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Information system development agility as organizational learning

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Abstract

Information System Development (ISD) agility is concerned with why and how ISD organizations sense and respond swiftly as they develop and maintain Information System applications. We outline a theory of ISD agility that draws upon a model of IT innovation and organizational learning. The theory adopts March's concepts of exploration and exploitation to investigate agility in the context of ISD organizations. Depending on their learning focus, ISD organizations make choices as to what sensing and responding swiftly means. This is reflected in how they value speed in relation to other ISD process goals, including quality, cost, risk and innovative content. The paper examines two specific Research Propositions: (1) ISD organizations locate themselves into different innovation regimes with respect to their need for exploration and exploitation, and (2) their perceptions of agility differ in those regimes as reflected in their process goal priorities. We validate these propositions through an empirical investigation of changes in ISD organizations' process goals and innovation practices over a period of over 4 years (1999–2003), during which time they shied away from exploration to exploitation while innovating with Internet computing. These ISD organizations viewed agility differently during the studied time periods as reflected in how they traded innovative content or speed vis-à-vis the other process goals of cost, risk, and product quality. In conclusion, this paper discusses implications for future research on agility in ISD organizations.

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Introduction

Agility can be defined in general as the quality or capability of being quick moving and nimble. In the context of information system development (ISD), agility can be defined as an ISD organization's ability to sense and respond swiftly to technical changes and new business opportunities. Accordingly, an agile ISD organization, one that develops and maintains Information System (IS), has the capability to sense and respond to unexpected environmental changes and to hone these skills to quickly deliver IS. The need for agility in ISD organizations has not been well recognized in the past literature. The focus here has been reducing variance in ISD products and processes and thereby increasing system validity and quality. Consequently, research has aimed at increasing process repeatability and control (Humphrey, 1989; Curtis *et al*., 1992) where researchers assume, *Ceteris paribus,* that development speed and products remain relatively constant and thus, ISD organizations do not need to be agile.

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Some of these assumptions were challenged in the 1990s when the rebels of the new economy proposed alternatives to the traditional ISD approaches: systems had to be developed flexibly in and for the market at a fast pace. 'Internet speed' became *mot dú jour* (see e.g., Pressman, 1998; Cusumano & Yoffie, 1999; Baskerville *et al.*, 2001; Carstensen & Vogelsang, 2001; Lyytinen & Rose, 2003a, b) and agility mattered for ISD organizations. Consequently, a significant proportion of system development research over the past several years has portrayed some type of agility as a desirable feature of good ISD practice (Cusumano & Yoffie, 1999; Turk *et al.*, 2004; Henderson-Sellars & Serour, 2005). This aligns with the new demands of global hyper-competition and dynamic capability (Cohen & Levinthal, 1990; D'aveni, 1994; Eisenhardt & Tabrizi, 1995; Eisenhardt and Martin, 2000) as well as with the principles of rapid product development (Kessler & Chakrabarti, 1996, 1999; Kessler & Bierly, 2002; Menon *et al.*, 2002) that have changed the environment of ISD organizations. In consequence, a steady stream of research on agility has emerged, and new agile ISD approaches (e.g., Extreme Programming, SCRUM, adaptive ISD, Agile Unified Process) have been promoted (Henderson-Sellars, 2005; Turk *et al.*, 2004). These approaches organize for the fast incremental delivery of system releases, based on constant monitoring of customer needs. Their main goal is in changing micro-processes and work arrangements during ISD by increasing the focus on code, improving communications, decreasing overhead, and by submitting to an early and consistent system delivery (Agile Alliance, 2002). These approaches make system delivery agile in two ways: (1) they shorten the time that elapses between system releases and enable flexible monitoring of development outcomes (e.g. Extreme Programming Turk *et al.*, 2004), and (2) they deliver the same functionality more quickly and with higher quality (Baskerville *et al.*, 2001; Lyytinen & Rose, 2003a). Their limitation is that they view agility only in the micro-context of software delivery and have not explored agility as a broader organizational response to environmental challenges.

To our knowledge, there are currently no studies that explore agility at the meso-level of ISD organizations: how changes in their system delivery processes influence or are influenced by environmental demands for agility (i.e., how the need for process agility reflects adaptations to a broader ecology of information technology (IT) and business innovations in which the ISD organization is embedded (Lyytinen *et al.*, 2005)). To address this void, this paper examines an ISD organization's agility where ISD delivery processes are understood broadly as IT innovation processes. In particular, this paper examines how the nature and scope of IT innovation and related organizational learning needs influence ISD agility. Hence, this paper investigates: (1) What types of agility can be identified within ISD organizations, and what are the antecedents to these types of agility? and, (2) How do different needs of agility influence ISD process goals and how they interact with one another?

We address these questions both through theory development and empirical analysis. First, the paper refines the concept of ISD agility, recognizing different types of agility needed during exploration and exploitation – the two modes of organizational learning that underlie organizational innovation (March, 1991) – and explores the antecedents for these types of agility by formulating a model of organizational learning associated with IT innovation (Levitt & March, 1988; March, 1991; Levinthal & March, 1993) (Question 1). Second, the paper examines how organizational learning demands vary during consecutive stages of IT innovation. Likewise, it investigates if these learning types set limits on the type of agility and explores how these varying needs for agility are reflected in ISD process goals (Question 2). The paper validates these claims by scrutinizing a longitudinal data set (covering over a 4-year period) collected in seven ISD organizations that adopted Internet computing during the dot-com boom. In particular, the paper investigates how organizational learning types can predict changes in process goals during innovation stages.

The remainder of the paper is organized as follows. Section 2 formulates the ISD agility model and reviews the literature in organizational learning. Section 3 describes the field study and research methodology, while Section 4 reports the main findings of the field study. The paper concludes by observing remaining research challenges, and discussing managerial implications.

ISD agility model

IT innovation

IT innovation has multiple sources and a broad scope (Swanson, 1994). Most IT-related innovations, such as agile ISD development, do not form a singular event but often subsume a chain of changes in IT capability or organizational design, each of which can portray significant departures from existing practices. Thus, a process innovation like adopting agile development can hinge on a complex ecology of antecedent innovations (Swanson, 1994; Lyytinen and Rose, 2003a).

Figure 1 shows the three primary activities in the IT value chain in which innovations can emerge. The arrows in Figure 1 illustrate how downstream organizations adopt innovations produced by upstream companies and activities in order to increase the overall scope and quality of their IT deployment. The three main types of IT innovations include the following:

(1) the creation of IT base technologies such as operating systems (referred to here as base or Type 0 innovation);
(2) the creation of processes, technologies and organizational arrangements for ISD that enable enhanced,

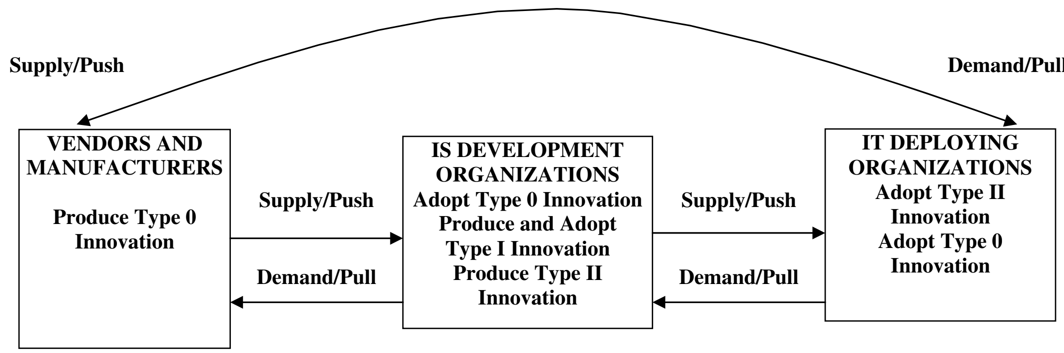

Figure 1 IT value chain and realms of IT innovation.

faster or more reliable delivery of IS (called Type I innovation) (see e.g. Mustonen-Ollila & Lyytinen, 2004); and
(3) the discovery and adoption of new types of IS solutions (Type II innovation) by organizations.[1]

Overall, an IT innovation can mean many things to different people, including the following (Lyytinen & Rose, 2003a, b):

(1) novel breakthroughs in computing capability (Type 0 innovation);
(2) departures from current ways of developing IS (Type I innovation); or
(3) novel IS applications adopted by organizations (Type II innovation).

The model implies that IT innovation can take place in any part of the chain, and in doing so, can affect innovations upstream or downstream (Swanson, 1994). The interactions between these innovations are not strictly causal but operate like tendencies. For example, innovations of Type II do not automatically cause changes in development processes or base technologies. Nor do Type 0 innovations automatically create Type I innovations (the case for such Type 0 innovations is much rarer but still possible).

In light of this model, ISD agility is concerned with improving sensing and response capabilities of ISD (Type I innovations) that result from (1) the need for IS deploying organizations (pull) to obtain their applications faster, or to discover and quickly adopt new types of IS applications (Type II innovation) and (2) sense and adopt swiftly Type 0 innovations that enable either quicker delivery of ISD or offer an opportunity to change the IS discovery and delivery mechanisms (push). The innovation model poses a significant question related to the order effects between innovations connected with or presumed by ISD agility: to what extent can and will sensing and adoption of Type 0 innovations lead to subsequent innovations of Type I and consequent changes in sense and response patterns associated with discovery and delivery of new IS (Type II innovation)? This paper assumes that connections between innovations are not causal but rather depend on (a) garnering new capabilities; (b) on what value management places on sensing; and (c) what value is placed on subsequent response speeds relative to other features of IS innovation (e.g., reliability, quality, cost). We seek to better understand how and under what conditions ISD organizations will effect changes that promote ISD agility. ISD agility is defined as the discovery and adoption of multiple types of ISD innovations through garnering and utilizing agile sense and response capabilities. This focus on sense and response capabilities are in contrast to promoting other types of IT innovations. In other words, this paper probes how concerns over the agility of Type I and II innovations (i.e. being nimble) affect innovation decisions and behaviors within ISD organizations.

Exploration and exploitation during IT innovation

The model of IT innovation shows what types of IT innovations are available for ISD organizations and how they might possibly interact (Swanson, 1994; Lyytinen & Rose, 2003a). The model, however, says nothing of how or why ISD organizations would choose between innovations that promote agility and under what conditions ISD agility becomes a desirable innovation feature. To phrase it differently, what capabilities must ISD organizations garner in order to innovate in an agile manner with Type I and II innovations? On the basis of the IT innovation model, we conjecture that the concern for agility within ISD organizations is influenced by two capabilities: (1) the capability of ISD organizations to swiftly sense and discover Type 0, I and II innovations; and (2) the capability of ISD organizations to transform and hone these innovations (e.g., respond) into implementation of other Type I or II innovations, such as agile methods.

These sense and respond capabilities, in turn, depend on the extent to which the ISD organization is able to mobilize and balance two learning capabilities – exploration and exploitation (March, 1991). The first one, exploration, is concerned with building capabilities that promote technology absorbtion and product innovation

[1]This paper follows this numbering of Lyytinen & Rose (2003a, 2003b).

that change environmental responses, that is, sensing base and process innovations and utilizing them for consequent new IS discovery. This ability reflects an ISD organization's ability to efficiently sense, acquire and absorb IS (product) and process innovations (Srinivasan *et al.*, 2002). The second capability, exploitation, depends on the ISD organization's ability (1) to use each occasion of IT innovation to improve their ISD delivery processes through continued Type I innovation by sensing and responding to emerging process needs; and the ability (2) to systematically learn from such occasions as to standardize and formalize garnered process knowledge into assets.

These two learning archetypes distinguish two modes in which ISD organizations sense, adapt and draw upon IT innovations. Exploration is about discovering opportunities, or new certainties, where ISD organizations search for novel competencies for IS and process discovery through second loop learning (Tushman & Anderson, 1986; Henderson & Clark, 1990; March, 1991; Eisenhardt & Tabrizi, 1995; Christensen, 1997; Winter & Szulanski, 2001). Exploration thus involves behaviors labeled as search, discovery, experimentation, and risk taking. In ISD organizations, exploration covers activities like technology sensing and monitoring, experimenting, convivial computing, prototyping, user-led innovation, and bricolage. Exploitation in ISD organizations is about garnering and refining IS delivery competencies through repeated actions over extended periods. Exploitation mainly follows trial and error learning (Nelson & Winter, 1982; Levinthal & March, 1993; Nonaka & Takeuchi, 1995; Eisenhardt & Martin, 2000) and is focused on harnessing old certainties. Exploitation thus embodies behaviors labeled as refinement, implementation, efficiency, production and selection. In ISD, exploitation reflects managerial aspirations associated with control, predictability, productivity and repeatability, that is, virtues followed in a vast majority of ISD and software engineering research (Lyytinen, 1987; Humphrey, 1989; Curtis *et al.*, 1992; Börjesson & Mathiassen, 2005).

Exploration and exploitation behave like water and fire (Brown and Eisenhardt, 1997; Tushman and Anderson, 1986); they have distinct organizational structures, processes, strategies, capabilities and cultures. As such, the process goals and incentives associated with these learning processes differ radically. Exploration draws upon organic structures, loose coupling, improvisation, chaos and emergence. Exploitation prefers mechanistic structures, tight coupling, routinization, bureaucracy and stabilization. Returns with exploration are uncertain, highly variable and distant in time, whereas exploitation yields returns that are short term, have a higher certainty and lower variance (March, 1991; Levinthal & March, 1993). Owing to this antagonism, organization theory scholars have suggested that effective organizations learn to tack between exploration and exploitation by dynamically balancing their resource bases through constant capability acquisition, integration, and re-combination (Lant & Mezias, 1992; Eisenhardt & Martin, 2000). Hence, an ISD organization's dynamic capability embodies a meta-capability: whether it learns to effectively blend exploration and exploitation. To accomplish this, ISD organizations learn to simultaneously explore and exploit multiple IT innovations. This paper submits to the view that learning needs associated with these innovations have an impact on how ISD organizations' process goals, such as the need to be agile with innovations, are prioritized by management, and how they interact.

ISD organizations that promote agility need to garner specific capabilities associated with exploration and exploitation and how to balance them. The dynamics of exploration and exploitation for ISD agility are depicted in Figure 2.[2] While being agile, ISD organizations need to swiftly explore – that is, sense and quickly match opportunities arising from the base innovation and associate them with IS discovery – and then expeditiously exploit these new competencies by responding effectively to resulting IS delivery challenges by continually and systematically revising the ISD delivery processes. This implies that unique exploration and exploitation capabilities are put in place as well as meta-capabilities that balance them during ongoing IT innovation processes.

Agile exploration is about sensing and adopting Type 0 base innovations that enable the ISD organization to quickly generate Type II and I innovations. The exploration agility assumes that: (1) the ISD organization can swiftly absorb and learn about Type 0 and I technologies; and (2) it can use these technologies to quickly discover Type II innovations – often the first of their kind. Thus, during agile exploration, an ISD organization discovers, invents and builds up new and novel IS products and ISD processes. Its exploration success is dependent on the absorptive capacity – the ISD organization's ability to value, assimilate, connect, and apply new knowledge in the form of ideas, technologies and skills in a short period of time (Cohen & Levinthal, 1990; Zahra & George, 2002). When the ISD organization is successful in exploration, it will transform its skill base. As a result, its products (Type II innovations) and processes (Type I innovations) undergo constant change. The more this change deviates in a given period from its current base, the more innovative in content is the change, that is, the more radical the exploration. The more the products or processes deviate from the current products or processes in a given period, the more innovative products or processes are generated, respectively. Thus, during early exploration, innovative content receives premium attention, while incremental process improvements are rarely followed. Therefore, development speeds normally slow down during exploration due to reduced attention to speed or cost.

[2]We want to stress that this is not a linear sequential model of innovation behaviors as organizations can follow any path or a sequence of paths during their innovation trajectory.

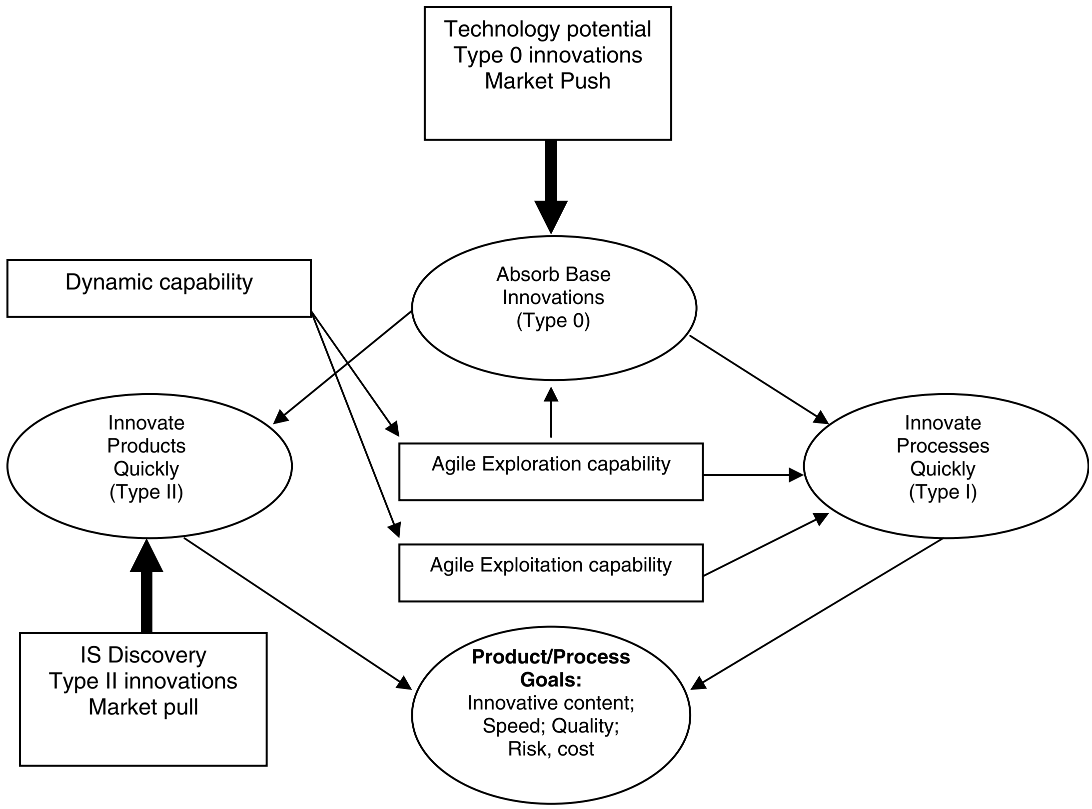

Figure 2 Agile ISD organization as exploration and exploitation.

The second element of an ISD organization's agility is its capability to smoothly exploit the fruits of their explorations. Accordingly, agile ISD organizations must learn at a specific critical point of their innovation trajectory to streamline, standardize, automate, and scale up their IS delivery. This depends on their ability to fix their product platform and then innovate consistently with IS delivery processes by continuously improving them as to maximize specific process outcomes related to speed, quality, risk, or cost. During exploitation, agile ISD organizations seek continually to remove friction from their delivery processes and utilize current assets to the fullest. It is important to observe, however (cf. the right arm of the innovation path in Figure 2), that adopting some base innovations can significantly increase development speeds. This happens with Type I innovations during exploitation that define development tasks on a higher granularity level for a given IS family through abstraction mechanisms (e.g., Web services), standardized functions across system platforms (e.g., relational database systems or browser-based user interfaces), or standardized architectural mechanisms (e.g., solution and architectural patterns).

When an ISD organization transitions from exploration to exploitation, it must build up its exploitation capability, often quickly. To this end, the ISD organization normally freezes product features and, subsequently, process structures, and properties. This triggers cascading changes in process goals. The focus shifts to efficiency, economies of scale, standardized components, and low variance outcomes. The shift invites increased attention to trial and error learning, which helps build standardized routines (Levinthal & March, 1993). As shown in Figure 2, owing to the structural and time dependencies between exploration and exploitation and their contrasting logics (the left-hand side *vs* the right-hand side in Figure 2), ISD organizations innovate with major IT innovations in a chaotic manner, and they have to do both at the same time. They only learn to balance learning needs through hard won experience. Subsequently, they organize in contradictory ways at consecutive stages of IT innovation.

ISD organizations, like all organizations, can entertain only a certain number of transformations without becoming totally disorganized. Therefore, ISD organizations organize themselves for major base IT innovations in a staggered pattern; they first increase their exploration agility while adopting radically new base technologies, but later on shift to exploitation agility by stabilizing product features and learning from their processes (Tushman and Anderson, 1986). As the contrast between early exploration and late exploitation is stark, ISD organizations will transform themselves in a punctuated manner by occasionally changing radically their locus of action, perception, and organizing principles. Therefore, each major innovation in the IT base will be appropriated through distinct and separate organizing principles. We denote these as *innovation regimes*. Being agile can thus mean that an ISD organization can transition itself smoothly between innovation regimes.

Innovation regimes and process goals

The main question within each innovation regime lies in what ways the ISD organization aspires to be agile so as to achieve goals related to exploration and exploitation. In other words: how do distinct imperatives for learning affect ISD process goals? In the following, we apply directed graphs, called process goal graphs, to represent the content of process goals associated with separate innovation regimes. As the process goals are often contradictory and interdependent, we use specific graphs called Kiwiat graphs (Van Kleijnen, 1980) to depict dynamic tradeoffs between contradictory process goals in each innovation regime. Such graphs have been used extensively to illustrate interactions and tradeoffs between contradictory goals in multiple criteria decision-making.

Each Kiwiat graph forms a directed graph with one start node and multiple ($n>2$) end nodes. Each arch in the graph is of similar length, and its direction is immaterial. Each arc represents one criterion or goal related to the decision problem.[3] The depicted coverage or size of the arch shows the proportional satisfaction[4] by a specific solution in relation to that process goal. In our case, the specific solution is the innovation regime. Thus, in process goal graphs, each process goal is depicted as a separate arc (vector) where its relative size (strength) shows to what extent this process goal is being satisfied within the selected innovation regime. By depicting the respective satisfaction of each process goal in that regime, this paper identifies typical process goal patterns associated with a specific type of ISD agility, during the IT innovation process. In addition, we examine how different process goals interact with each other during each interaction regime. As shown below, these interactions can be derived through content analysis from interview data. Some of these interactions also draw upon March's analysis of variances in return and their certainties during different learning modes. They also draw upon studies on new product development and the ISD literatures that have studied tradeoffs of speed for quality and cost (Boehm & Papaccio, 1988; Atkinson, 1999; Nambisan & Wilemon, 2000).

The main issue in formulating the graphs is to select a set of process goals that can exhaustively represent typical organizational goals associated with all possible innovation regimes. Traditionally, in the ISD management literature, speed has been one of three classical interdependent attributes, others being quality and cost. Thus speed – *Ceteris paribus* – needs to be simultaneously heeded, and, as such, traded off with regard to two other process goals (Nambisan & Wilemon, 2000). The classical three — speed, quality, and cost — thus make up 'the Iron Triangle' (Atkinson, 1999, p. 337; Nambisan and Wilemon, 2000) of project management; improvements in one attribute come only at the expense or degradation in one or both of the other two. Yet, the process goals of the Iron Triangle alone are not enough to cover learning goals associated with exploration and exploitation. If these are taken into account, the three process goals need to be expanded by considering the goals associated with promoting significant IT innovations facing ISD organizations. March's (1991) idea of exploration points out the need to differentiate between projects, which discover new products or processes from those, which just lean on or improve existing products and processes. Therefore, this paper adds the process goal of innovative content into the set of considered process goals. The idea of radical exploration and the increasing variances in return also suggest that risk is another key process goal (i.e., tolerance towards, or level of risk associated with the innovation). It is assumed below that these five process goals – innovative content, speed, risk, quality and cost – interact dynamically during different stages of IT innovation and that there are specific patterns in which these goals are organized during separate innovation regimes. Process goals interact in each regime, while some goals dominate. Studying the interactions between these goals helps explain the shape of goal patterns and how this shape will change if there is a change to any or some of the goal levels. The next section shows how these five process goals interact with the early exploration and late exploitation phases.

Process goals for early exploration regime Figure 3 shows a process goal graph for the early exploration regime associated with significant IT base innovation where radical product innovation dominates (see Figure 2 and its interactions between base technologies and product innovations that form major innovation source). Within this regime, agile ISD organizations seek to increase the innovative content radically, tolerate relatively high risks, expect relatively fast software delivery with a medium cost, but do not expect high quality. To speed up such explorations, they need to sacrifice their capability to deliver a fully workable solution.

Thus, when an ISD organization explores with major IT innovations, it will innovate in an inherently unpredictable manner. It will not focus on the speed of discovery because motivation for speed during this phase is in fact slow (Lambe & Spekman, 1997). It is also hard to know

[3]Arcs can also represent constraints, but this paper will not explore it further as our models do not represent specific constraints.

[4]This paper uses these graphs to illustrate the nature and organization of process goals in different innovation regimes. Therefore, this paper will bypass the problems associated with establishing the metrics and instruments for tapping into phenomenon underlying the process goal.

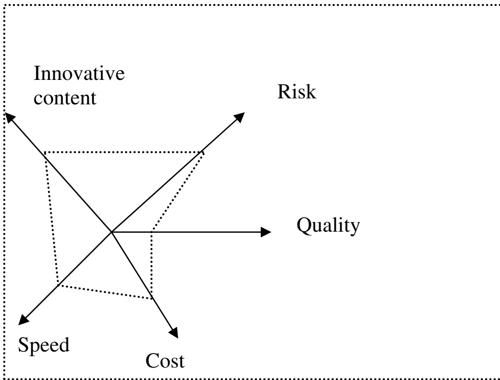

Figure 3 A profile of process goals for early exploration.

how long it takes to innovate; although many times, speed in IS discovery matters. In order for speed to be maintained or increased in early exploration (e.g. hyper-competition- D'Aveni, 1994), it is expected that other goals must be compromised – notably, traditional 'Iron triangle' goals of quality and cost. Likewise, an increased level of risk is involved in exploration. Such levels of uncertainty in ISD projects, however, 'are significant sources of project risk' (Boehm and Papaccio, 1988 p. 1467). Traditionally, risks in ISD projects are mitigated by increased time and effort (i.e., cost), or, conversely, risks increase when those factors are in short supply (Boehm and Papaccio, 1988).

During early exploration, ISD organizations thus aspire to increase the innovative content of the IS discovery. Accordingly, this paper observes the following interactions captured in a set of formulae between a change in innovative content and a change in achieving other process goals.

Goal interactions when innovative content dominates (GI1)

(1) + Innovative Content → + Risk (i.e. when innovative content increases risk, increases)
(2) + Innovative Content → + Cost
(3) + Innovative Content → – Quality
(4) + Innovative Content → – Speed.

These formulae show why ISD organizations must tolerate higher risks, medium to high costs and lower quality in order to be agile in early explorations. Likewise, if they want to be more nimble, they may have to paradoxically sacrifice their innovativeness. Traditional exploration studies have not examined the dynamic nature of and speed of exploration (cf. March, 1991). No published studies about the exploration agility in terms of speed of discovery, other than some non-empirical work on fast product development (Lambe & Spekman, 1997), were found. Yet, in hyper-competitive circumstances (D'Aveni, 1994), such as those observed during the Internet dot-com boom (Cusumano & Yoffie, 1999; Baskerville *et al.*, 2001; Lyytinen & Rose, 2003a, b), the need for heightened speed was observed during early exploration. This set up highly contradictory needs for both increased innovation content and increased agility. Under these conditions, the higher speed of exploration could only happen at the expense of other process goals:

Goal interactions for speed when innovative content dominates (GI2)

(1) + Speed → + Risk
(2) + Speed → + Cost
(3) + Speed → – Quality
(4) + Speed → – Innovative Content.

As can be seen from these interactions, when exploration ensues with a heightened concern for speed in terms of prompt sense and response, speed and innovative content take precedence over all other process goals. They cannot, however, both be optimized simultaneously as an increase in one will counteract the change in the other resulting in a fundamentally ambidextrous organizational design. During fast product exploration, ISD organizations must thus be willing to incur exceptionally high risks and costs, as they want to increase both speed and innovative content, as was consistently the case during the dot-com boom.

Process goals for late exploitation regime When exploration shifts toward exploitation, standardized solutions become common and delivery speed becomes more important (Lambe & Spekman, 1997). Product innovation becomes constrained and refined, and standardized delivery methods are invented to improve and re-use delivery processes. During exploitation, ISD delivery processes are refined to increase their speed, drive down costs, improve product quality, and increase certainty. This is the motivation for adopting 'structured' approaches to improve software delivery quality, such as CMM (Humphrey, 1989; Curtis *et al.*, 1992), as they drive down ISD costs and improve quality (Boehm & Papaccio, 1988).

How this change is reflected in process goals is next discussed for the late exploitation regime. We chose this innovation regime for illustration as it represents a nearly opposing organizing logic as compared to early exploration (the lower right part of Figure 2 after everything else in Figure 2 is fixed). Therefore, the idea of agility in this regime is quite different. This is a contingency where small incremental variations in mature products can be observed while the main emphasis is placed on gradual process innovation. The associated process goal graph is shown in Figure 4. It shows that during late exploitation, ISD organizations will place a heavy emphasis on increases in IS quality and delivery speed while minimizing their cost and risk. They do so by standardizing and making repeatable most of the product and process features. Such product or process goal combinations are typical for mature and well-defined IS product markets

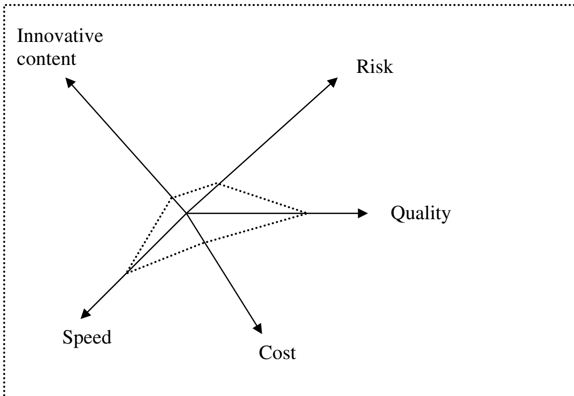

Figure 4 Process goal profile for late exploitation.

where requirements are stable and easily identifiable. In this scenario, firms operate more within the normal constraints of the Iron Triangle, which include cost reduction, increased quality, risk avoidance, and increased speed. They remove the exploration goal to increase innovative content. The following dependencies are observed as a result when quality and cost dominate:

Goal interactions when cost and quality dominate (GI3)

(1) – Innovative Content → – Risk (i.e. when innovative content decreases, risk decreases)
(2) – Innovative Content → – Cost
(3) – Innovative Content → + Quality
(4) – Innovative Content → + Speed.

In general, the IS delivery during late exploitation will be faster for the same IS functionality, as ISD organizations minimize cost by achieving economies of scale (use of capital intensive technologies like CASE tools, and by leaning on repeated production of IT artifacts), and scope (investments in specific domains and learning by doing for those application domains).

In light of this analysis, the following questions are empirically investigated:

Research question (1) What types of agility can be identified in ISD organizations and what are the antecedents to these types of agility?
Research question (2) How do different needs of agility influence ISD process goals and how do they interact with one another?

To address these questions, the following two propositions will be empirically addressed:

Proposition (1) ISD organizations locate themselves into different innovation regimes with respect to their need for exploration and exploitation as predicted by the learning model shown in Figure 2 (Research question 1);

Proposition (2) ISD organizations' perceptions of agility differ in those regimes as reflected in their process goal priorities as predicted by Figures 3 and 4 and interaction formulae GI1:1–4, GI2:1–4, and GI3:1–4 (Research question 2).

Research method and sites

To empirically investigate these questions and propositions, we chose to conduct a longitudinal multi-site case study (Yin, 1994). The purpose of the study was to formulate theories of ISD agility and validate Proposition 1 and 2 through multi-site cases. The chosen research method allows for a replication logic by which emerging theoretical insights can be corroborated in different contexts. Doing so triangulates both theory and data (Eisenhardt, 1989; Strauss and Corbin, 1990). A 4-year field study was carried out with a theoretical sampling of seven ISD companies adopting Internet computing. The concept of Internet computing involves a relatively broad and evolving set of distributed computing models and solutions that rely on open, ubiquitous networks and associated sets of protocols and services. It draws upon models of computing that operate within open, heterogeneous, and distributed computing environments (Lyytinen and Rose, 2003a, b). In the context of internet computing, Web-development refers to computing applications that utilize Internet browsers and a set of open standards and protocols that include XML, HTML, http, URL, TCP/IP, combined with the extensive use of middleware architectures in leveraging the service.

The companies included in the sample met the following criteria: (1) they were developing Web-based systems; (2) they were recognized by their peers as agile, that is, fast adopters of advanced technologies; and (3) they worked mostly for outside and leading edge clients through contractual relationships that made them very focused on cost and development risks. We sought to maximize the variations in our sample that would improve external validity (Yin, 1994). Companies had different sizes and operated in different industry sectors in terms of the services provided (ranging from manufacturing, financial services and public administration to retail and transportation). They had experience using Web-based technologies in several application domains (back office, front office, and inter-organizational applications). The geographical scope of their operations varied largely as some were local ISD firms while others were part of global companies. The firms also had large variations in ISD experience, ranging from as few as four years to 40+ years. A summary of the firms' characteristics is included in Table 1.

The data were gathered primarily between June 2000 and April 2003 at three different points in time (2000, 2001, and 2003). The exact times and periods of data collection are shown in Table 2. For all seven companies, the data are not complete owing to attrition (some of the companies went out of business or were bought or sold). For some data sets, there were problems with the poor

Table 1 Firm characteristics

FIRM	*Firm 1*	*Firm 2*	*Firm 3*	*Firm 4*	*Firm 5*	*Firm 6*	*Firm 7*
Division focus	Custom software development. Primarily e-business applications	B2B e-Business consulting solutions	Small spin-off of parent. Web-based ASP for parent company's customers	E-Business consulting specializes in mobile computing	Systems integrators to upgrade legacy systems to include Web and mobile solutions	E-Business solutions specializes in mobile computing Need-based assembling of components and applications	Management consulting, development, IS products, networking and hosting services
History	15-year-old firm – mainframe and client server shop with 500 employees in 4 locations	Part of a large, multinational business consulting company	Part of a large financial company with several thousand employees	Multinational e-Business consulting firm founded in 1995 with several thousand employees	e-Commerce development firm founded in 1996, starting with six employees	Large multinational e-Business consulting and software development firm	Mature, large, multinational development and IT service firm
# Employees in division	Several hundred	Several hundred	70	100+	200+	700+	Several hundred
Typical work week	40 h	50 h	50 h	60 h	37.5 h	Varies	37.5 h
Employee turn-over/year	18–30%	15–30%	<10%	3%	3%	Uncertain	Uncertain
Organizational structure	President Branch manager Field manager Project manager	Partner Director Project and technical managers	CIO, then flat	Client manager Project manager	Entirely flat, except for salary issues.	Rigid vertical hierarchy with formalized methodologies for all aspects of business	Company is divided into autonomous units based on market sector of client
Project team characteristics	15–20 people including: business analysts, architects, lead developer, other developers, QA person	Architects, analysts, expert developers, rookie developers	Informal	Flat with the following roles: project assistant, technical lead, designer, information architect	Informal	Rigid vertical hierarchy	Broken down by customers (approximately 50/customer) and subsequently by teams (of 10 each)

Table 2 Data collection summary

FIRM	*Firm 1*	*Firm 2*	*Firm 3*	*Firm 4*	*Firm 5*	*Firm 6*	*Firm 7*
Interview Date 1	June 2000	June 2000	June 2000	October 2000	September 2000	November 2000	September 2000
Interviewees in Time 1	Six senior employees, including an executive, managers, and software architects	A senior manager of an IS development group and one of his key developers	The CIO, and the five key senior technologists who were responsible for the creation of the spin-off	Five senior employees including ISD project managers, developers, and the senior technology architect	One of the founding executives who was responsible for development of business processes	Four senior employees including a systems architect, manager, and software engineer	One senior manager of IT development services
Interview Date 2	October 2001	October 2001	October 2001	August 2001	August 2001	August 2001	August 2001
Interviewees in Time 2	One software architect from the first interview	A senior manager of an IS development group and one of his key developers from the first interview	Two technologists from the first inter-view	Two employees from the first interview	Same interviewee from the first interview	One manager from the first interview	Manager who replaced manager in the first interview
Interview Date 3	March 2003	March 2003	No interview	No interview	March 2003	April 2003	April 2003
Interviewees in Time 3	An architect from Time 1, the replacement of executive in Time 1, and a developer not in Time 1 interview	Developer from Time 1	Firm absorbed by parent company and IT employees reassigned. Intervie-wees not available. Time 3 information gathered via e-mail with one of the original interviewees and review of online documentation of parent firm in March 2003.	Finnish office closed. Interviewees not available.	Same interviewee from the first interview	One manager from the first interview	Manager who replaced manager in the first interview

quality of the tapes and therefore they could not be transcribed verbatim, but instead, the main facts were solicited. Interview data were organized into three different temporal periods: pre-2000 (Time 1); 2000–2001 (Time 2); and 2002–2004 (Time 3). These periods correspond with the consecutive stages of the dot-com innovation cycle. Here, pre-2000 represents fast market growth and the period of fast product innovation and hyper-competition (D'Aveni, 1994), that is, early exploration; Period 2000–2001 stands for the recession and crisis that signals a marked shift towards exploitation (need for meta-capability of dynamic configuration); and 2002–2004 stands for the new recovery and modest growth of the markets where exploitation begins to dominate (full exploitation). Six of the seven firms were heavily engaged in exploration at Time 1. Firm 6, however, was following a strategy of allowing business partners to focus on exploration while they focused on exploiting more mature technologies explored by their partners.[5]

The data were obtained through semi-structured interviews with senior management and senior developers who managed the knowledge bases and skills needed to execute a technology and business strategy. The archives of company documents were also examined, including documentation of system development and technology strategies, and notes were made during the visits. A range of 1–6 individuals from each company participated. A total of 19 interviews were conducted with a typical interview time of approximately 2 h each. The transcribed data cover approximately 700 pages of interviews. Specifically, interviewees were asked to clarify the extent, scope, depth, and speed of changes in their ISD during the Internet computing adoption.

Data analysis was conducted following the inductive method (Yin, 1994). The transcript of each company for each period was subject to a within-case analysis that involved repeatedly reading the transcript and taking thorough notes regarding the firms' perceptions of agility, its antecedents and resulting process goals and how they related to their innovations. After each individual case, the researchers carried out cross-case comparisons that involved listing the similarities and differences among the firms in terms of their process goals during each period. Two researchers coded these transcripts individually. Coding was compared for inter-coder reliability and differences in interpretation were identified and discussed until consensus could be found. Data codes within cases were then converted into tabular form and again analyzed by both researchers to confirm findings within and across cases and to identify gaps or contradictions. Any discrepancies or contradictions were scrutinized and original transcripts revisited for clarification. The tables were iteratively modified until both researchers were satisfied with the reliability and validity of the findings. Once the data weres organized into tables and matched with our research questions and propositions, the findings were formally developed, and a summary was written and presented for external review to participants of the field study. Phone interviews were conducted with individuals from three firms. For each of the three follow-up interviews, the findings identified in the analyses and their explanations were confirmed and validated.

Findings

The models in Figures 3 and 4 highlighted interactions between the five process goals of speed, innovative content, cost, risk, and quality associated with ISD at different innovation regimes. Concerns for all these goals were identified across the seven firms during different innovation regimes (see Tables 3a and b, and 4a and b for details). Thus, while exploring, the organizations had to operate outside the concerns of the traditional 'Iron triangle,' which shows that the concern for learning and agility changed radically across different tempi, which also addresses our Research question 1 (What types of agility can be identified in ISD organizations?). As indicated in Section 2, the goals are assumed to be strongly interrelated and contradictory. To validate the interactions and their contradictory nature, researchers scrutinized the tables and interview data to determine which of the interactions between process goals, as noted in Figures 3 and 4, and formulae in GI1:1–4, GI2:1–4, and GI3:1–4, were evident in the data at different innovation regimes.

Strong evidence indicated that during early exploration, for each increment in speed, there was a significant increase in risk, and cost, and a decrease in quality as proposed above (GI2:1, GI2:2, GI2:3). Tables 3a and 3b, data from the exploration regime, demonstrate that evidence of these tradeoffs was found in 19 of 21 possible cases. For example, a developer in Firm 1 indicated,

> *Because you are moving so fast through the whole thing, if you mess up somewhere it impacts you a whole lot more than it would have impacted you in a slower process.*

Likewise, a participant from Firm 7 noted,

> *You have less time to think and you don't have the time to think of everything.*

The subsequent tradeoffs in the propositions each involve innovation. In order to recognize these tradeoffs and their differences between exploration and exploitation regimes, longitudinal data needed to be analyzed. The change in innovation modes from exploration to exploitation needed to be identified first in order to demonstrate the phenomenon. Once identified, related tradeoffs could likewise be found.

At Time 1, the exploration mode existed for each firm, except for Firm 6 (see above), which was already in

[5]Details of exploration phases of the seven firms are documented in Lyytinen and Rose, 2003b and are summarized herein for brevity. The transition and exploitation phases are what are novel to this data analysis and those aspects are included in detail.

Table 3a Evidence of interactions between speed *vs* quality, costs, and risks during early exploration regime (USA Firms)

FIRM	*Firm 1*	*Firm 2*	*Firm 3*
SPEED UP, QUALITY DOWN	'I suspect we're going to have more defects…If everything works right, you done really good job. But because you moving so fast through the whole thing, if you mess up somewhere it impacts you a whole lot more than it would have impacted you in a slower process'	'In the dot-com world we saw, you know, get it to market (as quickly as possible) for any price. Now we see get the quality (high in trade for speed and cost).'	'But before, I mean, one of the problems is that everybody was trying to do things so fast you tended to try to use a lot of third-party products, throw them together, kind of hash them together. That itself causes instability and quality problems. You don't have to do that as much if you're pacing yourself.'
SPEED UP, COSTS UP	'Generally they'd rather have it come in on time. Most of the time. Once in a while you'll find somebody who pushes back…tweezing every nickel'	'Clients are looking for a couple of things. They're looking to see how fast you can deliver, the quality you can deliver to, and what cost you can deliver at. And what you have to do is try to balance those three needs while competing against other people in the same field.'	'When time's compressed, testing and quality always go out the window because programmers still develop so many lines of code a day. Or how much you want to press the time. So you start deciding what doesn't get done'
SPEED UP, RISKS UP	'Development quality depends on which side of the fence they're on financially too. Depends on the risk of the business too. It costs a little bit more but it also is a hedge many risks'	'And obviously you have the risk of not having the same quality because you do not yet have the (time to have the) knowledge as you would have in a client server based environment.'	'They took more risk to save time' 'But we take on more risk. Truth is as soon as we saw we were behind originally, we should have moved that date out by the time that we felt like we were behind. That's what we ended up doing anyway, there's no magic bullet.'

exploitation mode. Exploration was recognized by the adoption of immature technologies, the intensity and breadth of learning taking place, a lack of methodologies, and the creation of radically novel process and product innovations. By contrast, exploitation was recognized by the stabilization of the aforementioned attributes. A change in the speed and scope of product and process innovation from radical to incremental demonstrates the movement from exploration to exploitation (Benner and Tushman, 2003). Tables 4a and 4b note when the various regimes were taking place for each firm and indicate the evidence that innovation regimes changed from exploration to exploitation. Likewise, the tradeoffs gained via the lack of radical innovation are listed along with evidence of those tradeoffs.

In Tables 4a and 4b, evidence that innovation was traded for each of the four other factors in our data set is noted in the quotes and made explicit in the bracketed section of each cell. Across all firms, except Firm 4,[6] the trade for speed is explicitly seen. In addition, there is at least one data point that demonstrates a tradeoff was made for the other three factors. In addition, while not shown in each cell, the tradeoffs for risk, quality, and cost are implied by the explicit tradeoff for speed. Therefore, firms have the option to take advantage of the currency of speed in trade for quality, risks, and cost. Collectively, Tables 3a and b and 4a and b exhaustively show evidence for GI1:1–4, GI2:1–4, and GI3:1–4.

The dominating goal in the early exploration regime was to improve innovative content, and the later goal was to freeze innovation (support for Proposition 1, nature of the innovation regime). It can also be observed, as suggested by GI2:4, that speed and innovative content were inversely related. In all but Firm 6, the inverse relationship was confirmed (Tables 4a and b). For example, Firm 3 completed their proof of product ideas during this stage and subsequently stopped employing radical product innovation as a means of improving their speed. As a result of moving to incremental innovation in the next period, they were planning to formalize their methodology that would enable the '*rapid software development and rapid implementations that we have to do*.'

Similarly, Firm 2 attributed increased speed in Time 3 owing to the move to incremental innovation in all three IT innovations in Figure 1. Specifically, increased speed was a function of stabilization in the '*methodology (Type I: PROCESS innovations), a function of increased skill sets (Type 0: BASE innovations), and a function of using*

[6]Firm 4 did not show this relationship because they did not effectively freeze innovation during the two interview periods in which they participated.

Table 3b Evidence of interactions between speed *vs* quality, costs, and risks during early exploration regime (Finnish Firms)

FIRM	*Firm 4*	*Firm 5*	*Firm 6*	*Firm 7*
SPEED UP, QUALITY DOWN	'A: Yeah, and clients asked us to reduce the number of hours, so it was a lot of pressure from the client side and we saw A: I think most biggest reasons were that they want to save some money and also they want to have it fast, fast, … And always, there was too little time to do those projects well'	'You can't test certain things that you might have been able to test before and so you don't know if the quality is as high in those cases, and so that's one…that's, of course, that is very natural, and that is true and that is how it goes.'	No specific evidence	'(with regards to increases in speed) I would like to add to the question of quality. That nowadays (customers) probably don't (even bother to) ask for the best of breed anymore'
SPEED UP, COSTS UP	'Q: say that you have to deliver same quantity even much radically compressed time. A: I think that's true. Yeah, quite many of the features clients take for granted, even it has to be re-implemented. Q: How do you meet that? A: Just with more people, usually'	'Needed to have more different technologies, a richer variety of technologies. But ahm but we needed to cut the expenses and we needed to make the decision of what we concentrate on (to be agile).'	No specific evidence	'Q: so you're passing on this risk to the customer. If you're profit margins are going up, you're passing on the risk. A: Yes, yes. Q: In the form of profits. A: Yes, yes. I believe we must share risks.'
SPEED UP, RISKS UP	'And you need to deliver them more quickly. And to deliver them more quickly, also risks are going up.'	'(with speed) the risks are higher that something goes wrong'	'Let's assume that customer has very good specifications, made by (another firm) or by us, and then they are entering that as their off B request for proposal for us. And asking ten weeks delivery. And we are saying that nobody can do that. We are not making proposal. That's it. There are lots of organizations that can take that risk. If they want.'	'(with faster speed) variance in risks is becoming bigger, they are difficult to assess also. Because you have so short time span you see, and the other thing is that there's much shorter time to learn about these things because the learning risks it takes also. You learn based on that if you fail, but you have less and less opportunities to fail, you aren't allowed to fail.'

packaged product type solutions (Type II: PRODUCT innovations).'

Overall, strong support was found for Proposition 1 that ISD organizations' perceptions of and need for agility will change between innovation regimes (Tables 4a and 4b).

Likewise, the other interactions between innovation content and risk, cost, and quality, as suggested by formulae GI1:-GI3, were detected (see data summaries in Tables 3a and b, Tables 4a and b). For example, a member of Firm 7 referred to the period *before* radical product innovation associated with Internet dominated as '*the good old days,*' while at the same time admitting that lower risks (as valued then) were now '*old fashioned*.' Similarly, Firm 5 noted that when it began adopting base innovations, radical product innovation (Period 1) and development slowed down, more resources were needed, and quality declined:

> *I already did miss the deadline and the resource allocation (target)… when there (have been) only just a couple of experts in certain (new base technology) and we needed to share the*

Table 4a Evidence of exploitation regime phase and interactions between innovation *vs* speed, quality, costs, and risks (USA Firms)

FIRM	*Firm 1*	*Firm 2*	*Firm 3*
Time of exploration	Time 1 and 2	Time 1 and 2	Time 1
Evidence of slowed innovation	Only taking clients with problems that are known solutions to the ISD staff. Scope of services is smaller than in Time 1.	Diminished set of base technologies used. Diminished scope of deliverables. '(Previously they were) less averse to suggesting innovation for new projects, where (now they are) more apt to lean toward pre-existing or canned technology implementations'	Reduced development staff as product specifications were frozen and methodologies to customize the product were developed. Eventually, methodologies were so perfected, the remaining IT team and the product were reabsorbed into the parent company from which it was spun. By stage 3, the project was headed by marketing and sales instead of IT.
Time period of evidence	Time 2 and Time 3	Time 2 and Time 3	Time 2
Impact of slowed innovation (trade-offs)	'I would say the speed of development is increased and the development quality is increased.'	'So all that helps because you spend less time doing the analysis and the selection of the tools…so that has helped in the making the development faster.'	'(during the period of high innovation, we gave up methodologies and) took more risk to save time…we had to take more risk and sometimes quality suffered because of it.' (Consequently, in the low innovation period, risk was reduced and quality improved while high speed was maintained)
	(Tradeoff of innovation for speed and quality)	(Tradeoff of innovation for speed)	(Tradeoff of innovation for speed, quality, risk)

knowledge by allocating the people that were not so big in that technology. it meant that also the amount of time and the amount of work used were exceeded but also the qualities, probably not the best possible one, when looking back at the … work.

The tradeoffs between innovative content and other goals are most evident across Period 1 – when product innovation dominates – is analyzed longitudinally. During this period, Firm 6 was already exploiting; it focused primarily on process improvements. They had already begun reaping the rewards of this change and noted that their quality was higher and costs and risks were lower because they had frozen product innovation and were primarily engaged in an assembly of '*ready made components*.' In addition, they had '*a set of solutions that (they knew) how to give and (could) give them quickly*.' In contrast, other firms were entrenched in exploration and experienced increased risks and costs with decreased quality. As the innovation regime changed during Period 2, each firm then moved into exploitation when the markets matured (Type II product innovations and base innovations stabilized). Consequently, their methodologies became increasingly formalized and were enforced on an organization-wide basis. At the same time, risks, costs, and quality moved to directions as predicted in Figure 4. For example, in time periods 2 and 3, Firm 2 was in exploitation mode. The interviewee noted that their '*methodologies and strategies are now mature*' and that quality was greatly improved as '*a function of better trained people, a methodology…and less innovation*.'

Collectively, these data show ISD organizations' process goals and their interactions vary (as noted in GI1:1–4, GI2:1–4, and GI3:1–4) in different innovation regimes. Thus, Proposition 2 (and Research question 2) was supported by the evidence that ISD organizations value different types of agility in different innovation regimes.

Discussion and conclusions

Our study shows that the concept of ISD agility is more multifaceted and contextual than conceived so far in the literature. It relates to the following aspects of being nimble: (1) the velocity to absorb base innovations and innovate with IS products; (2) the velocity to shift from one innovation regime to another (organizational flexibility); (3) the velocity to learn from your experiences (trial and error learning); and the (4) velocity to deliver IS solutions. Each one of these demands different competencies and expects managerial shaping of alternative organizational goals and incentives. Our findings suggest that the dynamics and interactions between these four types of agility need more careful attention in the future.

The meso-analysis carried out in this paper helps to bridge the gap between micro-level IS design-oriented notions of agility (Agile alliance, 2002; Turk *et al.*, 2004; Henderson-Sellars and Serour, 2005) and strategic

Table 4b Evidence of exploitation regime phase and interactions between innovation *vs* speed, quality, costs, and risks (Finnish Firms)

FIRM	*Firm 4*	*Firm 5*	*Firm 6*	*Firm 7*
Time of exploration	Time 1 and 2	Time 1 and 2	Time 0	Time 1
Evidence of slowed innovation	Innovation slowed, but prematurely so. Implemented a methodology called 'Framework' to build systems. Unfortunately, 'Framework' turned out to be a poor mythology that, 'every client said (was) too heavy'	Base innovation is frozen. Moved to developing incremental service innovations because of repeat business with 'less features (being) made for the next version'	From Time 1 had a strategy of exclusively exploiting solutions that were well understood in the marketplace. As such, innovation was frozen internally except for integration of outside solutions.	'I would say that, it actually depends pretty much on the project. If we're doing Intranet site, normally we can expect a certain amount of clients, okay, we already know that which are kinds of platforms and tools and this and that works, so instead of some of the procedures we would have to go through if we didn't know that stuff already.'
Time period of evidence	Time 2	Time 2 and Time 3	Time 1	Time 2
Impact of slowed innovation (tradeoffs)	No evidence because they froze process innovation while still in product exploration phase.	'The applications, all the software development, and the tools for our software engineers, they are better than they used to be. And that of course, yeah, makes, makes the outcomes more reliable and the actual software engineering easier. So yes time (i.e., speed) is small(er) than it used to be.	Impact were systems that were 'Less risky…of course because there are so many ready made, ready tested components… (also) they're high quality because they've been tested'	Without innovation, reuse increases and subsequently the 'timeline's gonna shrink…That is profit.'
		(Tradeoff of innovation for speed, costs, and quality)	Also, they confirmed their way of 'Q: dealing with the time compression is to only take primarily jobs that are almost identical to ones that you've had before and so you have a set of solutions that you know how to give and you can give them quickly.' 'A: Yeah. Exactly.' (Tradeoff of innovation for risk and quality and speed)	(Tradeoff of innovation for cost and speed)

managerial choice-oriented concepts of agility delivery (Sambamurthy *et al.*, 2003; Pavlou & El-Sawy, 2005). In particular, the concept of ISD agility shows that micro-level concerns for agility with shorter release cycles may help achieve better responsiveness during exploitation, but it does not recognize concerns for explorative agility that result from increasing a firm's strategic options through fast exploration. Our analysis of ISD exploration agility and the need to balance exploration and exploitation across ISD delivery processes offers one way to examine specific organizational activities and prerogatives that flow from choosing strategic options and how the strategic choices and ISD delivery activities can be aligned. Although our research may only form a first step in this direction, it begins to expand our knowledge about how meta-capabilities for ISD organizations are built up, how they are composed, and how they interact during exploration and exploitation.

This study organizational learning topic that has received scant attention so far: the velocity needs associated with exploration and exploitation and how they need to be balanced. Research on organizational learning has looked at marked differences in exploration and exploitation (Levitt & March, 1988; March, 1991; Levinthal & March, 1993), including how a single-sided focus leads to competency traps and speculation (Levinthal & March, 1993), how to balance them (Eisenhardt & Martin, 2000), or how to organize for them (Tushman & Anderson, 1986; He & Wong, 2004). This paper adds to this growing literature from a new angle. March's theory suggests that sensing is different when one either explores or exploits, and configuring a response differs when one either explores or exploits. Our study suggests that an important and largely ignored aspect is the time-related aspect: the need for being swift. The sense of urgency being nimble emerges from environmental contingencies and managerial preferences related to innovation.

Although followed theoretical multi-site sampling offers significant benefits for generalization (Yin, 2004), we still cannot necessarily generalize findings for less innovative companies as all studied companies were leading edge innovative companies. The findings apply only to specific units in some companies that were dedicated to learn about and innovate with Internet computing. Owing to the confidential nature of data and extended periods of observation, we could not rely on more objective constructs to observe process changes or the ways in which these organizations established and measured their goals. We also were constrained by access to few key informants in each organization, who were in charge of their Internet strategies. Thus, we could only triangulate across different observations of the same data point (interviews at different time points) and across other published materials and our observations. Yet, as shown in Table 2, in most firms we had access to more than one interviewee. There are several avenues for future research. First, we need to generalize with a more representative sample of ISD organizations. We also need to develop more rigorous constructs for agility during exploration and exploitation. Finally, we want to examine contingency factors that explain variance in agility in organizational contexts.

This paper developed a theoretical model of ISD agility that views it as form of organizational learning that is how ISD organizations can pace their exploration and exploitation rhythms. The model predicts that ISD agility is not a universal feature across the IT innovation trajectories and it differs across innovation regimes. As a result, ISD process goals will change when management changes its preferences with regard to a type of agility. These changes are affected by the scope and depth of innovations in base technologies, the need for swift discovery of IS products in the market, and the changes in the demand for improvements in ISD delivery processes.

To understand how concerns for ISD agility change and to validate the proposed ISD agility model, a multi-site, longitudinal case study was conducted in seven ISD organizations to assess the following research propositions: (1) ISD organizations locate themselves into different innovation regimes with respect to their need for exploration and exploitation, and (2) their perceptions of agility differ in those regimes as reflected in their process goal priorities. Supporting evidence was found for both Research Propositions: (1) a significant variance in perceptions of agility prevailed across innovation regimes and between companies sharing a different learning focus; and (2) the process goals were traded off differently at separate innovation regimes. In general, our findings show that ISD organizations monitor their agility in terms of how effective they think they are in assimilating disruptive technologies and at what stage of assimilation they are. They tradeoff development speed against other criteria such as risk, cost, quality, or innovative content, depending on how novel and original the IT innovation is. How these tradeoffs are organized depends on garnered organizational competencies, shifting managerial focus and competitive demands. As a result, ISD organizations learn to organize themselves differently during consecutive innovation regimes. These form different ecological niches that follow alternative organizing logics where managers must view differently what agility means.

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