al. 2008; Feldman and Orlikowski 2011). While descriptions of strategy-as-practice connote micro-level examinations, Jarzabkowkis and Spee (2009) found that most studies examining strategy from a practice perspective focus on meso-level (i.e. organizational or sub-organizational) actions performed by aggregate actors (i.e. groups such as engineers or middle level managers).

The reciprocal relationship between structure and agency lies at the heart of the practice perspective. Jarzabkowkis (2003) argues, for example, that strategy emerges out of four interactive components: the collective structures of the organization, the primary actors, the practical activities in which they interact and the strategic practices through which they interact. In a similar vein, Regnér (2008) describes how organizational performance is built on assets resulting from activities involved in configurations of structure and agents. This conceptualization is depicted in figure 1.

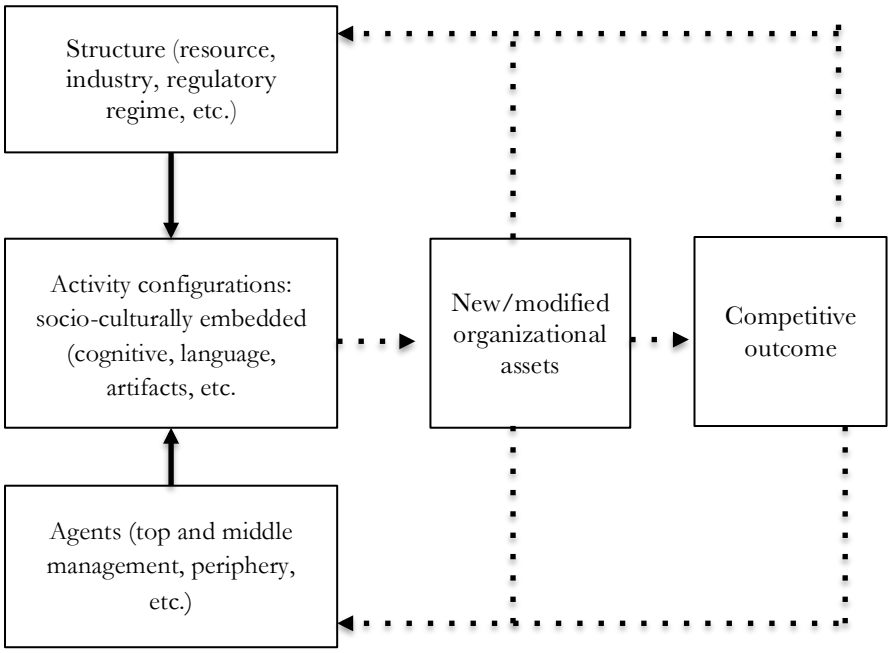

Figure 1. Practice Determinants of Competitive Outcomes (adapted from Regnèr 2008)

Management research increasingly highlights the role of the material in organizational practice (Gherardi 2009; Corradi et al. 2010), whereas IS scholars are paying closer attention to how organizational practices are entangled with technology (Orlikowski and Scott 2008; Cecez-Kecmanovic et al. 2010; Leonardi 2011). Given the increasing use of practice-based approaches and acknowledgement of the importance of sociomateriality in these fields (Leonardi and Barley 2010; Vaara and Whittington 2012; Carlile et al. 2013), this interest in microfoundations of organizational activities is likely to persist.

The strategy-as-practice approach has potential for strengthening the relevance of organizational research by illuminating ways in which actors, objects and understandings are entangled in multifaceted bundles of practices (Orlikowski 2007; Jarzabkowski and Spee 2009; Leonardi 2011; Jarzabkowski and Pinch 2013). The integration of actors and technology within emergent practice poses significant challenges in IS research, which has often led to over-emphasis on social components over technical components or vice versa (for a debate on this issue, see King and Lyytinen 2006). For example, Orlikowski and Scott (2008) criticize the analytical separation of technology, work and organizations arguing

that there is an *"inherent inseparability between the technical and the social"* (p. 443). A practice perspective addresses these concerns by considering the enactment of situated structures.

In the IS field, the practice perspective has extended technodeterministic understandings by providing insights into the emergent shaping of sociotechnical structures (Markus and Robey 1988; Orlikowski and Robey 1991; Orlikowski 2000). In particular, it has illuminated why IT-driven organizational change that does not adequately consider the context is likely to fail as the technology is implemented into messy configurations of practices (Orlikowski 1992; Stolterman 1992; Henfridsson 1999; Ciborra 2000; Holmström 2000; Wiberg 2005). The practice perspective is aligned with a long tradition of IS research emphasizing the role of users in shaping structures (e.g. Langefors 1966; Ehn 1988; Lamb and Kling 2003). The emergent character of IT-organization interaction, and the associated influence of decentralized actions on strategy, have been examined in diverse industries, such as maritime shipping (Rolland and Monteiro 2002), process automation (Holmström et al. 2010; Sandberg et al. 2010), and health care (Aanestad and Blegind Jensen 2011; Wimelius 2011). A common theme across these contexts is how the value of IT in practice is constructed through interactions between macro and micro level actions.

IT is typically implemented to improve organizational performance (Sambamurthy et al. 2003; Kohli and Grover 2008). To have such an impact, practices have to be changed (Melville et al. 2004; Galliers 2011). When IT is increasingly related to strategic outcomes, understanding the adaptations and reciprocal relationship between IT and practices across levels ranging from local to organization-wide is a growing concern (Bharadwaj et al. 2013). Gaining abilities for such IT-based strategizing is itself a continuous process, as pointed out by Orlikowski (2002, p. 249):

> *"knowing is not a static embedded capability or stable disposition of actors, but rather an ongoing social accomplishment, constituted and reconstituted as actors engage the world in practice."*

2.3 A Capability Informed Taxonomy

This dissertation is based on the premise that sustainable organizational performance is directly linked to continuous adaptation, innovation, and transformation of resources, routines and competencies according to the competitive landscape (Nelson and Winter 1982; Teece et al. 1997; Augier and Teece 2009; D'Aveni et al. 2010). In this section I review the

literature on organizational capabilities and outline the taxonomy adopted throughout this dissertation.

Organizational capabilities are often discussed in conjunction with creation, adaptation and deployment of resources. Briefly, the RBV assumes that organizations possess various resources (physical assets and intangible competencies), that these resources are heterogeneously distributed and that imperfect mobility of these resources creates sustained competitive advantage (e.g. Penrose 1959; Barney 1991; Conner and Prahalad 1996). The theoretical foundations of organizational capabilities have been suggested to be tautological, impose causality retrospectively, fail to acknowledge the depreciation of resource value and have limited applicability in terms of prescriptive implications (e.g. Priem and Butler 2001). A core argument in this criticism is that the high level of abstraction effectively inhibits any practical examination. In responding to such criticism articulating an operational capability-informed conceptual grounding of organizational change, Winter (2000, p. 983) defines an organizational capability as:

> *"a high-level routine (or collection of routines) that, together with its implementing input flows, confers upon an organization's management a set of decision options for producing significant outputs of a particular type".*

In this perspective, the notion of routine is taken as a starting point, as routines can have diverse scales and significance while capabilities are consistently substantial, thus it provides flexibility in level of analysis. In Winter's conceptualization, capabilities can be clarified by outlining how they differ from routines. For example, in this view routines have variable visibility while capabilities are known to some degree, as reflected in the "set of decision options" component of their definition.

Organizational routines have been discussed in the literature at least since the 1940's (Stene 1940) and have often been subsequently used to explain how organizations do what they do. A regularly used definition of routines is "*repetitive, recognizable patterns of interdependent actions, carried out by multiple actors"* (Feldman and Pentland 2003, p. 95). The role of routines in organizational change has been examined thoroughly in the academic literature. For example, Nelson and Winter (1982) base their understanding of operations and interaction in their evolutionary theory of economic change on a conceptualization of routines as the "genes" of organizations. They argue that organizational memory is built on routines and since knowledge in these routines resides with individuals it is codified through actions, hence organizations remember by doing. Feldman and Pentland (2003) extend previous understanding of routines

as sources of efficiency and inertia, arguing that routines can be "loci" of flexibility and change. This argument is based on an understanding of routines as having ostensive (structure, idea, schematic) and performative (action and enactment) aspects, and that this relationship creates constant opportunities for selection, variation and retention of practices.

Examining organizational change at the capability level, scholars have used the notion of dynamic capability to explain the role of routines in modifications of organizations' resource bases (Teece et al. 1997; Eisenhardt and Martin 2000).Eisenhardt and Martin (2000, p. 1107) define dynamic capabilities as:

> *"The firm's processes that use resources–specifically the processes to integrate, reconfigure, gain and release resources–to match and even create market change. Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die"*

In discussing dynamic capabilities scholars have often emphasized that their purpose is to evolve current practices and operational capabilities (Helfat and Winter 2011) Outlining a capability hierarchy, Winter (2003, p. 992) suggests a "zero-level", corresponding to operational capability (Helfat and Winter 2011), as being the "how we earn a living now capabilities". Acknowledging that requirements for patterned activity impose doubts about whether or not higher order capabilities "exist", Winter proposes that there are multiple levels of change capabilities. For example, in this view the capability to substantially innovate core processes is of a higher order than the capability enacted when McDonalds opens a new outlet. However, both result in changes at the operational level. Conceptualizing capabilities as hierarchical also brings the issue of value from investments into play. As Collis (1994) points out, the existence of higher-order capabilities also implies that organizations must consider the level(s) at which they need to develop capability. Such investment decisions are closely related to the organizational environment and its dynamism. If, for example, exogenous changes rapidly erode competencies at a low level of dynamic capability it might be advantageous to develop higher order capability (Winter 2003).

Teece (2007) introduces a more granular understanding of dynamic capabilities, focused on an organization's capabilities to sense, seize and transform according to market opportunities and threats. These disaggregated dynamic capabilities are based on specific "microfoundations", i.e. "distinct skills, processes, procedures,

organizational structures, decision rules, and disciplines". Sensing capabilities can be understood as "Analytical systems (and individual capacities) to learn and to sense, filter, shape, and calibrate opportunities" (Teece 2007, p. 1342). In this conceptualization these capabilities are related to an organization's ability to direct internal R&D, select technologies, tap suppliers' and complementors' innovations, exploit exogenous technology developments and identify market changes and opportunities. Seizing capabilities are described as "Enterprise structures, procedures, designs and incentives for seizing opportunities" (Teece 2007, p. 1342) and implemented by delineating business models, formulating decision-making protocols, managing complements and platforms, and building loyalty and commitment. Transformative capabilities refer to "Continuous alignment and realignment of specific tangible and intangible assets", based on governance, knowledge management, decentralization and co-specialization (Teece 2007, p. 1342).

The role of planning in dynamic capabilities is highlighted in a recent conceptualization of improvisational capability, defined as "the ability to spontaneously reconfigure existing resources to build new operational capabilities to address urgent, unpredictable, and novel environmental situations" (Pavlou and El Sawy 2010, p. 444). In this conceptualization, improvisational capabilities differ from dynamic capabilities in terms of planning, stability and systematicness. Leveraging dynamic capabilities is considered particularly appropriate in environments with relatively predictable wave-like types of disturbance, while improvisational capabilities are needed for adaptation to highly turbulent storms, according to the analogies presented by Holsapple and Jin ((2007). This distinction relies on Winter's (2003) argument that ad-hoc problem solving and change through activation of dynamic capabilities are distinct. However, it should be noted that he also regards routine and patterns as essential elements of an organizational capability and notes that "brilliant improvisation is not a routine" (2003, p.991). As such, it seems unclear whether or not "improvisational capabilities" qualify as distinct organizational capabilities. An alternative conceptualization is that an organization's ability to spontaneously reconfigure is related to high order sensing, seizing and transforming capabilities.

Capabilities are not static, but like assets and competencies depreciate. Helfat and Peteraf (2003) (p. 1000) identify several stages in organizational capabilities: the founding stage in anew organization; the development stage, during which the capability is gradually built; and the maturity stage, followed by retirement (death), retrenchment, replication,

or increases in the capability through renewal, redeployment or recombination. Accordingly, organizations striving to maintain capabilities need to generate capability continuously. Table 3 summarizes the taxonomy outlined in this section.

Table 3. Definition of Key Capability-related Constructs

Construct	Definition
Organizational capability	"a high-level routine (or collection of routines) that together with its implementing input flows, confers upon an organization's management a set of decision options for producing significant outputs of a particular type" (Winter 2000, p. 983)
Routine	"repetitive, recognizable patterns of interdependent actions, carried out by multiple actors" (Feldman and Pentland 2003, p. 95)
Operational Capability	"`how we earn a living now´ capabilities" (Winter 2003, p.992; Helfat and Winter 2011)
Dynamic Capability	"The firm's processes that use resources–specifically the processes to integrate, reconfigure, gain and release resources–to match and even create market change. Dynamic capabilities thus are the organizational and strategic routines by which firms achieve new resource configurations as markets emerge, collide, split, evolve, and die" (Eisenhardt and Martin 2000, p. 1107)

2.4 Strategizing with Digital Assets

In line with practice theory, a common theme in the IS literature is that while technology creates value and is often essential for contemporary organizations the possession of IT does not in itself create competitive outcomes (Kohli and Grover 2008). Technological development, process innovation and new forms of organizing have turned IT investments into something akin to "hygiene factors" — necessities for survival (Peppard and Ward, 2004; Bhatt and Grover, 2005). Recent progress in strategic thinking on the role of IT in organizational performance suggests that we need to re-conceptualize the relationship between IT and organizational capabilities (Sambamurthy et al. 2003; Peppard and Ward 2004; Bharadwaj et al. 2013; Woodard et al. 2013). The notion of IT capability provides a relevant framing of the role of IT in organizational performance from a perspective of IT as a functional resource necessitating alignment with organizational strategy (Bharadwaj 2000; Wade and Hulland 2004). The literature on IT capability often considers the impact of IT on organizational performance as contingent

on matches with the competitive landscape (e.g. Stoel and Waleed 2009) and incorporate the impact of IT on business value through constructs such as "Business IT strategic thinking" and subcategories thereof such as "Clarity of vision regarding how IT contributes to business value" (Bharadwaj et al. 1999; Chen et al. 2013). In this perspective IT is considered an important resource that can be utilized for functional purposes mainly in terms of exploitation in operational capabilities.

As discussed in previous sections, the fusion of IT and organizational practice has been suggested to spawn mechanisms promoting a digital business strategy perspective. In a similar vein, Galliers (2007, p. 238) considers IS and organizational strategy mutually constitutive:

> *"The next stage of strategy evolution will involve a shift in thinking from business strategy and knowledge strategy, to Information Systems strategizing. By integrating Information systems consideration into the discourse on business and knowledge strategy, the resultant thinking will become mutually constituted and* ***significantly*** *more robust."*

The need for organizations in many industries to rethink the role of IT and accordingly develop digital business strategies, as suggested by Bharadwaj et al. (2013), accentuates the issue of *how* they implement such strategies. In examining such processes, considering strategy from a practice perspective has a number of important benefits, as suggested by Regnér (2008). First, it acknowledges that assets are generated through formation processes rather than planning. Second, it allows inclusion of diverse actors. Third, it includes diverse contextual aspects. Fourth, it includes interpretive flexibility in the relative importance of structure and agency. Fifth, it allows examination of the "micro-mechanisms" of strategizing, and inclusion of creativity.

Extending mainstream literature on capabilities and IT, Drnevich and Croson (2013) argue that strategic thinking on IT has largely neglected the role of IT in organizational-level strategy. They argue that "digitally attributable capabilities" both enhance operational capabilities and enable dynamic capabilities. To extend the analytical utility of the IT capability notion these research streams, taken together, suggest a need to examine "digital business strategizing", i.e. how organizations "do" strategy from a holistic perspective (Peppard et al. 2014). Considering organizational capabilities as high level routines (Winter 2000), for the purposes of this dissertation I define an organization's digital capability as *a collection of routines for strategizing by leveraging digital assets to create differential value*. Digital assets here refer to the available IT resources, knowledge of IT design, and competences for implementing IT

effectively. This perspective on capabilities incorporates the fusion of IT with organizational strategy and the "strategy-as-practice" approach.

Organizational capabilities are not constant, they evolve over time and if not upheld they vanish (Helfat and Peteraf 2003). As illustrated in Figure 2, capability levels have an inherent tendency to depreciate over time, but they may also appreciate or depreciate due to exogenous events and endogenously induced investments[4]. Exogenous events include technological innovations and changes in the competitive landscape. Endogenous events include investments in the digital capital stock and increases in competency through learning or competitive actions.

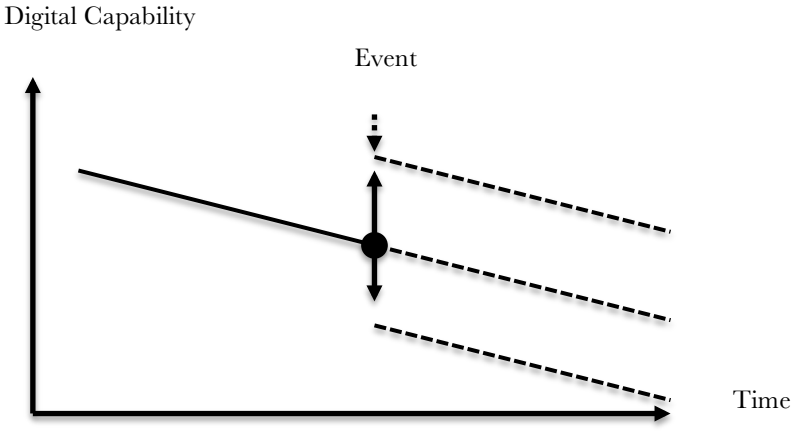

Figure 2. The Evolutionary Trajectory of Organizational Digital Capability

Consider an organization in a competitive landscape characterized by a non-trivial level of IT use. If they make no investments in either IT assets or competencies, their ability to develop and pursue competitive actions typically decreases over a five-year period and almost definitively over a ten-year period. Exogenous events can cause an organization's digital capability to change in the short term. A typical example of a technologically-induced decrease would be the introduction of new operating systems or standards. If the organization does not upgrade existing assets, such an event will cause depreciation of digital capability due to technical incompatibility and adverse effects on competencies. An

[4] In a broader sense than merely including acquisition, organizations can, for example, maintain or extend capabilities by devoting resources to competency development.

example of an event causing digital capability to rise is Apple's decision to incorporate a fingerprint reader in its scanners, which created new strategic options for the scanners' suppliers, sparking jumps in their capability[5]. In the long run, however, digital capability generally decreases over time if not upheld. Accordingly, organizations striving to extend or maintain their digital capability need to engage in capability generating processes. The following section outlines the conceptual grounding for my investigation into how organizations can do this.

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5 These events were probably offset when hackers later demonstrated a successful method for faking fingerprints.

3 COEVOLUTION OF IT AND BUSINESS STRATEGIES

This section first introduces the perspective on organizational performance adopted in this dissertation, then briefly outlines a framework for analyzing the coevolution of IT and business strategies, and finally examines capability-generating routines. Figure 3 outlines the analytical framing expounded in this section on digital capability's impact on competitive actions and organizational performance[6].

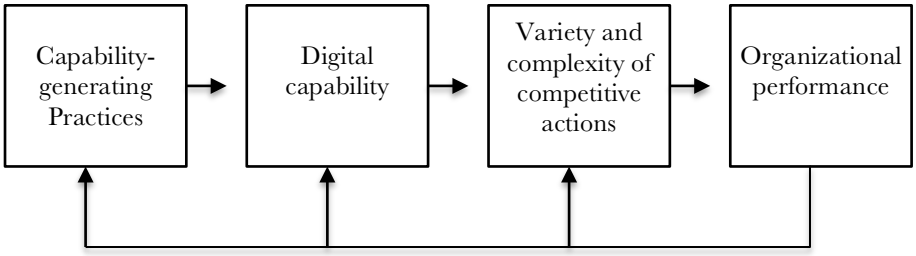

Figure 3. Digital Capability and Organizational Performance

3.1 Organizational Performance through Coevolution

Extensive research has shown that IT impacts organizational performance, but the details of how this relationship plays out remain a key area of concern for IS researchers (Brynjolfsson and Hitt 1998; Drnevich and Croson 2013). An important reason why impacts have been difficult to isolate is that results of investments are heavily dependent on implementation and alignment of technology and practice (Orlikowski 1992). However, scholars have also argued that there is a fundamental theoretical disconnect between levels at which IT changes influence operational performance and are measured (Ray et al. 2004; Drnevich and Croson 2013).

In this section I briefly review perspectives on the objective of strategizing processes (improvement of organizational performance) by first describing viewpoints on the complex and adaptive landscapes in which organizations compete then presenting a framework for such analysis in terms of portfolios of competitive actions as strategic options.

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6 These relationships are theorized from an emergent perspective regarding consequences of IT as unpredictable and dependent on social interactions (Markus and Robey 1988).

Overall, these sections advocate the need for *evolvability* and present a sensitizing framework for strategizing.

3.2 Perspectives on Competitive Advantage

> *"Capitalism [...] is by nature a form or method of economic change and not only never is but never can be stationary" (Schumpeter 1942, p. 82)*

Sustained superior performance is very rare in contemporary competitive landscapes. A study covering 40 U.S. industries shows that few firms can sustain positions that generate superior profitability, and those few maintain it for five to seven years, on average, depending on the industry (Wiggins and Ruefli 2005). Based on the work of Karl Marx (2004), the Austrian economist (Schumpeter 1942) suggested that existing competitive positions erode through creative destruction processes, i.e. entrepreneurs or external shocks disturb existing equilibria through innovations. Later, Kirzner (1973) questioned the assumption of market equilibrium and proposed that entrepreneurial actions instead remedy imbalances and create temporary equilibria. However, regardless of whether innovation is viewed as a disruptive or equilibrating activity, competitive advantage is increasingly considered temporary in the strategic management literature (D'Aveni et al. 2010).

In recent decades strategic thinking on organizational performance has been dominated by three contrasting perspectives on sources of value creation (Woodard et al. 2013): the logics of positioning (e.g. Porter 1980), leverage (e.g. Barney 1991) and opportunism (e.g. Schumpeter 1934; Shane and Venkataraman 2000). The logic of positioning emphasizes the type of competitive forces in the industry, strategic positions in terms of price and differentiation, and the need to align configurations of value chains with chosen positions for successful implementation (Porter 1980; Porter and May 2001). In contrast, the logic of leverage highlights the need for organizations to generate and control heterogeneous resources that are not perfectly mobile, and develop capabilities to apply these resources in ways that yield competitive advantages (Barney 1991; Amit and Schoemaker 1993; Makadok 2001).

While these lenses separately provide important insights into organizational performance, their limitations also impose restrictions, as Burke (1984, p. 49) points out "a way of seeing is also a way of not seeing – a focus upon object A involves a neglect of B". By emphasizing industrial positions and picturing market structures as exogenous and

given, the process of establishing unique configurations resulting in organizational performance is neglected. By positioning availability of resources as the locus of organizational performance, acquirement of "sticky" resources and dynamic processes are overlooked. Similarly, by stressing the ability to seize opportunities, the importance of strategic positions is underemphasized. Accordingly, scholars have underlined the need for organizations to develop dynamic capability to constantly co-evolve and re-position according to nascent opportunities, which results in constantly changing competitive positions (Teece et al. 1997; Tanriverdi et al. 2010).

Drawing on biological evolutionary theory, strategy scholars have suggested that strategic positions can be modeled as fitness landscapes (Kauffman 1993; Beinhocker 1999). Such fitness landscapes are represented as three-dimensional maps with peaks and valleys of fitness. In biology, the topography represents combinations of genes or traits that influence organisms' survival and reproduction, whereas organizational scientists visualize strategic positions as peaks and valleys. In terms of representations of competition in these landscapes, industry variations imply topographical dissimilarities. Some competitive environments may have a single "mountain" in a relatively flat landscape (like Mount Fuji), but most are rugged and have multiple peaks and valleys (similar to the Alps)- However, the height of a certain position is not constant, either in biological or competitive landscapes. As the environment changes, so does the level of fitness for a certain combination of traits (Kauffman 1993).

Several scholars have proposed that as organizing logics, products and services become increasingly interconnected and advanced, correspondingly complex and adaptive competitive landscapes emerge (Beinhocker 1999; Camillus 2008; Tanriverdi et al. 2010). Examples of complex systems include galaxies, ecosystems, brains and cities. In contrast to complicated problems„complex problems do not have optimal solutions, as components of the focal system adapt, morph and interact according to actions. Solutions to an isolated sub-problem in such complex situations yield different results when interacting in the composite system. In such competitive landscapes, path dependency implies that organizations making the same strategic selections may achieve different results, due to differences not only in positions and available resources but also in connections with partners in their value-creating system. Furthermore, the competitive landscapes are adaptive in the sense that they change rapidly according to the continuous flux of actions taken by among other competitors, regulators and customers.

These characteristics increase rates of evolution and the erosion of previously profitable peaks in the competitive landscape (Nelson and Winter 1982).

Organizational strategizing involves predicting the future for making decisions. In complex and adaptive competitive landscapes such predictions are highly uncertain in terms of both accuracy and longevity. Accordingly, decision-makers need to continually reconsider their previous choices. The most important trait for prolonged survival in these competitive landscapes does not seem to be holding the highest temporary point, but an organization's ability to continuously "mix short and long jumps" from one position in the landscape to another (Beinhocker 1999). As competitive landscapes evolve, the profitability of certain positions shifts and organizations need to find ways to co-evolve by transforming the kinds of value they offer and how they do so (El Sawy et al. 2010; Tanriverdi et al. 2010). The ability to move between positions is path-dependent in terms of restrictions and affordances provided by previous resource investments. Adaptable configurations of previous investments are generally more valuable than non-adaptable investments, especially in highly uncertain contexts since the environment normally changes more rapidly than organizations (Bowman and Hurry 1993; Luehrman 1998; McKelvey 1999). In order to co-evolve with gradual erosion and seismic external shocks in the competitive landscape scholars have suggested that decision-makers need to create a large portfolio of options in terms of possible competitive actions (Kogut and Kulatilaka 1994; Sambamurthy et al. 2003), and abilities to reconfigure and gain new capabilities (Teece et al. 1997; Helfat et al. 2007).

3.2.1 Competitive Actions as Strategic Options

Organizational resources and capabilities do not in themselves affect performance, actions do (Sirmon et al. 2007). The number and complexity of competitive actions enabled by an organization's resources and capabilities have been shown to fundamentally affect organizational performance (Ferrier and Smith 1999; Ndofor et al. 2011; Chen and Miller 2014). Competitive actions are detectable moves challenging the status quo, initiated to affect strategic positions through innovations in products, services or processes (Smith et al. 1991; Sambamurthy et al. 2003). However, since competitive actions are enabled by organizations' existing resources and capabilities, decision-makers need to engage in investment decisions in advance to launch specific competitive actions. Given the substantial impact of competitive actions' range and

complexity on organizational performance, the eroding nature of competitive positions in many industries, and time lags in capability building, organizations need to engage in proactive strategizing.

In uncertain situations decision-makers often strive to postpone resolution, to wait and see until more information is available and uncertainty has decreased. In these situations, new information can be gathered or events may occur that substantially impact the desirability of different paths. The attraction of "keeping options open" reflects the desirability of limiting risks by maintaining the option to abandon a certain course of action for a more preferable course. For more than a century scholars have discussed the monetary value of holding options (Bachelier 1900) and during the last four decades examined how option theory can inform strategic thinking (Myers 1977).

The notion of real options draws on financial options, i.e. contracts acquired by making a small initial investment that provide the holder with a preferential advantage to exploit a specific investment opportunity. Financial options provide the holder with the right, without obligation, to make a specific investment at a future point in time (Black and Scholes 1973). Strategic management scholars have construed that real options reflect organizational decision-making as an incremental and path-dependent processes marked by uncertainty (Bowman and Hurry 1993). A strategic option exists when an organization has preferential access to certain competitive actions through its existing stock of resources and organizational ability. The real options lens has been suggested to integrate the logics of positioning and leverage by subjecting analysis of capability valuation to market mechanisms (Kogut and Kulatilaka 2001, p.745). Furthermore, analyzing strategic decisions through the option lens provides ample opportunity to incorporate the value of limiting downside risks associated with sequential decision-making (McGrath 1999).

Organizations are immersed in emergent change processes where the end state of both levels of capabilities and their functional fit in the competitive landscape are uncertain. Similarly to technical design processes, both the ability to perform functions in the future and the value of these abilities are unknown (Baldwin and Clark. 2006). Organizational capabilities have been suggested to constitute platforms for competitive actions and have properties similar to options, i.e. carry rights but not the obligation to engage in future opportunities (Luehrman 1998; Kogut and Kulatilaka 2001). In conformity with financial options, the initial investment provides an organization with preferential access to certain actions while the downside risk is limited

since the holder has not committed to pursuing the specific investment. Since the holder of such an option can choose to commit at a future stage, uncertainty increases its value. For example, an option on a highly volatile share is worth more than one on government bonds, since the price of the stock is likely to increase more and the holder can choose not to invest if the value decreases. Similarly, the value of strategic options increases with uncertainty when the range of plausible competitive actions that organizations might wish to take is greater than in more static contexts. In essence, real options theorists strive to include the value of flexibility in analyses of strategic decision-making, as described by Kogut and Kutilaka (2001, p. 746):

> *"…an important feature of any framework is a process of discovery and experimentation. It is this process that the heuristic of real options attempts to impose and evaluate. If strategy is seen as the choice of capabilities that provide the appropriate flexibility for a stochastically changing landscape, then it is critical to try to infer the value of design and investment that provides the flexibility to respond to opportunities. An organization cannot, however, expend all of its resources on search, nor can it simply ignore the importance of change and evolution. A real option heuristic is a way to discern the value of particular paths of exploration in evolving environments."*

Real options are characterized by uncertainty, the possibility for organizational decision-makers to exercise preferential advantage at a future point in time, and irreversibility (Kogut and Kulatilaka 2001). Uncertainty is what provides option value; in situations where there is no uncertainty decision-makers have access to all the relevant information for evaluating competitive actions and hence do not gain anything from postponing decisions. Discretion about whether to execute a future competitive action is the characteristic that limits downside risk associated with acquiring a specific option. Without the possibility to decline further commitment of resources, the initial investment decision is binary in terms of commitment and risk. Irreversibility is closely related to path dependency and organizational inertia, and it is the one aspect that provides preferential advantage by eradicating possibilities to revisit the initial decision point. Irreversibility relates both to inability to recover the initial investment and assessment of the dependence of competitive actions on resources that are scarce and difficult to imitate. Accordingly, the value of plausible competitive actions decreases when competitors gain capabilities enabling similar moves (Barney 1986).

While financial options have important similarities with strategic options, there are also important differences between them. Financial

options rely on assumptions of standardized pricing and tradability of the underlying resource (Black and Scholes, McGrath) and they are both acquired and activated through simple market transactions. Strategic options are also dependent on previous investments, but they cannot be acquired through non-contextual transactions. Instead, they are mainly obtained through learning, analysis and building of organizational resources and capabilities (Helfat and Raubitschek 2000). Furthermore, strategic options have been argued to differ in terms of associated challenges in abandonment process and externalization of value-effecting events from the investor (Adner and Levinthal 2004). Despite these differences, the similarities in terms of sequential decision-making and consideration of uncertainty imply that an option lens can help inform strategic thinking. For example, real options reflect incremental decision-making on resource investments as framing future actions rather than merely constituting a specific path (Luehrman, 1998).

Bowman and Hurry (1993) present a life-cycle model of strategic options (*The Options Chain*) that describes the incremental nature of strategic decisions and the propensity of acquired resources to create new options. According to the model, options can be classified as shadow, real or struck options. Organizations hold large numbers of unknown possible competitive actions, but as long as they are not recognized they do not constitute viable alternatives and do not affect the organizations' performance. Through recognition, enabled by internal sense-making or external changes in the competitive landscape, shadow options may become real options that await activation. Organizations may at a later point strike an option by pursuing the competitive action, which may then generate new shadow and real options.

Strategic options fall into two separate categories that create distinct strategic paths: incremental and flexibility options (Sharp 1991; Bowman and Hurry 1993). Incremental options are gradual transformations of an existing strategy and they can be struck via calls (further investment in the underlying resource) or put (reversing a strategic path by selling the resource). Striking a call option generates further options (e.g. investment in new customer relationship management systems) while striking puts terminates further options by reversing a strategic path (e.g. selling a business unit). Flexibility options involve investments in fundamentally different resources than those currently held by the organization. Striking flexibility options generates further options that differ in nature from others in the option bundle. For example, Apple's decision to pursue the development of mobile phones involved

investment in fundamentally different resources and capabilities, and generated new types of options as compared to continuous investments in traditional personal computers.

3.3 Evolutionary Mechanisms

Darwinian theory of evolution through natural selection processes has been suggested to be applicable to diverse use contexts, including social systems and human culture (e.g. Dawkins 2006). Indeed, Darwin explicitly considered the wider applicability of his evolutionary principles to areas such as language, morals, and social groups (Hodgson 2005).
In this section I first review the translation of evolutionary theory to organizational research and examine the notion of coevolution. I then discuss evolvability and argue that architectural features of digital technologies enable rapid evolution, and that such evolution also affects evolutionary rates of organizational routines due to imbrication between them in practice.

3.3.1 Evolutionary Organizational Theory

Evolutionary theory of organizations draws on Darwinian models of natural selection, which postulate that the process of natural selection is the basis for biological evolution. Natural selection acts on inherited variations, eliminating organisms with combinations of traits that are disadvantageous for survival and reproduction in their specific environment. Thus, evolution through natural selection is dependent on three essential generative principles: variation, retention, and selection (Aldrich et al. 2008). First, in order to introduce change into a population, variation is needed. In biological systems this occurs through genetic mutations or recombinations, in social systems the sources vary depending on the unit of analysis. Second, the introduced variation needs to be retained in some way so that it can be replicated. In biological systems, this occurs mainly through the transmission of genes (although membranes, "epigenetic patterns" and various substances are also inherited), in social,systems theorists suggest this happens through routines, habits, understandings etc. (Nelson and Winter 1982). Third, variations that are well adapted to the environment provide competitive advantages for the host organism (or organization) in some way, and thus are selected (or competing variants are eliminated by selective pressures), thus enhancing longevity or speed of reproduction.

In addition to the three generative principles, key concepts in evolutionary theory include the genotype-phenotype distinction, the

units of replication and selection, and adaptation vs. selection (Lewin and Volberda 1999; Hodgson 2005; Hodgson 2013). Genotype refers to the unit passing on information (e.g. DNA), whereas phenotype refers to traits of the instantiation based on this information (e.g. characteristics of a specific giraffe). In social settings, how information is passed on and how it plays out in practice is more ambiguous. To deal with these analytical challenges, several analogous notions of replicators (genotypes) and interactors (phenotypes) have been suggested. Nelson and Winter (1982) suggest, for instance, that routines can be analytically considered as an organization's genes, and thus examples of social replicators (Hodgson 2013). The adaptation vs. selection debate refers partly to how desirable features are replicated, for instance whether giraffes inherited long necks due to the behavior of their ancestors or if the individuals with long necks had greater probabilities of surviving and creating offspring (it should be noted that this is a gross simplification: numerous adaptive mechanisms, e.g. responses to drought, and behavioral patterns, are enshrined in genes).

While it is more or less undisputed that evolutionary theory can contribute to understandings of emergent social systems, the optimal way to translate it remains a source of debate. Recently, scholars have debated whether biological processes are merely analogous to processes in social contexts, or if the underlying abstract evolutionary principles are the same (Aldrich et al. 2008; Hodgson 2013; Scholz and Reydon 2013). Applications in analyses of social evolution have also been criticized for vague treatment of core concepts and failing to clarify the level of analysis (e.g. Volberda and Lewin 2003; Hodgson 2013). It should also be noted that there are fierce ongoing debates about evolutionary principles among biologists.

Hodgson, Sholz and Reydon (2013) argue that application of evolutionary theory to organizational concerns needs to move beyond simple transfer and instead translate core concepts to the area of concern. Against this backdrop, I seek to apply the generative evolutionary principles of variation, selection and retention by explicitly specifying that the notion of coevolution used in my analysis refers to the reciprocal development of IT strategizing and business strategizing. In my theorizing I consider strategizing practices as the replicators, and both actors and sociotechnical structures as interactors. Further, I consider these coevolutionary trajectories as being frequently triggered by innovations in digital technology.

For the purposes of this dissertation, I theorize digital capability as generated from coevolution of IT and business strategizing at various

levels. A coevolutionary perspective implies the ability to consider embeddedness and effects between multiple levels, multidirectional causalities, non-linearity, positive feedback and path-dependency (Lewin and Volberda 1999). In the context of digital business strategy, effects arising from *multiple levels* include both macrocoevolution, occurring between organizations and their environment, and microcoevolution, occurring within levels in an organization. Variation, selection and retention mechanisms introduced in digital technology or its application operate both at macro- and micro-levels and events at one level often impact the other. For example, as pointed out by Baum and Singh (1994), microevolution occurs in contexts affected by macroevolutionary competitive selection processes. *Multidirectional causalities* imply that changes may occur in all interacting entities and that effects and feedback may move in any direction. Further, events may impact through direct relationships (one-to-one impacts) or diffuse as one or more populations evolve according to events in a larger ecosystem of populations. *Nonlinearity* implies that feedbacks from one event may result in unexpected change through complex relationships arising through the multidirectional causalities involving events at multiple levels. For example, system-level changes arising from modification of a specific variable are often difficult to predict due to numerous unexpected dependencies. *Positive feedback* describes how organizations or other bounded units both influence their external milieu and are influenced by it. Accordingly, organizations sharing the same environment recursively impact each other through what Lewin and Volberda (1999) refer to as circular causality. Finally, coevolution suggests *path and history dependence* in that variations in organizations and technology may emanate from historical variation and selection pressures.

3.4 Strategizing through Capability-generating Routines

In this section I present theory on digital capability building, structured according to the three dynamic capabilities sensing, seizing and transforming (Teece 2007). In developing digital capability, simple planning of organizational design and resource acquisition is clearly not sufficient. As pointed out by Teece *"capabilities cannot easily be bought; they must be built"* (Teece et al., p. 529). Instead, I consider capability generation as mainly involving shaping of practice. Formulated in the coevolutionary semantics, organizations need to develop mechanisms generating digital variation, informed selections, and effective retention

mechanisms according to the complexity of their competitive landscape. Accordingly, digital capability generation involves: (1) *sensing* by implementing routines to tap into innovations in processes, business models and technology; (2) *seizing* by designing routines for analyzing and learning about the applicability of new knowledge and innovations, and identifying shadow options; and (3) *transforming* or coevolving by embedding new knowledge and innovations, and building adaptable social and technical structures supporting current strategy and a large number and complexity of competitive actions (Bowman and Hurry 1993; Teece 2007). The conceptual framework for examining these issues is outlined in Figure 4. In the following section I briefly outline the routines involved in activation of the dynamic capabilities sensing, seizing and transforming.

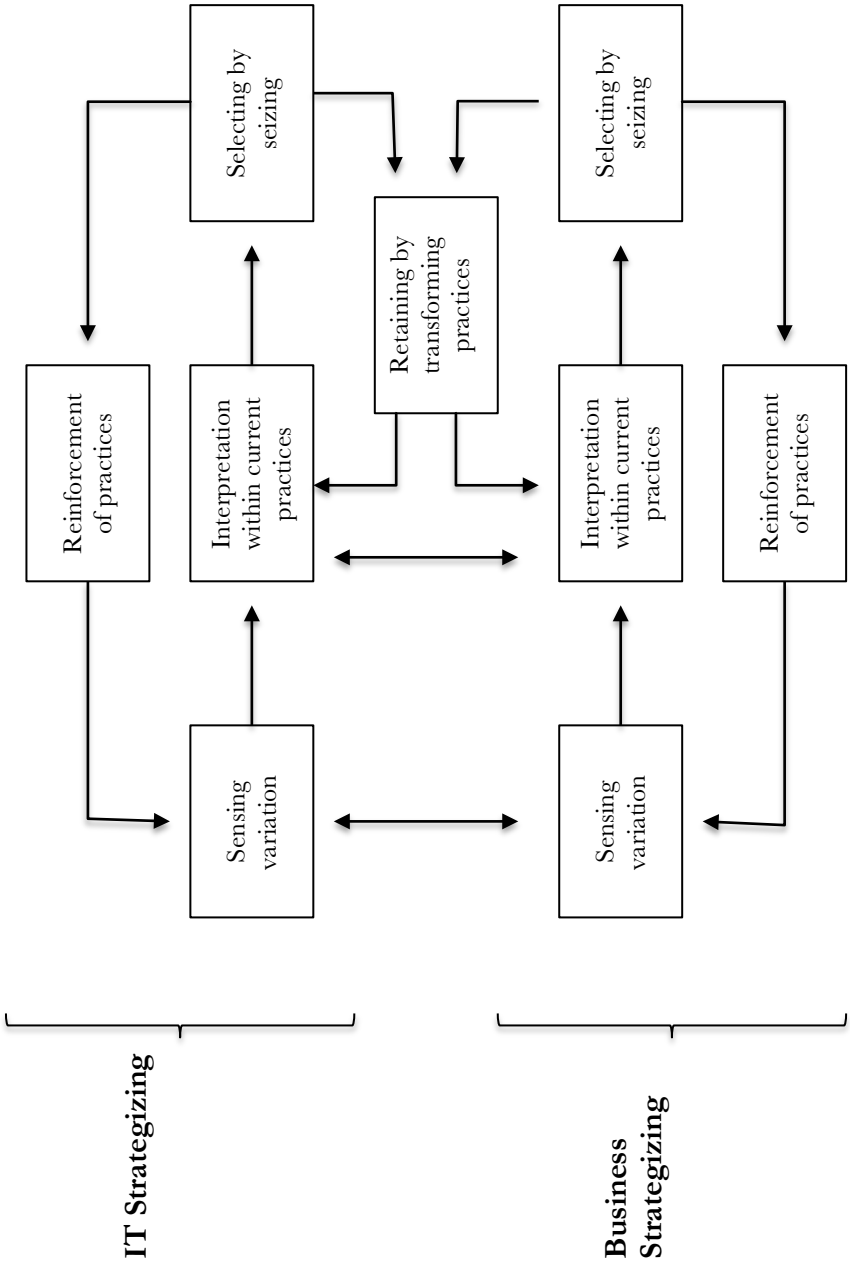

Figure 4. Coevolutionary Strategy Processes (Adapted from Volberda and Lewin 2003 and Daft and Weick 1984)

Sensing Variation

Purpose

Coevolution with digital innovation and other changes in rapidly changing competitive landscapes requires organizations to monitor the external environment in order to spot and address opportunities and threats (Pavlou and El Sawy 2011). Sensing capability is closely related to the "acquisition" dimension of absorptive capacity described by (Zahra and George 2002, p. 2002), i.e. "a firm's capability to identify and acquire externally generated knowledge that is critical to its operations. Prior investments and knowledge impose boundaries on the sensing activities that organizations can engage in. The aim of activities activating seizing capabilities is to gain insights into prospective substantial actions competitors might take, trends among customers and suppliers, R&D outcomes pertaining to the specific competitive landscape and general innovation in IT that potentially affects the organization (Teece 2007). Ultimately, the aim of developing sensing capability is to identify variations that may impact the competitive landscape or can be used to increase the range or complexity of competitive actions. The purpose of these routines is to identify possibly relevant variation rather than evaluating it.

Enacted through routines for:

- Internal R&D/IT development
- Tapping into external sources for R&D/IT development
- Tapping into suppliers' and complementors' innovations
- Identifying customer-induced change

Seizing through Selection

Purpose

Seizing capabilities allows organizations to engage in learning processes in order to understand, evaluate and select desired variation by contextualizing it. Seizing through selection is fundamentally an analytical activity, but involves action in terms of taking decisions on, for example, process change or design moves regarding the digital capital stock. If sensing capabilities support idea-generating types of capabilities (in the sense that they are not intended to be overly discriminating), seizing capabilities instead facilitate the filtration and contextualization of acquired information. The output of seizing capabilities is change in

terms of selection. In the context of digital capability building, output from activating seizing capabilities includes new configurations of the digital capital stock, and new available competitive actions through recognition of shadow options or investments. One way to evaluate the state of the digital capital stock is to examine the options it affords in terms of competitive actions and its adaptability (Woodard et al. 2013). A low level of either implies that the organization might need to invest further in capability building.

Enacted through routines for adapting:

- Enacting competitive actions through new business models/products/services
- Adapting to IT change
- Adapting to environmental opportunities/threats

Transforming for Retention

Purpose
The final capability activated in digital capability building is transforming, the mechanism integrating fundamental variations through reconfigurations (Zahra and George 2002; Teece 2007). Transformation capabilities add, delete or reinterpret existing competencies and assets to achieve this end. Transforming capability encompass processes for turning knowledge into practice and vice versa. As such, it generates change by adapting performative or ostensive dimensions of routines, or through planned change. The purpose of activating this capability is to produce continuous cycles of alignment and realignment across coevolutionary levels and dimensions of IT capability.

Enacted through routines for transforming:

- Transforming architecture of digital assets
- Transforming organizing logics and structures
- Transforming ostensive and performative dimensions of routines
- Transforming business models

4 METHODOLOGY

4.1 Positioning the Research

4.1.1 An Overview of Information Systems Research

IT strategy is but one of many facets of IS research. The IS discipline at large is concerned with the design, use and implementation of IT in social contexts. Given the rapid development of IT in organizations and society, the IS discipline is characterized by evolution and change. In this section I provide a brief overview of the IS discipline's roots and debates on its core in order to situate this dissertation within a historical and social academic context.

The academic field of information systems (often referred to as "Informatics" in Scandinavia) started to emerge in the late 50's when IT was increasingly adopted in organizations (Leavitt and Whisler 1958; Davis 2006). Before that, computers were basically restricted to research and military purposes. In 1955 practically no organizations used computers, in 1965 approximately 20 000 computers where in use, and in the 70's they were widely adopted (Dickson 1981). Based on an increasing appreciation of decision-making and information processing as key activities in management, improvements in data processing capacity spurred interest among both scholars and practitioners. Most of this early interest in applications of IT addressed management issues, as indicated by the frequently used notion of management information systems (MIS).

The field emerged from a loosely coupled community linked by a shared interest in the application of IT. These scholars came from various educational and professional backgrounds such as management, accounting and computer science (Davis 2006). Accordingly, they had different understandings of what constituted the mutual area of concern, methods for examining those issues, and boundaries of the field. In comparison to computer science (then often referred to as "Computing") the IS field developed slowly. For example, the International Federation for Information Processing (IFIP), which was founded in 1960, did not recognize IS until 1976 through the creation of Technical Committee 8: Information Systems (Davis 2006). Davis (ibid) suggests three reasons for this time lag: technological immaturity, diverse backgrounds, and applicability of findings in existing fields. The immaturity of technology meant that computing capacity had to evolve from punched card data in order for interesting applications to be

developed. The diverse backgrounds implied that scholars identified themselves as belonging to the originating field, and did not push for IS to be recognized as a distinct field. Finally, acceptance of findings in journals and tracks at existing conferences meant that there was no urgent need to establish the field. Hence, already in its founding stage, IS both benefitted and suffered from diversity.

Despite the initial slow progress, the mid 60s to mid 70s showed significant theoretical growth, including important definitions of the notion of information system (Hirschheim and Klein 2012). Notable conceptualizations include datalogical and infological systems (Langefors 1966, further detailed below), inquiry system (Churchman 1971), socio-technical systems (Mumford and Weir 1979) and human-activity systems (Checkland 1981). Also in terms of research infrastructure important progress was made with establishment of conference such as the Hawaiian International Conference on System Sciences (HICSS) in the mid 70s, Information Systems Research in Scandinavia (IRIS) 1978 and the International Conference on Information Systems ICIS (1980). In 1977 the first journal specifically devoted to IS – MIS Quarterly – appeared.

The founding father of IS as a research discipline in Sweden was Börje Langefors. Langefors became the first Swedish professor in the field in 1967 at KTH in Stockholm. At that time the field was called information processing, which later was replaced by the term administrative data processing. Langefors distinguished among "infological problems" and "datalogical problems" (Langefors 1966, in Iivari and Lyytinen 1999). Infological problems referred to what type of information that needed to be provided to satisfice users needs. Datalogical problems concerned how to structure data in computing systems to provide this information (Hirschheim and Klein 2012). Langefors articulated the infological equation to formalize this theorization as: $I = i(D,S,t)$. In this equation, I is the conveyed information, D denotes the data made available, S the users prior knowledge, t is the time for the user to interpret the data and i is the interpretation process (Langefors 1966, inIivari and Lyytinen 1999). In formulating his equation, Langefors recognized the importance of prior knowledge and experiences in interpreting information.

While the North American tradition is closely linked to management issues, and departments often localized within business schools, the Scandinavian school has instead emphasized the role of users at multiple levels in organizations. Early Scandinavian research in the field focused strongly on the changed role of users, emphasizing how they should be included in development of information systems (Nygaard and Bergo

1975; Ehn 1988). The aim has been to give users a voice in development projects, and at the same time enhance the quality of the resulting systems. The Scandinavian approach in the 70's was grounded in co-operation between researchers, developers, users and union representatives of workers. The collaborative approach evolved over time, and during the 80's and 90's one important approach in Scandinavian IS research was reflective systems development which pointed towards the practices of developers as opposed to formal methods (Mathiassen 1998; Iivari and Lyytinen 1999). The collaborative approach with focus on users within organizations has remained (e.g. Ehn 1988) and developed into a strong position of collaborative research approaches such as action research (Iversen et al. 2004), engaged scholarship (Mathiassen and Nielsen 2008), and lately action design research (Sein et al. 2011). While the North American IS tradition converged over the years, the Scandinavian tradition found its "unity in plurality" (Iivari and Lyytinen 1999). The common ground that still has characterized Scandinavian IS research has been evolutionary approaches (as compared to formal planning), active user involvement, openness towards theoretical variety, and collaborative approaches such as action research (ibid).

In this dissertation I explore an area of concern at heart of the North American tradition, the relationship between IT and business strategies. However, I do so through a Scandinavian approach. For example, the strategy-as-practice lens emphasizes micro level actions and strategy as an activity at multiple levels in the organization. The research is also inspired by collaborative research approaches in that I have sought to address the gap between theory and practice. I have done so by grounding the research in a thorough understanding of context and practice, and by making an effort to communicate findings to the organizations.

There has been an ongoing debate that reflects serious doubts on the state-of-the-art in IS research. The debate is largely related to the diversity of the field. While embraced by some (Robey 1996; Lyytinen and King 2004), it has been criticized by others. The key argument against diversity in IS research is that it would allow for any topic, weaken the cumulative tradition, and diminish the field's identity. Accordingly, diversity would stand in the way for achieving disciplinary progress (Benbasat and Zmud 2003). This topic has spurred a heated debate that Lyytinen and King argues is related to how "the IS field continues to be haunted by feelings of inadequacy" (2004, p. 221) referring to this as an "anxiety discourse" (2004, p. 222).

In this debate I sympathize with the pro-diversity argument. Since IT and its enactments continue to evolve rapidly, a large variety in research methods and areas of concern prepares the field for multiple trajectories. In the vocabulary used in this thesis, diversity provides options for dealing with multiple evolutionary paths. Over time, we have for example on a local arena seen scholars addressing issues such as workplace democracy (Ehn 1988), information systems design (Stolterman 1991), IT-enabled organizational changes (Henfridsson 1999; Holmström 2000) and the role of IT in health organizations (Wimelius 2011). The range of application areas in such research reflects how our study object is not easily separated and confined.

However, although maintaining an inclusive stance and fostering diversity is more viable than having an intellectual elite define the "IS core" (Lyttinen & Kling, 2004), qualifying as an academic field require an identity. To prevent the "many blooming flowers of IS research" approach from turning into "anything goes", Robey (1996) argue that researchers' have a responsibility to pursue diversity in disciplined ways. Such discipline is described from a pragmatic view where the aim of studies must guide application of theory and methods. Accordingly, while diversity is important for the discipline at large, a clearly articulated focus is essential for any individual research project. For the purposes of this thesis the focus is on organizational and IT strategy.

4.1.2 Philosophical Foundations

In line with emergent perspectives, I consider IT-implicated organizational change as evolving in unpredictable ways from interaction between technology and human actors (Markus and Robey 1988). Emergent perspectives stress that change in organizational structure cannot be understood by studying only the influence of IT, or the purposes of technology designers and information processing need but rather the interactions between them. In rejecting the more or less unbounded rationality implicit in techno-deterministic and organizational design approaches, the emergent perspective is left with considerable complexity in theorizations as pointed out by Markus and Robey:

> *Prediction in the emergent perspective requires detailed understanding of dynamic organizational processes in addition to knowledge about the intentions of actors and the features of information technology. This added complexity makes emergent models difficult to construct (Markus and Robey 1988, p. 588-589)*

This dissertation is based on qualitative methods (Mason 2002) with an underlying interpretive approach. The way in which research is

conducted reflects underlying assumptions about ontology i.e. the nature of things (Van de Ven 2007), and epistemology i.e. the nature of knowledge and how we acquire it (Hirschheim 1985). The literature on philosophy of science present a multitude of perspectives of ontological and epistemological stands. Important streams in the IS literature include positivism, interpretivism and critical perspectives (Orlikowski and Baroudi 1991). The research presented in this dissertation is based on an interpretivist approach where "access to reality (given or socially constructed) is only through social constructions such as language, consciousness, shared meanings and instruments" (Myers 2009, p. 38). The sociotechnical characteristics of IS include both technical aspects, that hold greater degree of inter-subjectivity and generate rather apparent events, and social aspects that often are harder to find common understandings on, and are harder to trace. For example, most people could agree functionality of the keyboard I am writing on but the issue of why I am doing it can be analysed in many ways. The interpretivist approach assumes that knowledge is socially constructed and accordingly we do not have means to identify any objective "real world". Much interpretive research denies the existence of an objective reality, as described by Walsham:

> *Interpretive methods of research start from the position that our knowledge of reality, including the domain of human action, is a social construction by human actors and that this applies equally to researchers. Thus there is no objective reality which can be discovered by researchers and replicated by others, in contrast to the assumptions of positivist science. (Walsham 1993, p. 5)*

The ontological stance in the perspective described by Walsham is either internal realism or subjective realism. In internal realism, reality is seen as common understanding, or in more formal words *"an inter-subjective construction of the human cognitive apparatus"* (Walsham 1995, p. 76). In subjective idealism each person is seen as creating their own reality (Walsham 1995).

Critical realism on the other hand combines an interpretive epistemology with a realist ontology (Sayer 2000; Henfridsson and Bygstad 2013). Critical realism considers the world as divided into three domains, the real, the actual and the empirical domains (Bygstad 2010). The real world exists as physical and social objects that potentially can generate events through certain mechanisms. If activated, these mechanisms can generate events in the actual domain that might be observed by us in the empirical domain. The interpretive epistemological position suggests that we cannot observe this real world but we can

approximate them. Hence, some of our theories approximate these mechanisms better than others (Bygstad 2010).

In this research I have adopted an interpretive lens with an emphasis on the epistemological implications without making an explicit point out of ontological perspectives. When reflecting in hindsight I consider critical realism appealing and aligned with my overall philosophical approach. However, I have not specifically addressed or purposefully leveraged it as an ontological perspective in this research. For example, the use of the word "mechanism" should not be interpreted as related to ontology. I have conducted this research with an emphasis on theory development as an activity for providing sense-making tools rather than based on an obsession with their true nature (Weick 1995).

For example, in the Discussion section I touch upon how scholars have debated on whether or not the transferability of Darwinian principles to social evolution is based on "*abstract ontological communality rather than analogy"* (Hodgson 2013, p. 973). Such debates might be fascinating intellectual exercises but of little value in terms of the theoretical applicability of the principles. Accordingly, I apply the evolutionary principles in this research without addressing such debates.

Having explicated the philosophical foundations of this dissertation, I now turn to describe how it was implemented in practice through research approaches.

4.1.3 Interpretive Case Studies

Research in the social sciences is often classified as quantitative or qualitative. Quantitative research strives to gain understanding through numbers that "*come to represent values and levels of theoretical constructs and concepts and the interpretation of the numbers is viewed as strong scientific evidence of how a phenomenon work."* (Straub et al. 2004). Qualitative research aims at understanding people, actions, and, social and cultural contextual aspects (Myers 2009). These approaches each have their strengths and weaknesses. While quantitative research can provide important insights on topics present in large populations, they eliminate many contextual aspects in order to isolate specific variables. When studying social aspects that are harder to quantify such as practices, culture or political aspects are instead preferable (Myers 2009).

This dissertation is based on qualitative case study research, which examines phenomena in the context of one or more units. Researchers in various epistemological positions such as positivism, interpretivism, use case studies. For example, one of the most widely recognized authorities on case studies is Yin (2003) who takes a positivistic stance.

Nevertheless, much of his description of case studies is widely adopted also by interpretive researchers (Walsham 1995). Case studies are conducted within a large range of domains such as sociology, psychology, anthropology and community planning (Yin 2003). In the context of business and management research, Myers (2009) define the method as:

> *"Case study research in business uses empirical evidence from one or more organizations where an attempt is made to study the subject matter in context. Multiple sources of evidence are used, although most of the evidence comes from interviews and documents."* (p. 76)

Case studies are well suited for examining "how" and "why" contemporary social phenomena occur where a rich understanding is required and the researcher does not control events (Yin 2003). They can be used for exploratory purposes when little research has been carried out but also to test, to explain or to compare (Myers 2009). I rely on case study research because the area of concern is contemporary, requiring rich insight of phenomena, the organizational contexts were not controllable and the purpose was explanation.

The empirical observations, the research data, are in the interpretive perspective constructed through interpretations. For example Walsham (1995) point to similarities between interpretive IS research and anthropology where Geertz *(1973)* provide an illuminating perspective on the nature of data: *"What we call our data are really our own constructions of other peoples constructions of what they and their compatriots are up to"* (p. 9). When taking notes from observations or conducting and transcribing an interview the researcher engages in interpretive activities that result in what we refer to as data. In a similar vein, Mason (2002) make an explicit point out of referring to qualitative data as "generated", as compared to collected, to highlight the active role of the researcher. This is related to the notion of "double hermeneutics" (Giddens 1976), i.e. social scientists interpret phenomena that are already interpreted by the research subjects, and the researcher influences these research subjects by being present and interacting.

Evaluation of research needs to be conducted according to underlying assumptions in terms of philosophical positions and the methods applied. For example, evaluating a qualitative case study according to reliability in terms of repeatability as often applied in quantitative methods is not useful since all contextual aspects cannot be emulated. A

widely adopted set of principles for evaluating interpretive research in IS is provided by Klein and Myer's[7]. In the following I reflect on the research in this dissertation based on these principles (summarized in table 4.

Table 4. Klein and Myer's Principles for Interpretive Research

Principle
1. The Fundamental Principle of the Hermeneutic Circle This principle suggests that all human understanding is achieved by iterating between considering the interdependent meaning of parts and the whole that they form. This principle of human understanding is fundamental to all the other principles.
2. The Principle of Contextualization Requires critical reflection of the social and historical background of the research setting, so that the intended audience can see how the current situation under investigation emerged.
3. The Principle of Interaction Between the Researchers and the Subjects Requires critical reflection on how the research materials (or "data") were socially constructed through the interaction between the researchers and participants.
4. The Principle of Abstraction and Generalization Requires relating the idiographic details revealed by the data interpretation through the application of principles one and two to theoretical, general concepts that describe the nature of human understanding and social action.
5. The Principle of Dialogical Reasoning Requires sensitivity to possible contradictions between the theoretical preconceptions guiding the research design and actual findings ("the story which the data tell") with subsequent cycles of revision.
6. The Principle of Multiple Interpretations Requires sensitivity to possible differences in interpretations among the participants as are typically expressed in multiple narratives or stories of the same sequence of events under study. Similar to multiple witness accounts even if all tell it as they saw it.
7. The Principle of Suspicion Requires sensitivity to possible "biases" and systematic "distortions" in the narratives collected from the participants.

1. The Fundamental Principle of the Hermeneutic Circle. The overarching principle of the hermeneutic circle, point to how

[7] An alterative set of criteria for evaluating this research, in order to avoid any connotations of radical interpretivism (c.f. the debate between Kling and Woolgar and Grint; Kling 1991; Woolgar and Grint 1991; Grint and Woolgar 1992; Kling 1992), could have been general qualitative guidelines such as "systematically and rigorously conducted" (Mason 2002). However, Klein and Myers principles are adopted to the extent that they almost constitute a standard for constructivist epistemological positions, and I have no objections to their usefulness.

understanding of the whole and the parts is dependent on each other. For example, a context is partly constituted by actions, these actions cannot be understood fully without appreciation of the context. This research adheres to this principle by explicitly drawing on the interactions between e.g. organizational context and micro level actions in this context, iterations between levels of analysis in the organizations, and analytical iterations between field work and analysis. For example, data collection in the Norrmejerier case was initially broad and focused on context appreciation while in the later phases we focused on micro level activities and specific IT solutions supporting these. Analysis of activities and identification of plausible IT enabled improvements required us to revisit process characterizations and examine understandings of the parts in light of the larger processes. Further, all cases involved iterations between fieldwork and analysis to continuously re-interpret findings and pre-conceived theoretical constructs.

2. The Principle of Contextualization. This principle relates to how interpretations are connected not only in terms of level of analysis but also in time. The historical and social context significantly affects our interpretations. Hence, the researcher should contextualize studies both for their own understanding but also the audience. In all of the reported case studies, significant efforts have been made to understand both how the situation emerged and its social context. A careful examination of historical events, as reported by different actors and documents, was done in all of the studies. For example, in analyzing the implementation of the ERP system and standardization of processes at Norrmejerier, the history in terms of mergers and ownership was found to significantly affect events. Further, all of the studies involved site visits which substantially increased the understanding of the social context. At Norrmejerier I also conducted observation for a number of weeks to better appreciate the organizational culture. Finally, in reporting the studies I have strived to provide "thick descriptions" to the audience by detailing historical and social contextual aspects.

3. The Principle of Interaction Between the Researchers and the Subjects. The subject-subject relationship in "double-hermeneutics", as pointed out by Giddens (1976), suggests that researchers carefully must consider how they generate data (Mason 2002). Interviewees are describing their interpretations, these descriptions are affected by the researchers presence and interaction. Further, the researcher makes new interpretations in analyzing the generated data. Hence, the researcher needs to reflect on how interactions affect data collection and analysis. Managing these interactions is a challenge in any qualitative research and

these studies do not constitute an exception. In interacting with people in the studied contexts I have tried to communicate my role as a researcher and sought informed consent, both in terms of being interviewed and in addition recorded. I have conducted all data collection at the informants' work place to avoid (or possibly decrease the "lab rat feeling") and, I have tried to gain feedback on my analysis, i.e. my interpretation.

4. The Principle of Abstraction and Generalization. While interpretive research acknowledges uniqueness and contextual influence, most researcher conducting studies with interpretive approaches agree on the value of abstractions and generalization. Knowledge claims of interpretive research do however mainly rely on understanding rather than causality. For example, Walsham (1993) describe how validity of generalizations rely on *"plausibility and cogency of the logical reasoning used in describing the results from the cases, and in drawing conclusions from them"* (p.15). He also describes four types of generalizations: developments of concepts, generation of theory, drawing of specific implications and rich insight (Walsham 1995, p. 79. In this dissertation I contribute these types of generalizations, of which the reader is the referee the "plausibility and cogency". I provide development of concepts (digital capability, performative and transformative trading zones in paper 2), in paper four I present an extended digital options theory, in paper 2, and 3 I draw specific implications, and in paper 5 I contribute rich insights on effects of digitalization.

5. The Principle of Dialogical Reasoning. The researcher also needs to reflect on the preconceptions that he or she brings into the study. During the studies I mainly did this by engaging in constant analyses of the generated data e.g. while transcribing interviews. Throughout the studies I have engaged in discussions with coauthors on data analysis (e.g. coding schemes) and we have also continuously reviewed findings together. Such discussions have been valuable in re-considering initial conceptions. Also, the studies have initially been explorative with little understanding of the research context. This does not prevent preconceptions but it might make them less firmly established. Finally, presentations of conclusions from the research at early stages required reflections on preconceptions that I brought into the studies, and feedback with alternative interpretations.

6. The Principle of Multiple Interpretations

In making sense of events, actors will have different interpretations even if observed from a similar viewpoint. Adding contextual aspects such as political agendas or role in a given event (e.g. project sponsor,

developer or user), accounts are likely to differ. Attaining interpretations from multiple viewpoint help separating events that are interpreted rather similarly and events where versions differ substantially. Such dissimilarities can, if analyzed thoroughly, inform the researcher on e.g. power, motives or cultural values. In conducting this research I attained viewpoints from multiple actors with different organizational roles to generate data that would allow multiple interpretations. For example, in Norrmejerier narratives on the ERP implementation differed rather substantially between people working with the implementation at the headquarter compared to users at the production site. These differences reflect how the system implementation became a political tool for achieving standardization of routines that was considered beneficial for the organization as a whole but perceived as suboptimal in specific units.

7. The Principle of Suspicion

The seventh and final principle emphasize critically analyzing the data in terms of conscious or unconscious distortions of narratives. One important way in which I did this was attaining interpretations from multiple actors and confirming recollections through documentation. Further, I made an effort out being clear on my role as a researcher rather than an analyst working for the management. For example, in one of the studies it was obvious that informants adapted their narratives to emphasize problems in specific parts of the overall operations in order to achieve change. This led me to clarify my role, generate data from more sources, and pay additional attention in my analysis of both the specific data but also the phenomena.

Having reflected on my research approach, I would like to re-emphasize that the overall assessment is left to the reader's evaluation of the "plausibility and cogency" of the arguments as described by Walsham (1995). To facilitate such evaluation, I have strived to provide transparency in terms of methods applied, assumptions and chain of reasoning. In the following, I describe the research contexts.

4.2 Research Contexts and Data Collection

In this section I briefly describe the four research contexts and the data collection for each study. In selecting cases, the level of access to research sites was a vital criterion as it considerable impacts data quality (Myers 2009). ProcessIT[8] (described below) was instrumental in gaining

[8] For more details see: http://www.processitinnovations.se/

such access. People in this organization referred me to gatekeepers in the research contexts, I was introduced as a member of a larger research community with proven capacity to deliver interesting output, and as a study object in itself. Further criteria where extremes/deviances (ABB and ProcessIT), variations across study objects (R&D centers), and how influential the phenomena was (Norrmejerier) (Flyvbjerg 2006; Seawright and Gerring 2008).

The description of the research contexts and data collection consists both of text written specifically for this purpose, and excerpts from the papers selected to provide the reader with an accessible overview. For a more detailed account, I refer to the full papers that are appended. The order of appearance equals the ordering of the research papers. One of the advantages of case studies is the ability to leverage multiple data sources such as documentation, interviews, observations and physical artefacts. Table 5 provides an overview of the data collected from such sources in the four research contexts.

Table 5. Data Overview

Research Context	Interviews	Observations, workshops	Other
ProcessIT	40 (Performed by co-author)	Co-author present in management meetings for five year period	- Organizational charts - Annual reports - Evaluation reports
R&D Centers	16 (2 performed by co-author)	- Workshop with involved actors	- Internal reports - Annual reports
Norrmejerier	40 (11 non-recorded)	- Three tours of production sites -Three weeks of observations at headquarter - Demo version of IT system	- Internal reports - System requirements analysis - Annual reports - Process maps
Process automation	21	- Seven site visits - Three workshops on ecosystem development	- Internal project documents - Annual reports - Product pamphlets, documentation and instruction manuals
TOTAL	**117 (75 performed by me, 42 by others)**		

4.2.1 ProcessIT

Paper 1. Process IT is an organization promoting collaboration between the IT industry, universities, public authorities and process industries in northern Sweden. The organization constitutes a platform for an open IT innovation network leveraging researchers' findings and competency, IT suppliers' commercialization capacity, and process industries' domain knowledge and use environments. ProcessIT was founded in 2003 and received substantial long-term financial support from a national R&D agency (Vinnova). ProcessIT has since the startup in 2004 grown to 64 industry partners and 46 researchers (numbers from 2009). From 2005 to 2009 the program has been able to launch 86 project activities, including 61 pre-studies and 25 projects. From these, it produced an outcome of 19 new products, four new IT companies, 29 installations in process and manufacturing industries. Taking a university perspective, ProcessIT had up until 2009 resulted in 81 research publications and 44 new project activities.

This study examined the design and orchestration of ProcessIT. In particular, it focused on development of knowledge brokering capacity to establish the organization as a platform for the innovation network. ProcessIT is an example of a persisting open IT innovation network producing substantial output. Salient examples can provide rich insights, in this case into management of the exploitation/exploration dichotomy in boundary spanning collaboration (Yin 2003; Flyvbjerg 2006). However, the most important reason for selecting ProcessIT as a study object was the access provided by the fourth author's role as a manager in the organization. He collected substantial amounts of data over a five-year period (2005-2009) as a component in evaluating and improving design and orchestration of ProcessIT. Over these years he conducted interviews with 40 informants (summarized in table 6) and collected extensive documentation such as progress reports and notes from internal meetings.

Table 6. Interview Summary ProcessIT

Time period	Stakeholder	No.
Period 1 2005-2006	Process industry firms	4
	IT firms	5
	Researchers	2
	Public authorities	3
Period 2 2007-2008	Process industry firms	3
	IT firms	4
	Researchers	4
	Public authorities	3
Period 3 2009-2010	Process industry firms	4
	IT firms	4
	Researchers	2
	Public authorities	2
Total		40

4.2.2 Collaborative R&D Centers

Paper 2. The study was conducted within a larger project aimed at increasing innovation output from the two universities of Umeå and Luleå. The area of concern was design of boundary spanning R&D collaborations and in particular how requirements for both stability and diversity where managed. Our investigation focused on university based R&D centers working with collaborative approaches to IT innovation (in an inclusive, application based meaning).

Data collection in this study was conducted in three phases. First, I held semi-structured interviews with twelve managers of R&D centers. The interviews were recorded, fully transcribed and covered questions regarding need identification, project management, and results delivery. Second, based on our initial analysis, we selected four centers to examine in more detail. Findings were presented and discussed at a workshop with involved actors from three out of four centers. Third, having conducted a thorough analysis, follow up interviews with these four centers were performed. I conducted all the interviews, accompanied by different partners from the project, except from two follow-up interviews that the fourth author performed. All in all, sixteen interviews were conducted, internal and public documents examined and one workshop held. The case descriptions were later reviewed by all of the managers in order to validate our analysis.

Table 7. Data Summary R&D Centers

Type of data	No.
Recorded interviews	16
Workshop	1
Other data sources	Internal and external documents

4.2.3 Norrmejerier

Paper 3 and 4. Norrmejerier is a dairy company in northern Sweden that is owned by over 600 local farmers and delivers 195,000 tons of milk annually. Norrmejerier is highly dependent on IT for coordination because of its distributed nature, the very limited durability of dairy products, and the supplier ownership. Consequently, Norrmejerier must constantly adapt its production to the amounts of milk the farmers produce and maximize the price paid for milk. While the implementation of Enterprise Resource Planning (ERP) during 2001-2002 led to substantial standardization of many transactions, it required constant adaptation due to user resistance and the unique process characteristics of the dairy industry.

This study examined information system design and information processing requirements in three different phases. The first round of interviews occurred during December 2007 and January 2008 and focused on assessment of IT capability, current problems, strategic vision and information needs within and across units. Initial interview participants were selected for their breadth of knowledge and overall perspective. The insights gained led to the selection of additional participants with more specialized knowledge of systems and processes. Overall, seven people were interviewed. Results from this phase are presented in paper 3.

In May and June 2009, I was physically located at Norrmejerier for three weeks, observing the organization's information processing and IT capability. I participated in meetings, spoke informally with employees, conducted interviews, and toured three production sites. During this time, I made extensive field notes (Yin 2003). To further understand how the ERP system worked, I utilized a demo version of the system. In addition, I gained insights from internal and public company documents such as an overall process map and analyses of information management in the production chain.

In spring 2010, an additional round of data collection was conducted to understand the impact of current IT capability on production

planning performance. This phase involved among other activities interviews with informants across the supply chain.

Table 8. Data Summary Norrmejerier

Type of data	No.
Recorded interviews	29
Non-recorded interviews	11
Meetings with Norrmejerier managers on study design and execution	7
Other data sources	Observations (three weeks at headquarter, three tours of production site), documents, demo versions of systems.

4.2.4 ABB

Paper 5. This study explored digitalization of ABB's solutions for process automation. ABB is one of the world's leading companies in power and automation technologies that operates in around 100 countries through their 150 000 employees. ABB holds a world leading position in the market of distributed control systems for process automation, i.e. IT steering how processes in for example the oil, pulp and mining industry operate. These use contexts are characterized by the use of heavy machinery and "extreme production environments" – in terms of intense noise, heat, dirt, vibration, etc. – which means that the platform must provide very reliable performance. We examined the evolution of ABB's process control system offerings from the 70's to the current version of their platform. In particular we analyze how the control system design gradually expanded in functionality by embracing architectural principles that followed digital system design.

Our goal in the first phase was to examine the implementation of an IS intended to provide data on the installed base at customers' sites. Specifically, we were interested in the maintenance of digital products, design challenges in interorganizational systems, and, potential effects on product and service sales. I spent five days at five different sites (three ABB offices and two mining plants). I conducted eight formal interviews, five with ABB employees in various roles and three with informants working with ABB's systems in a large mining company. ABB also provided access to extensive project documentation and system demonstrations. A first round of coding took place during the

data collection as we developed descriptive categories of the identified changes in the relevant automation systems.

In the second phase, we conducted another round of coding to develop our understanding through theoretically grounded themes. I also conducted three more interviews and collected further documentation related to the IS project, which by this time had been halted.

In autumn 2011, a project on the development of the platform's eco-system was launched. The objective was to identify ways of increasing the number of certified solutions from third-party developers within the platform's eco-system. This initiative also provided the starting point for the third phase of the research project. Together with colleagues in the project, I performed formal interviews (10), participated in meetings and workshops, and collected documents from several sources: ABB, three process industry companies (two in mining and one in the pulp industry), and third-party developers.

Table 9. Data Summary Process Automation

Source	Interviews	Site Visits and Observation	Workshops	Documents
ABB	10	Four units including R&D center	Participated in three workshops on ecosystem development	Internal project documents and publicly available reports, product pamphlets and presentations.
Process Industries	7	Two mining sites and one pulp	Participated in three workshops on ecosystem development	Site descriptions and summaries of information processing and applications in plant
Third-party Developer	4	N/A	Participated in three workshops on ecosystem development	Documentation of solutions and companies
Total	**20**	**6**	**3**	

4.3 Data Analysis

Before outlining my approach to interpreting the data in the specific case studies, I would like to clarify the role of the dissertation's theoretical framework in such data analysis. The theoretical framework for this

dissertation is a product of the research rather than an initial lens. Initial theoretically informed understandings provided direction in an emergent process and where later either abandoned or refined. Walsham's (1995) analogy of scaffolding that is removed once it has served its purpose, describe well the role of these theoretical preconceptions. This approach has allowed me to analyse data with an openness to revising assumptions and dropping my theoretical tools (Glaser and Strauss 1967; Walsham 1995; Holmström and Truex 2011). However, it might also have negatively impacted the design and analysis of the separate case studies in relation to the cover paper by causing me to overlook important aspects. In the following I describe the role of data analysis in the case studies, a high-level description of the data analysis approach, and iterations between analysis and development of research contribution. However, for detailed accounts of the data analysis in each case study I refer to the appended research papers.

As described in section 4.2 there are important differences between the studies in terms of for example number of iterations between data collection and analysis, size of data sets, number of units of analysis and types of phenomena. Nevertheless, there are also similarities in terms of the overall data analysis approach. Except for the ProcessIT study, they all involve the following activities with varying number of iterations:

1. Exploratory data collection phase
2. Data analysis involving refining the initial understanding
3. Further data collection
4. Refinement of coding schemes and development of themes in new data analysis
5. Analysis of results through theoretical framework

In the reported case studies, I entered the research contexts with an initial understanding of the area of concern that was only loosely tied to theoretical pre-conceptions. For example, in the ABB case, I was initially interested in interorganizational information systems and business services. As the data collection and analysis revealed interesting tensions between life cycles of software and other production equipment, focus gradually shifted to the digitalization process. Having collected additional data, I conducted a new round of coding. After another round of data collection, new themes were developed that were informed both by theory and insights gained from previous analyses. This high-level description of the data analysis process illustrate how generation of data

codes and themes involved interactions between theory, research question and coding activities as recommended by Mason (2002).

The case studies have generated substantial amounts of data to be indexed in the coding processes. For example, interviews in the Norrmejerier case alone (not counting the extensive amounts of documents collected) generated over 200 000 words in about 400 pages. To structure such extensive amounts of information I used the qualitative data analysis software Atlas.ti. Both this software and the coding schemes were tools used for indexing and labeling the data sets. As such, they facilitated, rather than drove, the analytical interpretive assessment of the data (Mason 2002; Myers 2009).

I have coded the data in order to organize it, develop familiarity with it and to get an overview of the recurrent themes. Developing coding schemes, reading the data and attempting to theorize it has been a part of my interpretation and theorization process. Accordingly, the data coding has been an instrumental activity in making sense of the data but it does not in any way replace the interpretations involved with theorizing from data. My approach to the data coding was based on theoretical thematic analysis and hence driven by my analytic interest (Braun and Clarke 2006). As described earlier these analytic interests varied and where developed over the course of the research projects. The coding was mainly focused on the semantic level (as opposed to latent, underlying meaning). Semantic coding includes labeling the material with codes and organizing it into to themes.

Overall, the actual coding process can be described according to the phases in thematic analyses recognized by Braun and Clarke (2006); familiarization with data, generating initial codes, searching for themes, reviewing themes, defining and naming (refining) themes, and producing the report. An example of a coding scheme applied in the final stages of an anlaysis is how I coded the Norrmejerier data according to five themes (IT capability, Production chain, Production planning activities, production planning IT support and production planning context) with 24 different codes.

As illustrated by the iterations in the case studies, data collection, data analysis, and development of research contributions in qualitative research are seldom marked by clear boundaries. (Myers 2009). In the reported case studies I have iterated between the three by reflecting on insights between interviews, conducting formal analyses between data collection phases, and reporting preliminary findings. For example, in the Norrmejerier case the formal data analysis conducted for reporting findings in paper 3, and the feedback received when presenting it,

informed further data collection in the later phases of the study. As described by Myers (2009), such iterations between activities are an inherent trait of qualitative research:

> *"from a hermeneutic perspective it is assumed that the researcher's presuppositions will affect the gathering of the data. The questions posed to informants will largely determine the answers that you get. The analysis will affect the data and the data will affect the analysis in significant ways. Therefore it is somewhat simplistic to think of the data analysis as distinctly separate from the data gathering phase. Often there is some iterative activity between the various phases in a qualitative research project" (p. 165)*

Reporting preliminary finding, both back to the organizations and to academics, has been an important instrument for engaging in dialogical reasoning in the analysis. The research papers included in this dissertation represent the current status of a research process that has been ongoing since 2008. Over these years, I have presented related versions in conferences with peer-reviewed proceedings and as book chapters. These outlets have provided important opportunities for feedback and reflection on my arguments. The papers, which are listed below, illustrate how I have iterated between data collection, analysis and dialogue on interpretation of the contributions of the presented research.

1. Sandberg, J. and Holmström, J. (2008). *"From Drift to Control: Examining Modular Architecture and Standardization of Organizational Processes through ERP Systems"*. Proceedings of 31th Information Systems Research Seminar in Scandinavia: Public systems in the future: possibilities, challenges and pitfalls., Åre.
2. Sandberg, J., Holmström, J. and Levén, P. (2009). *"Overcoming the Alliance/Innovation Paradox: Enacting Fractionated Trading Zones in Academy/Industry Collaboration"*. Proceedings of the 32nd Information Systems Research Seminar in Scandinavia: IRIS 32 Inclusive Design, Molde University College, Molde, Norway.
3. Sandberg, J., Holmström, J. and Lyytinen, K. (2009). *"Decelerated IT Innovation: Negotiating Global IT Innovation Initiatives in Local Settings"*. Proceedings of JAIS Theory Development Workshop, Phoenix.
4. Sandberg, J., Holmström, J. and Lyytinen, K. (2010). *"Decelerated IT Innovation: Negotiating Global It Innovation Initiatives in Local Settings"*, IEEE Computer Society.
5. Holmström, J., Mathiassen, L., Sandberg, J. and Wimelius, H. (2011). *"Green IS: Steps Towards a Research Agenda"*. Green Technologies:

Concepts, Methodologies, Tools and Applications IGI Global**:** 27-35.

6. Holmström, J., Sandberg, J. and Mathiassen, L. (2011). *"Educating Reflective Practitioners: The Design of an IT Management Masters Program"*. Proceedings of the Seventeenth Americas Conference on Information Systems, Detroit, Michigan August 4 th-7th 2011.

5 SUMMARY OF PAPERS

This chapter summarizes the appended papers and in terms of area of concern, theoretical framework, investigated problem, unit of analysis and contribution. Table 10 provides an overview of these dimensions.

Table 10. Overview of the Papers

	Paper 1	Paper 2	Paper 3	Paper 4	Paper 5
Area of concern	Knowledge brokering in open innovation	Balancing diversity and stability in open innovation	Design of organizationa l information systems	IT enabled process innovation	Digitalization and platform ecosystems
Problem	Re-using boundary spanning linkages while avoiding inertia	Balancing stability and diversity in innovation networks	Managing adaptation of standardized IT solutions and routines	Identification of desirable IT investments	Managing coevolution of IT and business strategies
Theoretical framework	Innovation and networks	Innovation and networks	IT infrastructure and systems design	Information requirements and options thinking	Digital innovation and platform strategy
Unit of analysis	ProcessIT (academy-industry innovation network)	Four collaborative R&D centers	Norrmejerier (Dairy company)	Norrmejerier	ABB's process automation division
Contribution	Insights on the role of network diversity and size, and empirical illustration of dynamics involved with generating ability for knowledge brokering.	Identification of two distinct types of boundary spanning R&D collaboration, insighst on balancement of stability and diversity, and design dimensions for collaborations.	Illustration of the reciprocal nature of IT and practices, empirical illustration of platform inspired thinking in design of organisations' information systems.	Theoretical micro-foundations of digital options, and provision of actionable principles for identification of IT investments for improved process performance.	Identification of effects from digitalization of physical artefacts and resultant hybridization of product platforms, and illustration of the coevolution of IT and business strategies.

The following sections summarize the five research papers. Similiarly to the descriptions of research contexts and data collection this section consists both of text written specifically for this purpose and excerpts from the papers.

5.1 Paper 1

Sandberg, J., Holmström, J. Mathiassen, L. and Levén, P. *"A Platform for Open IT Innovation: Knowledge Brokering in Academia-Industry Collaboration"*, currently under review (first round).

In this paper, we report experiences from a longitudinal case study of the design and orchestration of a platform for collaboration in a large-scale regional IT innovation program – ProcessIT Innovations – with particular emphasis on the management challenges involved in facilitating interactions between IT providers, IT user organizations and IT researchers. We base our inquiry in data collected over a five-year period, from 2005 up until 2010. One of the authors, Per Levén is, and has been since the inception of ProcessIT, actively involved with its management and design. Over this five year period he generated extensive amounts of data including 40 interviews, which we leveraged in our investigation of how innovation networks can create structures for re-use of linkages among participants. A fundamental trait of open innovation is that value is created by sufficient dissimilarity, e.g. actors bring different types of competencies or resources into the collaboration. Often, there is a fundamental matching problem in these processes, while actors could benefit greatly from collaborating lack of awareness prevent them from doing so since they are not aware of each other's competencies. ProcessIT was founded to improve such matching processes by connecting participants from industry, universities, and public authorities in collaborative R&D projects.

While extant research on open innovation and knowledge brokering has shown that boundary-spanning innovation hold great promise, less attention has been paid to how such efforts are established and managed in the context of academia-industry collaboration for IT innovation. The paper thus aims to provide insights into design and orchestration of boundary-spanning IT innovation efforts involving academia and industry. We contribute to the literature on open IT innovation by examining how key nodes becomes a driving force by assuming the knowledge brokering role in search and match processes. Furthermore,

we address the issue of relationships organization and management by proposing that building knowledge brokering capability is an iterative, reinforcing, process in which managers of IT innovation programs can leverage distinct innovation modes (Perkmann and Walsh 2007; Chesbrough et al. 2008).

The notion of knowledge broker is proposed as a way to understand collaboration between heterogeneous groups in open IT innovation platforms. Development of knowledge brokering capabilities allows the open IT innovation platform to link actors separated by structural holes, thus enabling the "dissembling and reassembling of extant ideas, artifacts and people" (Hargadon 2002, p. 41). We have identified particular innovation modes and outlined the dynamics of how their application over time. These innovation modes were tightly connected to development of the four knowledge brokering capabilities access, learning, linking and implementation in the case of ProcessIT. Building on experiences from the ProcessIT program we assert that the reinforcing nature of knowledge brokering capabilities play an instrumental role in the evolution of an open IT innovation platform. We also provide empirically grounded insights into how the capability building process can be supported by consideration of portfolio configuration in terms of these innovation modes over time. Our findings extend prior research that has called attention to the role of knowledge brokers in innovation by specifying how knowledge brokering capability building is an iterative and reinforcing process in academia-industry collaboration, necessary for a sustainable open IT innovation platform. Furthermore, our analysis point to the role of diversity in the capability building process by suggesting that the appropriate configuration of innovation modes varies as capabilities and collaboration evolve over time.

5.2 Paper 2

Sandberg, J., Holmström, J. Napier, N. and Levén, P. *"Balancing Diversity in Innovation Networks: Trading Zones in University-Industry R&D"*, currently under review (second round).

Collaborative innovation between universities and industry has attracted increased attention from scholars and practitioners alike. Although the potential of such innovation networks is great, variances in cultures, goals and knowledge poses significant challenges. In this study, we investigated how heterogeneous actors can balance opportunities and

challenges associated with diversity in R&D collaborations that span such cultural and structural boundaries. In particular, this study emphasizes the balance act of stability for efficiency in interactions, and diversity to increase innovation potential through application of competencies in new domains.

We draw on network and trading zone theory to examine the innovation processes of four research centers involved in university-industry R&D networks. For each case, we analyze the center's management model, innovation processes and outcomes. Analyzing within and across cases, we contribute to the research on innovation networks primarily in three areas.

First, our study builds on the appreciation of heterogeneity in innovation processes and contributes to the literature on innovation networks by illustrating how diversity must be balanced according to opportunities and challenges. We provide a cross-case analysis of four research centers orchestrating innovation networks, and we describe the role diversity plays in collaboration across boundaries.

Second, the results demonstrate how the trading zone concept can be used and further developed. In particular, we have explored two distinct types of trading zones: the performative and the transformative. In the performative trading zone, collaboration is mainly designed with exploitation in mind and exchange is conducted through boundary objects. Further, since the parties do not engage in substantial negotiation of differences in understanding, the end-state of the trading zone remains heterogeneous. In the transformative trading zone, parties engage in collaboration with a more explorative mindset. Since much of the exchange consists of non-codified knowledge, interactional expertise is essential for the trade. A substantial degree of engagement between the parties results is increased understanding of the other parties. Hence, the trading zone evolves and becomes gradually more homogenous.

Third, in this study we identify four important dimensions for configuration of innovation networks according to purpose and the desired levels of diversity in the collaborations: their means of trade (i.e. interactional expertise or boundary object), tie configuration (relationship based of transaction based), main knowledge mobility mechanisms, and, type of trust dependency (competency or appropriability).

5.3 Paper 3

Sandberg, J. (2010), *"Coping with Complexity: Exploring Modularity and Flexibility in IT Infrastructure Adaptation.",* in Holmström, J. Wiberg, M. and Lund, A. (Eds.), Industrial Informatics Design, Use and Innovation: Perspectives and Services, p. 85-101.

In this paper I report findings from the first exploratory phase of a study of design of organizational information systems in Norrmejerier, a dairy company operating in the north of Sweden. This study focused on the implementation of a large enterprise system and the accompanying tension between adaptation of the system and processes.

Complex systems are known to create great challenges for the hosting organization. This chapter illustrates the importance of reducing their complexity and of modularity when implementing them. The reported findings suggest that one way to increase standardization and control, while at the same time providing the required functionality, is to restrict use of universal solutions to generic functions and complement them with specialized applications.

Such a design of the organization's information system is similar to platform architecture in holding core modules relatively stable and allowing more peripheral ones to vary. Platform architecture generally allows adaptability through the loose coupling between the core modules and the more peripheral ones. As the supplier (and evolution in the larger environment) sets the evolutionary rate for large off-the-shelf solutions, the host organization needs to respond to system evolution. The two alternatives available are either to implement upgrades and follow the evolutionary rate set by the supplier, or to only implement those absolutely necessary. The latter strategy will however at a certain point most likely lead to a situation where either a large upgrade to current technology is necessary, or the implementation of a new system. If the host organization wishes to pursue gradual evolution by implementing more incremental updates, loose coupling between the ERP system (the core modules) and applications providing more specific functionality significantly reduces complexity in updating systems.

5.4 Paper 4

Sandberg. J, Mathiassen, L. and Napier, N. (forthcoming), *"Digital Options Theory for IT Capability Investment"*, Journal of the Association for Information Systems.

The fourth paper presents the full study of Norrmejerier and outlines an extension of existing theory on digital options. The paper examine IT enabled process innovation, in particular the identification of desirable IT investments for improved performance. We illustrate the applicability of the proposed theory by examining a specific process for production planning and generate actionable digital options, i.e. IT capability investments that have been found to be both desirable and feasible. The fieldwork I conducted generated 40 interviews, notes from three weeks of observations and multiple site visits, and detailed documentation provided by the organization.

The proposed theory outline the microfoundations of digital options through a conceptual model of key constructs and their relationship and a life-cycle model describing how they change as they evolve. The conceptual model describes for example how options frame potential investments in IT and that information requirements suggest IT characteristics for analysts to search for. For example, high connectivity requirements suggest to search for IT that provides reach while high equivocality suggest that relationship type of IT services can increase performance. The life-cycle characterization point to how digital options can be available, actionable or realized. An available digital option is an opportunity awaiting recognition, an actionable has been found to be both desirable and feasible, and a realized digital option is an IT capability investment that has been made.

The theorization in this paper also includes principles suggesting how to analyze processes in order to identify opportunities for IT enabled innovation. These principles are illustrated through a detailed analysis of Norrmejerier's operations.

5.5 Paper 5

Sandberg, J., Holmström, J. and Lyytinen, K. (2013). "*Platform Change: Theorizing the Evolution of Hybrid Product Platforms in Process Automation*". Platform Strategy Research Symposium. Boston MA.

The fifth and final paper report findings from a study of the evolution of ABB's platform for process automation. The study examines coevolution of IT and business strategies over four decades. The study includes data from 20 interviews with people in ABB, host-organizations, and third-party suppliers. In addition, I participated in three workshops on creation of an ecosystem on ABB's 800xA platform with representatives from these organizations. Further, official and

internal documents where instrumental in tracing changes in both technology and strategies.

Our analysis shows that the progressive digitization of the platform's functions resulted in an increasingly loosely coupled architecture, which promoted novel stretch-fit patterns linking increased technological variability and necessary realignments across multiple use contexts. This called for constant changes in the firm's strategy and value logic. We identified several novel challenges in managing hybrid platforms that arose as the platform provider had to cope with the contrasting life-cycles of digital and physical components. The study extends current platform theory by illustrating how digitizing analog components creates a new breed of hybrid platforms with specific platform design challenges. It also demonstrates that generativity, which was enabled by digitizing the functions of the studied control system, leads to increasingly distributed forms of platform control whereby the platform often evolves in unpredictable ways as new combinations of features become integrated thanks to the platform's expansive scope and the intensity of learning. Finally, our analysis suggests that platforms and strategies co-evolve through a stretch-fit pattern in which new digital capabilities increase technological variation that in turn calls for new strategic alignments to match new use and production contexts. These findings can be applied to the new breed of platforms emerging in such diverse fields as intelligent cities, power grids or new generation traffic or power train systems.

6 DISCUSSION

In this dissertation I explore the generation of digital capability, i.e. organizations' collections of routines for strategizing by leveraging digital assets to create differential value. In doing so, I recognize several specific areas of concern deserving particular scrutiny: the endorsement of variation through management of boundary-spanning collaborations, functional selection through evaluation of digital assets as enablers and inhibiters of organizational ambidexterity, and retention of selected assets through transformation of sociotechnical structures enacted in practices.

Having investigated these issues theoretically and empirically, I examine insights and implications. In the following sections, I first discuss the notion of digital capability and then analyze generative processes through an evolutionary lens.

6.1 Digital Capability

The dissertation draws on three premises in examining organizational ability to strategize through digital assets. First, based on an emerging stream of research considering IT as fused with practice, IT strategy is investigated from a holistic perspective. That is, organizational strategy is increasingly formulated and executed by leveraging digital assets (Bharadwaj et al. 2013). Second, drawing on practice-based approaches to IS and organizational analyses (Jarzabkowski and Spee 2009; Feldman and Orlikowski 2011), strategy is considered as something organizations do in continuous processes involving actors at multiple levels. In this perspective strategy involves both emergent in-use enactment and deliberate planning processes (Mintzberg 1978). Third, competitive advantages are increasingly transitory (D'Aveni et al. 2010), and important effects of digital capability on organizational performance in this landscape are the variety and complexity of competitive actions it enables. The implications and resultant framework, which collectively indicate that digital capability is an important predictor of organizational performance, are discussed in further detail below.

6.1.1 Strategizing through Digital Assets

As argued throughout this dissertation, the fusion of practice and IT implies that digital technologies are no longer merely functional resources. They are rather significant drivers of strategic change (Yoo et al. 2010; Lee and Berente 2012; Svahn 2012). Accordingly, the relationship between IT and business strategies is reciprocal and

coevolutionary (Benbya and McKelvey 2006; Bharadwaj et al. 2013; Peppard et al. 2014). Digital innovation has disrupted organizing logics in numerous sectors such as the media, mobile communication and finance industries (Mallat et al. 2004; Boczkowski 2005; Selander et al. 2013). Within these industries, digitalization has affected not only the resultant products and services, but also strategic dimensions such as the scope, scale, speed and sources of value creation. Paper 5 on platform evolution provides an empirical illustration of how digitalization creates generativity.

Digitalization of ABB's platform clearly drove business strategy in multiple, unforeseen ways, affecting the scope, scale, speed and sources of value creation. It introduced loose coupling by disconnecting previous hard-wiring of product scope to process automation. As layers became loosely coupled, and both data and interfaces standardized, the scope of the company's product strategy was no longer confined to specific physical control functions. Accordingly, ABB had to reconsider the scope of both the system's construction and the markets to target. In terms of system development and production, the company outsourced certain modules, such as the operating system and PC hardware production, while expanding others, e.g. system maintenance. The markets considered included the construction and security industries, but eventually the company decided against entering totally new markets. Instead, ABB expanded the scope of services targeted to existing markets. Digitalization also affected the scale of its value creation. As most system design became centralized and customized by configurations of modules, the resources required for each installment fell dramatically. The most important change in terms of speed, necessitated by the surrender of important control points, was a shift from slow periodic transformations of the architecture to generative pulses of variation in a continuous process of incremental change. Finally, the evolutionary voyage of ABB's 800xA process control system illustrates how value appropriation transferred from a physical product to services and software.

As a vast range of products and services are now digitalized, suppliers in technology-oriented industries have a clear intuitive need for digital capability. In order to deliver competitive solutions, the ability to design IT-based solutions and business models is essential since digital technology is integrated into the very products or services supplied. For users of such technology in industries delivering analogous products and services the role of digital capability is less intuitively apparent. For such organizations, strategizing by leveraging digital assets is not tied to

product alterations but rather processes. Consider, for example, the users of ABB's process automation systems. By adopting digital control systems these organizations gained important functional benefits, but they also committed to digital evolutionary rates. Most of the process industries included in this study decided to standardize through procuring system modules from only one supplier. As ABB decided to use Windows as a platform for their equipment, customers procuring their systems from ABB also transferred from Unix. Implications for these user organizations included needs to develop new in-house competency, implement continuous incremental software updates and adapt maintenance practices. It is more important for such companies to avoid risks in system management, rather than extend functionality, since system breakdowns cause very costly operation halts. A clear conclusion is that managing the tension between variation introduced by incremental innovation, and risks associated with change, increases the strategic importance of design and maintenance practices.

Norrmejerier (paper 3 and 4) provides another example of a user organization that mainly strategizes through digital assets in terms of process adaptations. In deciding to customize core elements of the internal IT platform rather than trying to adapt processes, they expect to create more value than costs associated with active system integration. By building digital assets for their logistics operations Norrmejerier was able to increase the scope of its value creation and create a spin-off service, selling transport to external actors. Sharing IT services with competitors in other geographic regions also allowed scaling by creating distribution alliances. While not optimal, coordination practices enabled by Norrmejerier's digital assets were also vital for improving supply chain efficiency. Taken together these examples illustrate how digital capability requirements vary across organizations.

6.1.2 Strategizing in Eroding Competitive Landscapes

Capitalism is built on change and shifts (sometimes positive, but generally eroding) in competitive advantages (Marx 2004), resulting in creative destruction processes involving the introduction of variation in terms of innovation, selection of preferred solutions, and retention of competitive variants (Schumpeter 1942). Such erosion of positions in competitive landscapes occurs through ongoing incremental changes introduced in organizations' environments, but also through more radical and disruptive events incurred, for instance, by legislation or innovation (Abernathy and Utterback 1978; Henderson and Clark 1990; Christensen 1997). The rate of incremental erosion and frequency of

disruptions vary depending on among other the type of industry and technological dependency.

Consideration of the rate and type of erosion is essential for rigorous analysis of the ideal digital capability for an organization. In order to persist, organizations competing in landscapes characterized by rapid and disruptive erosion generally need to launch frequent, complex competitive actions. In contrast, those operating in relatively stable competitive landscapes, where erosion is slow and incremental, can coevolve with environmental changes by launching less complicated competitive actions that lie closer to existing positions.

In terms of acquiring different types of strategic options that are adapted to uncertainty, organizations in rapidly eroding and frequently disruptive landscapes need flexibility options while organizations in gradually eroding landscapes mainly need incremental options (Bowman and Hurry 1993). The dichotomy between exploration and exploitation suggests that there is an inherent trade-off between strategizing for short-term efficiency and long-term adaptability (March 1991; Gibson and Birkinshaw 2004). Investments associated with capability generation need to be balanced with plausible benefits (Winter 2003). The rate of erosion impacts the value of holding multiple and complex competitive actions by increasing uncertainty. As identified by options theory, uncertainty increases the value of holding multiple options (Black and Scholes 1973; McGrath 1999; Sambamurthy et al. 2003).

In addition to these environmental aspects, organizations within the same industries have differing ambitions for leveraging digital assets in strategizing. This is not surprising as generating digital capability may have strongly differing costs and benefits for organizations seeking (or needing) to repeatedly launch competitive actions by leveraging digital assets and others that are mainly striving to refine current practices. Two salient classes of organizations are identified in a recent literature review: IS innovators and conservatives. The former *"seek to be innovative through new IS initiatives while the IS conservative represents an organizational perspective to create value through effectively refining and improving existing IS practices"* (Chen et al. 2010 p. 244). The difference in strategic take on IT result in distinctive approaches to digital evolution, as I will examine further below.

6.2 Coevolutionary Capability Generation

Applying theoretical concepts developed in other domains involves translating key constructs and units of analyses to ensure analytical

usefulness. Comparing development of social and economical systems with nature is appealing since it provides us with physical representations of phenomena. Darwin´s view on evolution in biological populations by natural selection bears significant similarities with incremental changes in a social structure, economical system, IT or organizational routines. The adaptations observed in biological populations driven by variation, selection and retention processes can be paralleled with adaptations of systems in digital ecosystems trickling through to users in process industries. Natural selection is a truly brutal process, bearing important similarities to capitalistic market mechanisms, thus this analogy (or abstract ontological communality, as argued for instance by Hodgson 2013) can be readily transferred to the evolution of industrial systems and IT strategies. However, translation of the concepts regarding processes that generate variations, differences in evolutionary rates, and adaptation in organisms to organizational analogues requires careful consideration. Thus, in the following section I discuss mechanisms of evolutionary change and the potential limitations of this perspective on IT strategy, the role of IT in the evolution of practices, and four organizational approaches to change.

6.2.1 Evolutionary Mechanisms in Strategizing

IT is an essential driver of the movement towards increasingly short-lived competitive positions (D'Aveni et al. 2010; Tanriverdi et al. 2010). In terms of evolutionary rate, IT has a number of similar characteristics to biological properties that are important for a high degree of evolvability, i.e. *"capacity to generate heritable phenotypic variation"* (Kirschner and Gerhart 1998, p. 8420). Kirschner and Gerhart (1998) suggest that five general characteristics underlie the impressive evolution of organisms: versatile protein elements, weak linkage, compartmentation, redundancy and exploratory behavior. These key characteristics provide great variation, robustness and flexibility, and reduce interdependence. Versatile protein elements mean that proteins can regulate distinct processes with little revision. A similarity in the IT domain is the standardization of data in binary representations (0s and 1s), allowing any type of computing artifact to process information as long as appropriate interpretation schemes are available. Weak linkages imply that processes are minimally dependent and functionally coordinated by information transfer, in contrast (for instance) to energy transfer by series of chemical conversions. In a similar vein, IT architecture leverages loose coupling, allowing recombination, reduction of constraints and modular innovation. Compartmentation is similar to the

notion of modularization, and reduces restrictions on changes in subparts of the system from other parts of the system. Accordingly, variation and selection can occur in subsystems in unconstrained ways as long as it does not cause serious loss of functionality in the overall system. Thus, compartmenation provides buffers for non-desirable variation. Redundancy refers to the existence of multiple functional elements (e.g. "back up" muscle cells in animals), allowing processes to continue when one breaks down. In a similar vein, IT is often fault-tolerant in the sense that changes are reversible, systems can be reprogrammed, data restored and applications removed and re-installed. In addition, programs may be installed on multiple devices. Finally, organisms have exploratory systems, for example the immune system, and random recombination creates enormous numbers of variants, few of which are successful. Similarly, the non-existing marginal and distribution costs remove barriers for prospective software developers, resulting in numerous possible solutions, few of which are selected by market mechanisms. Table 11 summarizes how IT charecteristics enable a rapid evolutionary rate through relentless innovation.

Table 11. IT and Evolvability

Evolvability aspect	IT characteristic	Implication
Versatile protein elements	Standardization of data	Basic building blocks can be used in numerous ways
Weak linkage	Loose coupling, service-oriented architecture	Flexibility for recombination, changes in subsystems and complexity reduction
Compartmentation	Modularization	Variation can occur in sub-systems with little restriction and risk for overall system.
Redundancy	Reversibility	Fault tolerance increasing tolerance for undesired variation
Exploratory behavior	Low barriers for innovation and distribution	High degree of variation at low cost

The evolution of biological organisms is a slow process, usually involving small inherited changes over numerous generations that generate diversity at all levels. Driving forces in this process are numerous mutations of individual DNA molecules and reorganizations of large parts of the chromosomes. In most cases this is a random

process, i.e. it causes stochastic changes in populations, thus most mutations reduce the "fitness" (survival and reproduction rates) of offspring. However, on rare occasions mutations confer traits that are favorable in the specific environment. Thus, they raise the survival and reproduction rates of the host organisms, and the beneficial mutations become 'fixed' in their populations (thereby driving the evolution of the populations and species).

Biological processes thereby randomly create large numbers of individuals with new properties and select those that are fittest at a given time and place. This is a trial and error process, causing most individuals with new variations to have less desirable traits than those lacking deleterious mutations and thus their rapid elimination, or failure to reproduce. One can say that nature allows many failures for one success. This evolutionary pattern is also evident within the IT industry. For example, Google releases diverse beta types of services to learn from their environmental fit (i.e. use practices) and quickly eliminate non-successful variants (e.g. Wave, Answers etc.). Similarly, tolerance of failure is essential in most digital platform ecosystems (e.g. apps for Apple's iOS), since core modules are detached from variation incurred in modules operating on the platform (Baldwin and Clark. 2006). In these ecosystems, a large number of module suppliers develop solutions, of which only a small minority will be successful. Since they are detached from the platform, costs of failure are low for all involved actors except possibly the suppliers.

While these selection processes efficiently operate on large populations, they do not offer much guidance for analyzing the adaptability of most IT user organizations. An important issue that has not yet been fully resolved is how organizations coevolve with the environment by adopting beneficial variation without suffering fatally from non-beneficial variation. Here the parallel between Darwinian evolution theory and socio-economic systems seems misleading. Organizations adapting IT to develop core activities do not generally deliberately create diverse assets to identify a small number of successes. Thus, comparison with Darwin's theory of survival of the fittest is clearly useful for analyzing large populations, such as an industry, and IT innovators within rapidly eroding competitive landscapes, but it seems to have less commonality with the evolution of organizations with moderately eroding digital assets and competitive positions. However, this conclusion ignores several important nuances and recent refinements of biological evolutionary theory.

A major question in biology was how populations of organisms with given pools of inherited genes and traits can cope with major environmental changes, which impose a need for dramatic adjustments for their survival. In recent years a new field of genetics has revolutionized the view on relationship between heredity and environment. The field is epigenetics were changes in the activity of a gene not are caused by changes in DNA itself and still cause stable long-term changes in the genetic outcome of a phenotype. Epigenetics refers to functionally relevant changes to the genome that do not involve a change in the DNA molecule or rearrangement of chromosomes (Goldberg et al. 2007). In biology during development cells acquire different fates to develop to a specific function like a liver cell, a muscle cell or a nerve cell by selecting distinct sets of genes to express or to keep silent. The decision of which genes to express and which genes to keep silent is remembered as cells continue to divide. This memory, or retention function, is provided by epigenetic mechanisms that install heritable changes in gene activity not caused by changes in the DNA sequence. Epigenetic memory mechanisms are essential for proper development of all multicellular organisms but also give evolution a tool for adaptation as a complement to natural selection via mutations and DNA re-arrangements. Epigenetics is similar to software in the sense that it allows reprogramming of functionality provided by the hardware/DNA.

These evolutionary mechanisms — natural selection of the fittest among numerous variants, together with epigenetic mechanisms (and specific protein regulating systems) allowing adaptations to environmental changes in an existing entity — constitute important engines of change. However, adaptations through modifications are risky, as adaptive changes can provide significant reward if they give a competitive advantage, but they can also cause fatal problems for the organism or organization. Thus, adaptive evolution poses important challenges, and the risks and costs associated with introducing variation and change can cause inertia in incumbent organizations, as illustrated for instance by the notion of the "innovator's dilemma" (Christensen 1997). Depending on the rate of erosion of the competitive landscape, environmental changes, and the organization's approach in terms of adapting existing IT or tendency to introduce new technology, four evolutionary strategies for leveraging these mechanisms can be distinguished.

Rapidly eroding positions	**External selection** Competing by excelling at adapting digital assets to variation in the competitive landscape. *Example: ABB*	**Survival of the fittest** Great variation introduced through digital assets and those found non-desirable discarded. *Example: Google*
Moderately eroding positions	**Adaptive evolution** Filtering external variants and selecting only those found necessary. *Example: Process industries*	**Internal selection** Competing by selecting and transferring available variants into the competitive landscape. *Example: Microsoft*
	IT conservative	IT innovator

Figure 5. Approaches to Digital Evolution

6.2.2 Designing and Orchestrating Adaptability

The research papers presented in this dissertation provide insights into specific areas of organizations' variation selection, and retention mechanisms. These papers each address one of the three main areas of concern (boundary-spanning, digital asset design and transformation of scoiotechnical structures) and mainly focus on distinct mechanisms. Papers 1 and 2, on boundary-spanning innovation, mainly contribute to understanding of mechanisms for sensing variation. Papers 3 and 4 mostly deal with mechanisms for selection and retention of variation, while the main emphasis in Paper 5 is on transformation. However, as illustrated in Table 12, these are the main foci of the papers, and there are substantial overlaps in aspects of the domain they address.

Sensing organizational capabilities facilitate the identification of variation in the environment in terms, for instance, of IT developments, business models or customer behavior, and thus innovation. As innovation by definition breaks with existing practices, to varying degrees, and is often serendipitous, openness to new alternatives is essential in such activities. Papers 1 and 2, on knowledge brokering and the role of diversity in boundary-spanning collaborations, illustrate challenges and opportunities in sensing activities. Verifications of benefits involved with open innovation processes are abundant, both in the innovation literature and in practice. Papers 1 and 2 illustrate the importance of collaboration in design and orchestration, as boundary-spanning collaborations incur transaction costs. The parties involved are

often unfamiliar with each other, hence mutual trust in partners' ability and intent need to be established. Organizational culture and goals vary and actors are often unfamiliar with each other's competencies, problems and solutions. To collaborate across such boundaries, it is important to develop structures that allow re-use of connections and flexibility in forming new collaborations, to ensure influxes of ideas. Paper 1 examines re-use of such connections through loose coupling, here referring to stability in core relationships constituting a platform for collaboration and flexibility in configuring specific projects. Paper 2, focusing on the need to balance diversity and stability, identifies two distinct modes of collaboration, transaction-based and relationship-based. The former involves transfer of codified knowledge (e.g. patents, prototypes) while the latter is more exploratory and involves transformation of practices. A key finding in this paper is the need to adapt collaborative design according to the desired type of innovation. Such design involves consideration of means of knowledge trade, tie configuration, knowledge mobility mechanisms and type of trust (contract- or relationship-based).

Table 12. Digital Capability-generating Elements Mapped by Each Appended Paper

	Paper 1	Paper 2	Paper 3	Paper 4	Paper 5
Sensing Variation					
Internal R&D/IT development			X	X	X
Tapping into external sources for R&D/IT development	X	X			
Tapping into suppliers' and complementors' innovation					X
Identifying customer-induced change	X	X			
Seizing through Selection					
Enacting competitive actions through new business models/products/services					X
Adapting to IT change			X	X	
Adapting to environmental opportunities/threats	X	X		X	X
Transforming for Retention					
Transforming architecture of digital assets			X	X	X
Transforming organizing logics and structures			X	X	X
Transforming ostensive and performative dimensions of routines			X	X	X
Transforming business models					X

In addition to collaborating with different external R&D parties, organizations often rely on competencies in the network of suppliers and complementors in their operational environment. In the IT industry salient examples are platform-based digital ecosystems. Paper 5 indicates that opening a digital architecture to suppliers increases the rate of variation through innovation, but also involves relinquishing control of evolutionary rates. Further, both the Norrmejerier studies presented in Papers 3 and 4, and the ABB study presented in Paper 5, provide examples of the importance of absorptive capacity in general and IT competency in particular in sensing external variation.

Seizing variation is essentially about evaluating and selecting desired variation, integrating incremental alterations of current practices, and striking incremental options by realizing competitive actions. Such changes include incremental alterations of business models, processes and digital assets in order to adapt to gradual evolution in the competitive environment, but also releasing products and services that are relatively aligned with current practices. These incremental adaptations of practices to seize beneficial variation can be realized through collaborations (as shown for instance in Papers 1 and 2), adaptations of digital assets (Papers 3 and 4) or competitive actions in terms of new value offerings (Paper 5). Two criteria when selecting variation to include in digital assets are the options they generate in terms of competitive actions and the technological debt incurred.

In order to retain variation diverging substantially from existing practices, organizations need to engage in transforming activities. The targets of such transformation include digital assets, organizing logics and structures, as well as both ostensive and performative dimensions of routines and business models. These dimensions are often intertwined and transformations of one affect the other. For example, the changes in Norrmejerier's IT structure affected the architecture of the company's ERP systems, organizing logics (e.g. centralization of planning) and routines (weekly planning). However, in this case business models were not substantially transformed, in contrast to ABB's digitalization of process automation.

7 CONCLUSION

As I hope has been made abundantly clear, the conceptual framework outlined in this dissertation provides a sensitizing framework rather than describing causal relationships. This framework may stimulate analysis and understanding of the role of IT in organizational strategy by pointing to foundational aspects and suggesting emergent relationships. In doing so, this research presents a guiding tool for analysis rather than simple answers. The implications of this theorization and suggestions for future research are presented below.

7.1 Implications for Research and Practice

This dissertation (and the underlying studies presented in the individual papers) examines the increasingly important roles of IT in organizational strategy. Based on research indicating that IT and business strategies are inextricably fusing, a holistic perspective has been adopted, scrutinizing associated phenomena through the lenses of evolutionary theory and practice-based approaches. In particular, it outlines a conceptual foundation for digital capability generation, i.e. routines for strategizing by leveraging digital assets to create differential value. The resultant theorization is also empirically illustrated through studies of boundary-spanning strategizing, design of digital assets, and coevolution of IT and business strategies over four decades resulting from digitalization. These results provide four contributions to research and practice.

First, this dissertation contributes to research on IT strategy by explicating digital capability. The notion of digital capability offers a conceptual framing of organizational routines for strategizing in competitive landscapes where IT is a key driver of organizational change. This theorization draws on extant research on fusion of IT with practice (El Sawy et al. 2010; Tanriverdi et al. 2010; Bharadwaj et al. 2013), strategy as emerging from ongoing processes occurring at multiple levels (Jarzabkowski and Spee 2009; Galliers 2011; Henfridsson and Lind 2013; Peppard et al. 2014), and organizational capability theory (Bharadwaj 2000; Winter 2003; Teece 2007). In integrating these theoretical streams, the notion of digital capability addresses IT strategy in multiple ways. The fusion view provides important insights into macro-level understandings of the role of IT in organizational performance, but does not address micro-level issues such as its adoption, implementation and affects in practice. Strategy-as-practice is an important lens for understanding these micro-level practices, but the characteristics of strategy links to macro-level understandings of the role of IT in

organizational performance are still in an emergent phase. Research on capabilities provides important insights into organizational performance, but largely neglects the increasingly important role of IT, or considers it a functional resource to be managed and aligned according to overarching strategic planning. Integrating these perspectives into a coherent theoretical framing thus extends our understanding of the emergent role of IT in ongoing organizational strategizing. Further, this theorization points to how organizations in industries with non-trivial levels of IT use must find ways to generate, and incorporate, understanding of not only digital technology but also digital business logics.

Second, this research provides important insights on the applicability of evolutionary theory to IS research, by presenting a framework for analyzing coevolutionary strategizing processes, approaches to digital evolution, and material properties of IT enabling evolvability. The framework, outlined in Figure 4, describes how organizations sense environmental variation, interpret it within current practices and either reinforce practices or transform them through selection processes. Figure 5 outlines four evolutionary strategizing approaches: *selection of the fittest*, *internal* or *external selection*, and *adaptive evolution.* "Selection of the fittest" is applied by companies such as Google and Apple, which create and release diverse variants of products or services into their ecosystems then select innovations that are successful. "External selection" is based on transferring variation selected in the environment (e.g. the IT industry) through careful adaptation to enjoy benefits without incurring major costs by disturbing current practices. This approach is illustrated by the transfer of ABB's 800xA process control system to a Windows platform, resulting in a need to coevolve, but in highly risk-avoidant contexts where change is seen as risk. "Internal selection" is instead leveraged by organizations with moderately eroding positions that are able to control innovation pace and select variation in the environment that is assessed as beneficial. For example, Microsoft can exercise relatively strong control and carefully incorporate variations the company selects internally. The final approach is "adaptive evolution", adopted by organizations striving to adapt existing digital assets and only incorporate essential variations. Examples include process industries that strive to make only absolutely required incremental changes. This approach is most likely to be adopted by organizations in low or moderately changing environments where rewards from innovation are low but risks are high. Finally, architectural features of IT, similar to those found in biological systems, providing evolvability are identified.

Organizations striving to generate digital capability should effectively manage variation, selection and retention mechanisms to create reinforcing evolutionary cycles. As practices are adapted to beneficial variation, understandings of IT and its implications in operations are likely to increase. These increases in IT competency in turn affect organizations' ability to pursue evolutionary cycles. The first step in creating these reinforcing cycles is probably to make IT's role as a strategic driver apparent at multiple levels in the organization. Further, organizations can benefit from evaluating and articulating their evolutionary approach and adapting their digital capability accordingly. For example, a*daptive evolution* and *survival of the fittest* approaches call for fundamentally different routines and competencies. Thus, an organization's evolutionary approach to IT should be aligned with its practices.

Third, this dissertation offers an empirical illustration of the coevolution of IT and business strategies sparked by the digitalization of ABB's platform for process automation. Most previous research has focused on explaining why strictly digital ecosystems emerge or how product platforms leverage modular architecture. In contrast, this investigation illuminates the adaptive mechanisms involved in the coevolution of technology and practice. The mechanisms in this context are particularly illuminating as digitalization occurred within existing practices, requiring ABB to carefully consider which variation to retain. Accordingly, this case offers an important illustration of how material and social structures are reciprocally shaped by, and shape, practice. An important lesson for organizations striving to leverage the generative power of digital technology is that they should carefully consider which architectural control points to open to suppliers, collaborators and customers. In this case, ABB relinquished control over the operating system, thereby increasing levels of both desirable and non-desirable innovation.

Fourth, Papers 1-4 offer specific guidance on the design and orchestration of selection, variation and transformation mechanisms for generating digital capability, construed by examining influxes of variation through boundary-spanning collaborations and selection through the design and analysis of digital assets. Guidance for boundary-spanning collaborations include recommendations to balance diversity and stability (as appropriate for the environment), identify the type(s) of variation required, and carefully consider the design of both IT and business strategies in terms of means of trade (i.e. interactional expertise or boundary objects), tie configurations (relationship-based or transaction-

based), knowledge mobility mechanisms, and type of trust dependency (competency or appropriability). Further, these studies highlight the importance of establishing connections across boundaries that can be re-used to decrease transaction costs, while allowing flexibility in configurations of actors. Finally, the analyses of the design and structure of digital assets indicate the importance of core systems' adaptability and their fit with both the environment and desired capabilities. They also provide foundations for a theory on digital options for IT investments. This theorization sets an agenda for academic research by articulating theory-based constructs and principles that can be subjected to further empirical and theoretical investigation. Further, it provides a method for examining options for IT investments to improve business processes.

7.2 Limitations and Future Research

The implications and contribution outlined in the previous sections are bounded by the research aim, theoretical foundation and research methods of this dissertation (Robey 1996) Important limitations and opportunities for future research are presented in the following.

First, applicability of the results relies on theoretical generalization rather than statistical probability and is hence bounded by the application of specific theories (Walsham 1995; Klein and Myers 1999; Yin 2003). Generalizing from case studies involve "level 2 inference" (Yin 2003), i.e. from findings to theory. When discussing generalizability in general we often think of statistical generalizability, which relies on inference from sample (level 1) to the aggregated population, and finally to theory (level 2). Inference from sample to population is a generalization from empirical statements to empirical statements, similar to generalization of specific instances in case studies to descriptive statements of the overall setting (Lee and Baskerville 2003). Lee and Baskerville (2003) point out how neither quantitative nor qualitative descriptions that rely on level 1 inference can be generalized beyond the observed domain. Instead, case studies (and quantitative methods) provide insights that are generalizable in terms of theory from the aggregated description (level 2 inference) (Lee and Baskerville 2003; Yin 2003). Such theoretical generalizability is bounded by the theory applied in the analysis, and for interpretive research evaluated on the grounds of "plausibility and cogency" (Walsham 1995). In this dissertation I examine IT strategy through a framework leveraging theory on e.g. evolution, dynamic capabilities and options. While I consider these to best explain the area of concern, a number of viable alternatives exist. For example, analysis through other

process theories on organizational change such as dialectics, teleology or life-cycle models are likely to generate alternative insights (Van de Ven and Poole 1995). Although IT strategy is a common area of concern across the empirical investigations, this was not explicit until the later phases of my studies. While components in the theoretical framework has been essential in my iterative approach to data collection and analysis, the final theorization on IT strategy is a product of the research (Walsham 1995). Implications include empirical grounding of findings but it might also have caused negligence of phenomena that would have been evident with a stronger theoretical guidance in conducting the studies. Overall, I have strived to provide rigor through transparency on the analytic generalizations made by justifying theoretical and methodological choices (Robey 1996). Neverthelsess, as in any resarch the impications rely heavily on choice of theories.

Second, drawing on four case studies provides rich insight on the multifaceted area of IT strategy but might also impose distance in interpretations, a triple hermeneutic. This dissertation is based on four distinct case studies that examines different facets of IT strategy. In outlining the general theoretical framework I have drawn on insights gained over a fiver year period. Doing so has involved revisiting findings in the studies and analyzing what implications they might have for IT strategy and digital capability. The analysis has not involved any conscious substantial re-interpretations. Nevertheless the studies where not analyzed through the overall theoretical framework. Hence, the larger framework has not been operationalized or applied to a specific context.

Third, the dissertation provides a theorization of digital capability and evolutionary mechanisms involved in generating it. While presenting a case on the coevolution of IT and business strategies there is no empirical tracing of neither the generation, nor the impact of digital capability. Accordingly, future studies should consider how to operationalize examination of evolutionary mechanisms and digital capability.

Fourth, important parts of the empirical investigations are retrospective (for example the ABB study), which might affect interpretations. While this is a serious limitation, I have tried to address it by collecting data from multiple informants and corroborate interpretations through archival documents when possible.

Fifth, this dissertation outlines four approaches to digital evolution but does not provide much guidance on how to select or implement

them. Future research on these issues could substantially improve usability of the conceptualization.

8 REFERENCES

Aanestad, M. and Blegind Jensen, T. (2011). Building Nation-Wide Information Infrastructures in Healthcare through Modular Implementation Strategies. *The Journal of Strategic Information Systems,* 20(2): 161-176.

Abernathy, W. J. and Utterback, J. M. (1978). Patterns of Industrial Innovation. *Journal Title: Technology review. Ariel,* 64: 254.228.

Adner, R. and Levinthal, D. A. (2004). What Is Not a Real Option: Considering Boundaries for the Application of Real Options to Business Strategy. *Academy of management review,* 29(1): 74-85.

Aldrich, H. E., Hodgson, G. M., Hull, D. L., Knudsen, T., Mokyr, J. and Vanberg, V. J. (2008). In Defence of Generalized Darwinism. *Journal of Evolutionary Economics,* 18(5): 577-596.

Alter, S. (2003). 18 Reasons Why IT-Reliant Work Systems Should Replace 'the IT Artifact' as the Core Subject Matter of the IS Field. *Communications of the AIS,* 12: 365-394.

Amit, R. and Schoemaker, P. H. J. (1993). *Strategic Assets and Organizational Rent*. 14**:** 33-46.

Arvidsson, V., Holmström, J. and Lyytinen, K. (2014). Information Systems Use as Strategy Practice: A Multi-Dimensional View of Strategic Information System Implementation and Use. *The Journal of Strategic Information Systems*.

Augier, M. and Teece, D. J. (2009). Dynamic Capabilities and the Role of Managers in Business Strategy and Economic Performance. *Organization Science,* 20(2): 410-421.

Bachelier, L. (1900). *Théorie De La Spéculation*, Gauthier-Villars.

Baldwin, C. Y. and Clark., K. B. (2006). Modularity in the Design of Complex Engineering Systems *Complex Engineered Systems: Science Meets Technology*. A. Minai, D. Braha and Y. Bar Yam. NY, Springer.

Barney, J. (1986). *Strategic Factor Markets: Expectations, Luck, and Business Strategy*. 32**:** 1231-1241.

Barney, J. (1991). Firm Resources and Sustained Competitive Advantage. *Journal of Management,* 17(1): 99-120.

Baum, J. A. C. and Singh, J. V. (1994). *Evolutionary Dynamics of Organization*. Oxford, Oxford University Press.

Beinhocker, E. D. (1999). Robust Adaptive Strategies. *Sloan Management Review*.

Benbasat, I. and Zmud, R. (2003). The Identity Crisis within the IS Discipline: Defining and Communicating the Discipline's Core Properties. *MIS Quarterly,* 27: 183-194.

Benbya, H. and McKelvey, B. (2006). Using Coevolutionary and Complexity Theories to Improve IS Alignment: A Multi-Level Approach. *Journal of Information Technology,* 21(4): 284-298.

Berente, N. (2009). *Conflicting Institutional Logics and the Loose Coupling of Practice with Nasa's Enterprise Information System*. Case Western Reserve University.

Bharadwaj, A., El Sawy, O. A., Pavlou, P. A. and Venkatraman, N. (2013). Digital Business Strategy: Toward a Next Generation of Insights. *MIS Quarterly,* 37(2): 471-482.

Bharadwaj, A., Sambamurthy, V. and Zmud, R. W. (1999). IT Capabilities: Theoretical Perspectives and Empirical Operationalization. *Proceedings of the 20th*

International Conference on Information Systems P. De and J. I. DeGross: 378-385. Charlotte, NC.

Bharadwaj, A. S. (2000). A Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation. *MIS Quarterly,* 24(1): 169-196.

Black, F. and Scholes, M. (1973). The Pricing of Options and Corporate Liabilities. *The Journal of Political Economy,* 81(3): 637-654.

Boczkowski, P. J. (2005). *Digitizing the News: Innovation in Online Newspapers*. London, England, MIT Press.

Bowman, E. H. and Hurry, D. (1993). *Strategy through the Option Lens: An Integrated View of Resource Investments and the Incremental-Choice Process*. 18**:** 760-782.

Braa, J., Monteiro, E. and Sahay, S. (2004). Networks of Action: Sustainable Health Information Systems across Developing Countries. *MIS Quarterly,* 28(3): 337-362.

Braun, V. and Clarke, V. (2006). Using Thematic Analysis in Psychology. *Qualitative research in psychology,* 3(2): 77-101.

Broadbent, M. (1998). *Leveraging the New Infrastructure: How Market Leaders Capitalize on Information Technology*, Harvard Business Press.

Brynjolfsson, E. and Hitt, L. M. (1998). Beyond the Productivity Paradox. *Communications of the ACM,* 41(8): 49-55.

Burke, K. (1984). *Permanence and Change: An Anatomy of Purpose*, Univ of California Press.

Bygstad, B. (2010). Generative Mechanisms for Innovation in Information Infrastructures. *Information and Organization,* 20(3): 156-168.

Camillus, J. C. (2008). Strategy as a Wicked Problem. *Harvard Business Review,* 86(5): 98-106.

Carlile, P. R., Nicolini, D. and Langley, A. (2013). *How Matter Matters: Objects, Artifacts, and Materiality in Organization Studies*, Oxford University Press.

Carter, C., Clegg, S. and Kornberger, M. (2008). Strategy as Practice. *Strategic organization,* 6(1): 83-99.

Cecez-Kecmanovic, D., Galliers, B., Henfridsson, O., Newell, S. and Vidgen, R. (2010). On Sociomateriality of Information Systems and Organizing. *Call for Papers–MISQ Special Issue).*

Chan, Y. E. and Reich, B. H. (2007). IT Alignment: What Have We Learned? *Journal of Information technology,* 22(4): 297-315.

Checkland, P. (1981). *Systems Thinking, Systems Practice*. Chichester, Wiley.

Chen, D. Q., Mocker, M., Preston, D. S. and Teubner, A. (2010). Information Systems Strategy: Reconceptualization, Measurement, and Implications. *MIS quarterly,* 34(2): 233-259.

Chen, M. J. and Miller, D. (2014). Reconceptualizing Competitive Dynamics: A Multidimensional Framework. *Strategic Management Journal.*

Chen, Y., Wang, Y., Nevo, S., Jin, J., Wang, L. and Chow, W. S. (2013). IT Capability and Organizational Performance: The Roles of Business Process Agility and Environmental Factors. *European Journal of Information Systems*.

Chesbrough, H., Vanhaverbeke, W. and West, J. (2008). *Open Innovation: Researching a New Paradigm*, OUP Oxford.

Christensen, C. M. (1997). *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail*, Harvard Business School Press.

Churchman, C. W. (1971). Design of Inquiring Systems: Basic Concepts of Systems and Organization.

Ciborra, C. (2000). *From Control to Drift: The Dynamics of Corporate Information Infrastructures*. Oxford, UK, Oxford University Press.
Cohen, W. M. and Levinthal, D. A. (1990). Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly,* 35(1).
Collis, D. J. (1994). Research Note: How Valuable Are Organizational Capabilities? *Strategic management journal,* 15(S1): 143-152.
Conner, K. R. and Prahalad, C. K. (1996). A Resource Based Theory of the Firm: Knowledge Versus Opportunism. *Organization Science,* 7: 477-501.
Corradi, G., Gherardi, S. and Verzelloni, L. (2010). Through the Practice Lens: Where Is the Bandwagon of Practice-Based Studies Heading? *Management learning,* 41(3): 265-283.
D'aveni, R. A. (1994). *Hypercompetition: Managing the Dynamics of Strategic Maneuvering*. New York, Free Press.
D'Aveni, R. A., Dagnino, G. B. and Smith, K. G. (2010). The Age of Temporary Advantage. *Strategic Management Journal,* 31(13): 1371-1385.
Davenport, T. H. (1998). *Putting the Enterprise into the Enterprise System*. 76**:** 121-131.
Davenport, T. H. (2013). *Process Innovation: Reengineering Work through Information Technology*, Harvard Business Press.
Davenport, T. H. and Short, J. E. (1990). The New Industrial Engineering: Information Technology and Business Process Redesign. *Sloan management review,* 31(4).
Davis, G. B. (2006). Information Systems as an Academic Discipline. *The Past and Future of Information Systems: 1976–2006 and Beyond*: 11-25, Springer.
Dawkins, R. (2006). *The Selfish Gene*, Oxford university press.
Dickson, G. W. (1981). Management Information Systems: Evolution and Status. *Advances in computers,* 20(1): 1-37.
Drnevich, P. L. and Croson, D. C. (2013). Information Technology and Business-Level Strategy: Toward an Integrated Theoretical Perspective. *MIS Quarterly,* 37(2).
Duncan, R. B. (1976). The Ambidextrous Organization: Designing Dual Structures for Innovation. *The Management of Organization Design*. R. H. Kilmann, L. R. Pondy and D. P. Slevin: 167-188. New York, Elsevier North-Holland.
Ehn, P. (1988). *Work-Oriented Design of Computer Artifacts*, Arbetslivscentrum Stockholm.
Eisenhardt, K. and Martin, J. (2000). Dynamic Capabilities: What Are They? *Strategic Management Journal*: 1105-1121.
Eisenmann, T., Parker, G. and Van Alstyne, M. W. (2006). Strategies for Two-Sided Markets. *Harvard Business Review,* 84(10): 92.
El Sawy, O. A. (2003). *The IS Core Ix: The 3 Faces of IS Identity: Connection, Immersion, and Fusion*. 12**:** 588-598.
El Sawy, O. A., Malhotra, A., Park, Y. and Pavlou, P. A. (2010). Research Commentary-Seeking the Configurations of Digital Ecodynamics: It Takes Three to Tango. *Information Systems Research,* 21(4): 835-848.
Feldman, M. S. (2004). Resources in Emerging Structures and Processes of Change. *Organization Science,* 15(3): 295-309.
Feldman, M. S. and Orlikowski, W. J. (2011). Theorizing Practice and Practicing Theory. *Organization Science,* 22(5): 1240-1253.
Feldman, M. S. and Pentland, B. T. (2003). *Reconceptualizing Organizational Routines as a Source of Flexibility and Change*. 48**:** 94-118.
Ferrier, W. J. and Smith, K. G. (1999). The Role of Competitive Action in Market Share Erosion and Industry Dethronement: A Study of Industry Leaders and Challengers. *Academy of Management Journal,* 42: 372-388.

Flyvbjerg, B. (2006). Five Misunderstandings About Case-Study Research. *Qualitative inquiry,* 12(2): 219-245.

Galliers, R. D. (2007). On Confronting Some of the Common Myths of Information Systems Strategy Discourse. *The Oxford Handbook of Information and Communication Technology*. R. Mansell, C. Avgerou, D. Quah and R. Silverstone: 225-243. Oxford, Oxford University Press.

Galliers, R. D. (2011). Furher Developments in Information Systems Strategizing: Unpacking the Concept. *The Oxford Handbook of Management Information Systems: Critical Perspectives and New Directions*. R. D. Galliers and W. Currie, Oxford University Press.

Geertz, C. (1973). *The Interpretation of Cultures*. New York, Basic Books.

Gherardi, S. (2009). Introduction: The Critical Power of Thepractice Lens'. *Management learning,* 40(2): 115-128.

Gibson, C. and Birkinshaw, J. (2004). The Antecedents, Consequences, and Mediating Role of Organizational Ambidexterity. *Academy of Management Journal,* 47(2): 209-226.

Giddens, A. (1976). *New Rules of Sociological Method*. London, Hutchinson.

Glaser, B. C. and Strauss, A. L. (1967). *The Discovery of Grounded Theory - Strategies for Qualitative Research*. Chicago, IL, Aldine Publishing Company.

Goldberg, A. D., Allis, C. D. and Bernstein, E. (2007). Epigenetics: A Landscape Takes Shape. *Cell,* 128(4): 635-638.

Gregor, S. (2006). The Nature of Theory in Information Systems. *MIS Quarterly,* 30(3): 611-642.

Grint, K. and Woolgar, S. (1992). Computers, Guns, and Roses: What's Social About Being Shot? *Science, Technology, and Human Values*: 366-380.

Grover, V. and Kohli, R. (2013). Revealing Your Hand: Caveats in Implementing Digital Business Strategy. *MIS Quarterly,* 37(2).

Haeckel, S. (1999). *Adaptive Enterprise: Creating and Leading Sense-and-Respond Organizations*. Boston, MA, Harvard Business School Press.

Hammer, M. (1990). Reengineering Work: Don't Automate, Obliterate. *Harvard Business Review,* 68(4): 104-112.

Hanseth, O. and Lyytinen, K. (2010). Design Theory for Dynamic Complexity in Information Infrastructures: The Case of Building Internet. *Journal of Information Technology,* 25(1): 1-19.

Hanseth, O., Monteiro, E. and Hatling, M. (1996). Developing Information Infrastructure: The Tension between Standardisation and Flexibility. *Science, Technology & Human Values,* 21: 407-426.

Hargadon, A. B. (2002). Brokering Knowledge: Linking Learning and Innovation. *Research in Organizational behavior,* 24: 41-86.

Helfat, C., Finkelstein, S., Mitchell, W., Peteraf, M. A., Singh, H., Teece, D. J. and Winter, S. (2007). *Dynamic Capabilities: Understanding Strategic Change in Organizations*. Oxford, UK., Blackwell.

Helfat, C. E. and Peteraf, M. A. (2003). The Dynamic Resource-Based View: Capability Lifecycles. *Strategic management journal,* 24(10): 997-1010.

Helfat, C. E. and Raubitschek, R. S. (2000). Product Sequencing: Co-Evolution of Knowledge, Capabilities and Products. *Strategic Management Journal,* 21(10-11): 961-979.

Helfat, C. E. and Winter, S. G. (2011). Untangling Dynamic and Operational Capabilities: Strategy for the (N) Ever-Changing World. *Strategic Management Journal,* 32(11): 1243-1250.

Henderson, R. M. and Clark, K. B. (1990). Architectural Innovation: The Reconfiguration of Existing Product Technologies and the Failure of Established Firms. *Administrative Science Quarterly*: 9-30.

Henfridsson, O. (1999). *IT-Adaptation as Sensemaking: Inventing New Meaning for Technology in Organizations*. Department of Informatics. Umeå University.

Henfridsson, O. and Bygstad, B. (2013). The Generative Mechanisms of Digital Infrastructure Evolution. *MIS Quarterly, forthcoming.*

Henfridsson, O. and Lind, M. (2013). Information Systems Strategizing, Organizational Sub-Communities, and the Emergence of a Sustainability Strategy. *The Journal of Strategic Information Systems*.

Hirschheim, R. (1985). Information Systems Epistemology: An Historical Perspective. *Research methods in information systems*: 13-35.

Hirschheim, R. and Klein, H. K. (2012). A Glorious and Not-So-Short History of the Information Systems Field. *Journal of the Association for Information Systems,* 13(4).

Hodgson, G. M. (2005). Generalizing Darwinism to Social Evolution: Some Early Attempts. *Journal of Economic Issues*: 899-914.

Hodgson, G. M. (2013). Understanding Organizational Evolution: Toward a Research Agenda Using Generalized Darwinism. *Organization Studies,* 34(7): 973-992.

Holmström, J. (2000). *Information System and Organization as Multipurpose Network*. Department of Informatics. Umeå.

Holmström, J., Mathiassen, L., Sandberg, J. and Wimelius, H. (2011). Green IS: Steps Towards a Research Agenda. *Green Technologies: Concepts, Methodologies, Tools and Applications* 27-35, IGI Global.

Holmström, J., Sandberg, J. and Mathiassen, L. (2011). Educating Reflective Practitioners: The Design of an IT Management Masters Program. *AMCIS Proceedings*: Paper 247. Detroit.

Holmström, J. and Truex, D. (2011). Dropping Your Tools: Exploring When and How Theories Can Serve as Blinders in IS Research. *Communications of the Association for Information Systems,* 28.

Holmström, J., Wiberg, M. and Lund, A. (2010). *Industrial Informatics Design, Use and Innovation: Perspectives and Services*, IGI Global.

Holsapple, C. W. and Jin, H. (2007). Connecting Some Dots: E-Commerce, Supply Chains, and Collaborative Decision Making. *Decision Line,* 38(5): 14-21.

Hopper, M. D. (1990). Rottling Sabre—New Woys to Compete on Information. *Harvard Business Review,* May/June: 118-125.

Iivari, J. and Lyytinen, K. (1999). Research on Information Systems Development in Scandinavia. *Rethinking Management Information Systems*: 57-102.

Iversen, J., Mathiassen, L. and Nielsen, P. A. (2004). Managing Risk in Software Process Improvement: An Action Research Approach. *MIS Quarterly,* 28(3): 395-433.

Jarzabkowski, P. (2003). Strategic Practices: An Activity Theory Perspective on Continuity and Change. *Journal of Management studies,* 40(1): 23-55.

Jarzabkowski, P. (2004). Strategy as Practice: Recursiveness, Adaptation, and Practices-in-Use. *Organization studies,* 25(4): 529-560.

Jarzabkowski, P. and Pinch, T. (2013). Sociomateriality Is 'the New Black': Accomplishing Repurposing, Reinscripting and Repairing in Context. *M@n@gement,* 16(5): 579-592.

Jarzabkowski, P. and Spee, A. P. (2009). Strategy-as-Practice: A Review and Future Directions for the Field. *International Journal of Management Reviews,* 11(1): 69-95.
Johnson, G., Melin, L. and Whittington, R. (2003). Guest Editors' Introduction. *Journal of management studies,* 40(1): 3-22.
Jonsson, K., Westergren, U. H. and Holmström, J. (2008). Technologies for Value Creation: An Exploration of Remote Diagnostics Systems in the Manufacturing Industry. *Information Systems Journal,* 18(3): 227-245.
Kauffman, S. A. (1993). *The Origins of Order: Self-Organization and Selection in Evolution*, Oxford university press.
King, J. L. and Lyytinen, K. (2006). *Information Systems: The State of the Field*, John Wiley & Sons.
Kirschner, M. and Gerhart, J. (1998). Evolvability. *Proceedings of the National Academy of Sciences,* 95(15): 8420-8427.
Kirzner, I. M. (1973). *Competition and Entrepreneurship*. Chicago, University of Chicago Press.
Klein, H. and Myers, M. (1999). A Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems. *MIS Quarterly,* 23(1): 67-94.
Kling, R. (1991). Reply to Woolgar and Grint: A Preview. *Science, Technology, and Human Values*: 379-381.
Kling, R. (1992). When Gunfire Shatters Bone: Reducing Sociotechnical Systems to Social Relationships. *Science, Technology, and Human Values*: 381-385.
Kogut, B. and Kulatilaka, N. (1994). Options Thinking and Platform Investments: Investing in Opportunity. *California Management Review,* 36: 52-71.
Kogut, B. and Kulatilaka, N. (2001). Capabilities as Real Options. *Organization Science,* 12(6): 744-758.
Kohli, R. and Grover, V. (2008). Business Value of IT: An Essay on Expanding Research Directions to Keep up with the Times. *Journal of the association for information systems,* 9(1).
Lamb, R. and Kling, R. (2003). Reconceptualizing Users as Social Actors in Information Systems Research. *MIS Quarterly*: 197-236.
Langefors, B. (1966). *Theoretical Analysis of Information Systems*. Lund, Studentlitteratur.
Leavitt, H. J. and Whisler, T. L. (1958). Management in the 1980s. *Harvard Business Review,* 36: 41-48.
Lee, A. S. and Baskerville, R. L. (2003). *Generalizing Generalizability in Information Systems Research*. 14**:** 221-243.
Lee, J. and Berente, N. (2012). Digital Innovation and the Division of Innovative Labor: Digital Controls in the Automotive Industry. *Organization Science,* 23(5): 1428-1447.
Leonardi, P. (2011). When Flexible Routines Meet Flexible Technologies: Affordance, Constraint, and the Imbrication of Human and Material Agencies. *MIS Quarterly,* 35(1): 147-167.
Leonardi, P. M. and Barley, S. R. (2010). What's under Construction Here? Social Action, Materiality, and Power in Constructivist Studies of Technology and Organizing. *The Academy of Management Annals,* 4(1): 1-51.
Levina, N. and Vaast, E. (2005). The Emergence of Boundary Spanning Competence in Practice: Implications for Implementation and Use of Information Systems. *MIS quarterly*: 335-363.

Lewin, A. Y. and Volberda, H. W. (1999). Prolegomena on Coevolution: A Framework for Research on Strategy and New Organizational Forms. *Organization science,* 10(5): 519-534.

Luehrman, T. (1998). Strategy as a Portfolio of Real Options. *Harvard Business Review,* 76(September-October): 89-101.

Lyytinen, K. and King, J. (2004). Nothing at the Center? Academic Legitimacy in the Information Systems Field. *Journal of Association for information Systems,* 5.

Majchrzak, A. and Markus, L. (2012). *Technology Affordances and Constraint Theory of Mis*. Thousand Oaks, CA, Sage.

Makadok, R. (2001). *Toward a Synthesis of the Resource-Based and Dynamic-Capability Views of Rent Creation*. 22**:** 387-401.

Mallat, N., Rossi, M. and Tuunainen, V. K. (2004). Mobile Banking Services. *Communications of the ACM,* 47(5): 42-46.

March, J. G. (1991). Exploration and Exploitation in Organizational Learning. *Organization Science,* 2: 71-87.

Markus, M. L. (1983). Power, Politics, and Mis Implementation. *Communications of the ACM,* 26(6): 430-444.

Markus, M. L. and Robey, D. (1988). *Information Technology and Organizational Change: Causal Structure in Theory and Research*. 34**:** 583-598.

Marx, K. (2004). *Capital: A Critique of Political Economy*, Digireads. com Publishing.

Mason, J. (2002). *Qualitative Researching*. London, Sage.

Mathiassen, L. (1998). Reflective Systems Development. *Scandinavian Journal of Information Systems,* 10: 67-118.

Mathiassen, L. and Nielsen, P. A. (2008). Engaged Scholarship in IS Research. *Scandinavian Journal of Information Systems,* 20(2): 3-20.

McAfee, A. and Brynjolfsson, E. (2008). Investing in the IT That Makes a Competitive Difference. *Harvard Business Review,* 86(7/8): 98.

McGrath, R. G. (1999). Falling Forward: Real Options Reasoning and Entrepreneurial Failure. *Academy of Management review,* 24(1): 13-30.

McKelvey, B. (1999). Avoiding Complexity Catastrophe in Coevolutionary Pockets: Strategies for Rugged Landscapes. *Organization Science,* 10(3): 294-321.

McLean, E. R. and Soden, J. V. (1977). *Strategic Planning for Mis*, John Wiley & Sons.

Melville, N., Kraemer, K. and Gurbaxani, V. (2004). *Review: Information Technology and Organizational Performance: An Integrative Model of IT Business Value*. 28**:** 283-322.

Mintzberg, H. (1978). Patterns in Strategy Formation. *Management science,* 24(9): 934-948.

Mintzberg, H. (1994). The Fall and Rise of Strategic Planning. *Harvard Business Review,* 72(1): 107-114.

Mumford, E. and Weir, M. (1979). *Computer Systems Work Design: The Ethics Method*. London, Associated Business Press.

Myers, M. D. (2009). *Qualitative Research in Business and Management*, Sage.

Myers, S. C. (1977). Determinants of Corporate Borrowing. *Journal of financial economics,* 5(2): 147-175.

Ndofor, H. A., Sirmon, D. G. and He, X. (2011). Firm Resources, Competitive Actions and Performance: Investigating a Mediated Model with Evidence from the in-Vitro Diagnostics Industry. *Strategic Management Journal,* 32(6): 640-657.

Nelson, R. R. and Winter, S. G. (1982). *An Evolutionary Theory of Economic Change*. Cambridge, MA, Harvard University Press.

Newell, S., Swan, J. and Galliers, R. (2000). A Knowledge Focused Perspective on the Diffusion of Complex Information Technologies: The BPR Example. *Information Systems Journal,* 10: 239-259.

Nygaard, K. and Bergo, O. T. (1975). The Trade Unions-New Users of Research. *Personnel Review,* 4(2): 5-10.

Nylén, D., Holmström, J. and Lyytinen, K. (2014). Oscillating between Four Orders of Design: The Case of Digital Magazines. *Design Issues,* 30(3): 53-68.

Orlikowski, W. and Baroudi, J. J. (1991). Studying Information Technology in Organizations: Research Approaches and Assumptions. *Information Systems Research,* 2(1): 1-28.

Orlikowski, W. J. (1992). The Duality of Technology: Rethinking the Concept of Technology in Organizations. *Organization Science,* 3(3): 398-427.

Orlikowski, W. J. (2000). *Using Technology and Constituting Structures: A Practice Lens for Studying Technology in Organizations*. 11**:** 404-428.

Orlikowski, W. J. (2002). Knowing in Practice: Enacting a Collective Capability in Distributed Organizing. *Organization Science,* 13(3): 249-273.

Orlikowski, W. J. (2007). Sociomaterial Practices: Exploring Technology at Work. *Organization studies,* 28(9): 1435-1448.

Orlikowski, W. J. and Robey, D. (1991). Information Technology and the Structuring of Organizations. *Information Systems Research,* 2(2): 143-169.

Orlikowski, W. J. and Scott, S. V. (2008). Sociomateriality: Challenging the Separation of Technology, Work and Organization. *The academy of management annals,* 2(1): 433-474.

Pavlou, P. and El Sawy, O. (2010). The "Third Hand": IT-Enabled Competitive Advantage in Turbulence through Improvisational Capabilities. *Information Systems Research,* 21(3): 443-471.

Pavlou, P. A. and El Sawy, O. A. (2011). Understanding the Elusive Black Box of Dynamic Capabilities. *Decision Sciences,* 42(1): 239-273.

Penrose, E. T. (1959). *The Theory of the Growth of the Firm*. New York, Wiley.

Peppard, J., Galliers, R. D. and Thorogood, A. (2014). Information Systems Strategy as Practice: Micro Strategy and Strategizing for IS. *The Journal of Strategic Information Systems*.

Peppard, J. and Ward, J. (2004). Beyond Strategic Information Systems: Towards an IS Capability. *The Journal of Strategic Information Systems,* 13(2): 167-194.

Perkmann, M. and Walsh, K. (2007). University-Industry Relationships and Open Innovation: Towards a Research Agenda. *International Journal of Management Reviews,* 9(4): 259-280.

Porter, M. (1980). *Competitive Strategy: Techniques for Analyzing Industries and Competitors*. New York, The Free Press.

Porter, M. E. and May (2001). Strategy and the Internet. *Harvard Business Review,* 79: 63-78.

Priem, R. L. and Butler, J. E. (2001). *Is the Resource-Based "View" a Useful Perspective for Strategic Management Research?* 26**:** 22-40.

Ray, G., Barney, J. B. and Muhanna, W. A. (2004). Capabilities, Business Processes, and Competitive Advantage: Choosing the Dependent Variable in Empirical Tests of the Resource-Based View. *Strategic management journal,* 25(1): 23-37.

Reckwitz, A. (2002). Toward a Theory of Social Practices a Development in Culturalist Theorizing. *European journal of social theory,* 5(2): 243-263.

Regnér, P. (2008). Strategy-as-Practice and Dynamic Capabilities: Steps Towards a Dynamic View of Strategy. *Human Relations,* 61(4): 565-588.

Robey, D. (1996). *Research Commentary: Diversity in Information Systems Research: Threat, Promise, and Responsibility*. 7**:** 400-408.

Robey, D. (1996). Research Commentary: Diversity in Information Systems Research: Threat, Promise, and Responsibility. *Information Systems Research,* 7: 400-408.

Rolland, K. and Monteiro, E. (2002). Balancing the Local and the Global in Infrastructural Information Systems. *The Information Society,* 18(2): 87-100.

Ross, J. W., Weill, P. and Robertson, D. C. (2006). *Enterprise Architecture as Strategy: Creating a Foundation for Business Execution*, Harvard Business Press.

Sabherwal, R., Hirscheim, R. and Goles, T. (2001). The Dynamics of Alignment: Insights from a Punctuated Equilibrium Model. *Organization Science,* 12: 179-197.

Sambamurthy, V., Bharadwal, A. S. and Grover, V. (2003). Shaping Agility through Digital Options: Reconceptualizing the Role of Information Technology in Contemporary Firms. *MIS Quarterly,* 27(2): 237-263.

Sandberg, J. and Holmström, J. (2008). From Drift to Control: Examining Modular Architecture and Standardization of Organizational Processes through ERP Systems. *Proceedings of 31th Information Systems Research Seminar in Scandinavia*. V. Asproth. Åre.

Sandberg, J., Holmström, J. and Levén, P. (2009). Overcoming the Alliance/Innovation Paradox: Enacting Fractionated Trading Zones in Academy/Industry Collaboration. *Proceedings of the 32nd Information Systems Research Seminar in Scandinavia*. Molde, Norway.

Sandberg, J., Holmström, J. and Lyytinen, K. (2009). Decelerated IT Innovation: Negotiating Global IT Innovation Initiatives in Local Settings. *Proceedings of JAIS Theory Development Workshop*. Phoenix.

Sandberg, J., Holmström, J. and Lyytinen, K. (2010). Decelerated IT Innovation: Negotiating Global IT Innovation Initiatives in Local Settings. *HICSS-43 Proceedings*. Kauai, HI, USA, IEEE Computer Society.

Sayer, A. (2000). *Realism and Social Science*. London, Sage Publications.

Schatzki, T. R. (1996). *Social Practices: A Wittgensteinian Approach to Human Activity and the Social*, Cambridge Univ Press.

Scholz, M. and Reydon, T. A. (2013). On the Explanatory Power of Generalized Darwinism: Missing Items on the Research Agenda. *Organization Studies,* 34(7): 993-999.

Schumpeter, J. A. (1934). *The Theory of Economic Development*. Cambridge, MA, Harvard University Press.

Schumpeter, J. A. (1942). *Capitalism, Socialism and Democracy*. New York, Harper and Row.

Seawright, J. and Gerring, J. (2008). Case Selection Techniques in Case Study Research a Menu of Qualitative and Quantitative Options. *Political Research Quarterly,* 61(2): 294-308.

Sein, M., Henfridsson, O., Purao, S., Rossi, M. and Lindgren, R. (2011). Action Design Research. *MIS Quarterly,* 35(1): 37-56.

Selander, L., Henfridsson, O. and Svahn, F. (2013). Capability Search and Redeem across Digital Ecosystems. *Journal of Information Technology,* 28(3): 183-197.

Shane, S. and Venkataraman, S. (2000). The Promise of Entrepreneurship as a Field of Research. *Academy of management review,* 25(1): 217-226.

Sharp, D. J. (1991). Uncovering the Hidden Value in High-Risk Investments. *Sloan Management Review,* 32(2): 69-74.

Siegel, P. (1975). *Strategic Planning of Management Information Systems*, Petrocelli Books.

Sirmon, D. G., Hitt, M. A. and Ireland, R. D. (2007). Managing Firm Resources in Dynamic Environments to Create Value: Looking inside the Black Box. *Academy of management review,* 32(1): 273-292.

Smith, K. G., Grimm, C., Gannon, M. and Chen, M.-J. (1991). Organizational Information Processing, Competitive Responses and Performance in the U.S. Domestic Airline Industry. *Academy of Management Journal,* 34: 60-85.

Stene, E. O. (1940). An Approach to a Science of Administration. *American Political Science Review,* 34(06): 1124-1137.

Stoel, D. and Waleed, M. (2009). IT Capabilities and Firm Performance: A Contingency Analysis of the Role of Industry and IT Capability Type. *Information & Management,* 46(3): 181-189.

Stolterman, E. (1991). *Designarbetets Dolda Rationalitet : En Studie Av Metodik Och Praktik Inom Systemutveckling*. Department of Informatics. Umeå University.

Stolterman, E. (1992). How System Designers Think About Design and Methods. *Scandinavian Journal of Information Systems,* 4: 137-150.

Straub, D., Gefen, D. and Boudreau, M.-C. (2004) "The IS World Quantitative, Positivist Research Methods Website."

Svahn, F. (2012). *Digital Product Innovation: Building Generative Capability through Architectural Frames*. Department of Informatics. Umeå University.

Tanriverdi, H., Rai, A. and Venkatraman, N. (2010). Research Commentary-Reframing the Dominant Quests of Information Systems Strategy Research for Complex Adaptive Business Systems. *Information Systems Research,* 21(4): 822-834.

Teece, D. (2007). Explicating Dynamic Capabilities: The Nature and Microfoundations of (Sustainable) Enterprise Performance. *Strategic Management Journal,* 28(13): 1319-1350.

Teece, D. J., Pisano, G. and Shuen, A. (1997). Dynamic Capabilities and Strategic Management. *Strategic Management Journal,* 18(7): 509-533.

Vaara, E. and Whittington, R. (2012). Strategy-as-Practice: Taking Social Practices Seriously. *The Academy of Management Annals,* 6(1): 285-336.

Van de Ven, A. and Poole, M. (1995). Explaining Development and Change in Organizations. *Academy of Management Review,* 20(3): 510-540.

Van de Ven, A. H. (2007). *Engaged Scholarship: A Guide for Organizational and Social Research*, Oxford University Press, USA.

Volberda, H. W. and Lewin, A. Y. (2003). Co-Evolutionary Dynamics within and between Firms: From Evolution to Co-Evolution. *Journal of management studies,* 40(8): 2111-2136.

Wade, M. and Hulland, J. (2004). The Resource-Based View and Information Systems Research: Review, Extension, and Suggestions for Future Research. *MIS Quarterly,* 28(1): 107-142.

Walsham, G. (1993). *Interpreting Information Systems in Organizations*. New York, John Wiley & Sons.

Walsham, G. (1995). Interpretive Case Study in IS Research: Nature and Method. *European Journal of Information Systems*: 74-81.

Weick, K. E. (1969). *The Social Psychology of Organizing*. Reading, Addison-Wesley.

Weick, K. E. (1995). *Sensemaking in Organizations*. Thousand Oaks, CA, Sage Publications.

Weill, P. and Aral, S. (2006). Generating Premium Returns on Your IT Investments. *Sloan Management Review,* 47(2).

Westergren, U. H. and Holmström, J. (2012). Exploring Preconditions for Open Innovation: Value Networks in Industrial Firms. *Information and Organization,* 22(4): 209-226.

Whittington, R. (2006). Completing the Practice Turn in Strategy Research. *Organization studies,* 27(5): 613-634.

Wiberg, M. (2005). *The Interaction Society: Practice, Theories and Supportive Technologies*, Information Science Pub.

Wiggins, R. R. and Ruefli, T. W. (2005). Schumpeter's Ghost: Is Hypercompetition Making the Best of Times Shorter? *Strategic Management Journal,* 26(10): 887-911.

Wimelius, H. (2011). *Duplicate Systems: Investigating Unintended Consequences of Information Technology in Organizations*.

Winter, S. G. (2000). The Satisficing Principle in Capability Learning. *Strategic Management Journal,*(21): 981-996.

Winter, S. G. (2003). Understanding Dynamic Capabilities. *Strategic Management Journal,*(24): 991-995.

Woodard, C. J., Ramasubbu, N., Tschang, F. T. and Sambamurthy, V. (2013). Design Capital and Design Moves: The Logic of Digital Business Strategy. *MIS Quarterly,* 37(2).

Woolgar, S. and Grint, K. (1991). Computers and the Transformation of Social Analysis. *Science, Technology, and Human Values*: 368-378.

Yin, R. K. (2003). *Case Study Research: Design and Methods*. Thousand Oaks, Sage.

Yoo, Y., Boland, R. J., Lyytinen, K. and Majchrzak, A. (2009). Special Issue: Organizing for Innovation in the Digitized World. *Organization Science,* 20(1): 278-279.

Yoo, Y., Boland, R. J., Lyytinen, K. and Majchrzak, A. (2012). Organizing for Innovation in the Digitized World. *Organization Science,* 23(5): 1398-1408.

Yoo, Y., Henfridsson, O. and Lyytinen, K. (2010). Research Commentary: The New Organizing Logic of Digital Innovation: An Agenda for Information Systems Research. *Information Systems Research,* 21(4): 724-735.

Zahra, S. A. and George, G. (2002). Absorptive Capacity: A Review, Reconceptualization, and Extension. *Academy of Management Review,* 27: 185-203.

Zammuto, R. F., Griffith, T. L., Majchrzak, A., Dougherty, D. J. and Faraj, S. (2007). Information Technology and the Changing Fabric of Organization. *Organization Science,* 18(5): 749-762.

Zenger, T. R. and Hesterly, W. S. (1997). The Disaggregation of Corporations: Selective Intervention, High-Powered Incentives, and Molecular Units. *Organization Science,* 8(3): 209-222.

Zittrain, J. L. (2006). The Generative Internet. *Harvard Law Review*: 1974-2040.