Towards A Theory of Organizational Information Services

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Abstract:

The use of information technology (IT) in organizations has undergone dramatic changes the past 30 years. As a result, it has become increasingly common to adopt a services rather than a traditional systems perspective to more accurately capture contemporary practices. There is, however, a lack of theories that can help us understand, assess, and design information services in organizational contexts. On this backdrop, we combine general notions of information processing options and requirements to outline a contingency theory of organizational use of information services. The theory suggests that information services are configurations of heterogeneous information processing capabilities; these services are evoked by organizational actors to help execute tasks and evoking different configurations may lead to equally satisfactory outcomes. The theory distinguishes between four types of services: computational, adaptive, networking, and collaborative services, and it suggests that organizational actors need portfolios of information services that are suited to the equivocality and uncertainty profile of the information processing they face. The paper defines the four types of services and how they relate to information processing requirements; it applies the theory to a study of information services in response vehicle policing; and, it outlines how the theory relates to standardization and unintended consequences of information services. We conclude by discussing the theory and its implications for research and practice.

Keywords: Task, information service, equivocality, uncertainty, contingency theory.

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Introduction

While the use of Information Technology (IT) in organizations traditionally is seen as 'systems' (Huber, 1982), it has become increasingly common to adopt a 'services' lens. Van Lengen & Morgan (1993) and Doll & Torkzadeh (1998) discuss how IT is used to support new information services; Brittain & MacDougall (1995) focus on IT-based services to provide accurate and up-to-date information within healthcare; Kraut et al. (1999) present alternative uses of internet and online services in households; Lyytinen & Rose (2003) describe how Internet computing has radically changed approaches to develop IT-based services; Kaitovaara (2004) discusses the packaging of IT services; and Broadbent et al. (1999) discuss portfolios of IT services at an aggregate corporate level in the context of business process redesign. There are also a number of widely distributed books (e.g., Kalakota and Robinson, 2003) advising managers how IT-based services can provide organizations with increased competitive advantage; viewing software as services is gaining increasing interest with phenomena such as Web 2.0 and web-services (O'Reilly, 2005; Dubey and Wagle, 2007); the emerging services science field aims at scientific study of how services are innovated and delivered (Chesbrough and Riecken, 2006; Spohrer and Riecken, 2006); and, Rai & Sambamurthy (2006) suggest that increased interest in services management poses important opportunities for information systems scholars to further investigate the use of IT in organizational contexts.

Some would argue that the distinction between 'systems' and 'services' is mostly analytical and that 'services' is increasingly preferred to 'systems' because of its positive connotations. However, several developments draw increasing attention to understanding IT usage in terms of services. The diffusion of communication and network technologies, greatly improved interfaces, ubiquitous use of processors, and commercially available application packages have facilitated promotion of service-oriented mindsets. Today, organizational actors seldom use one application at a time. They use a portfolio of IT artifacts, combine them to suit particular tasks, and constantly communicate and collaborate both inside and outside the organization's boundaries mediated by IT. As an example, extracting a report of overdue invoices from a company's order system and then using addresses from this list in a spreadsheet application as the mail-merge list for a reminder-letter written in a word processing application can be seen as evoking a subset of four heterogeneous information processing capabilities: producing information from a data-base query; writing a letter in a word processor; selecting and copying information from the query into the spreadsheet; and, automatically merging the spreadsheet data with the document according to the fields designed to extract spreadsheet data. In situations like these, people engaged in producing and using information choose from a portfolio of information services based on factors such as individual preferences and variety in information processing needs. As a result, one person may choose to use a spreadsheet to mail-merge the letters, another person may decide to type each individual address and outstanding amount. To capture these developments, the focus has gradually shifted from application of distinct information systems towards evocation of portfolios of information services (Braa et al., 2000) supported by comprehensive IT infrastructures (Broadbent et al., 1996; Broadbent and Weill, 1997). There are,

however, no theories available that explain how information services differ from information systems, how general notions of services are translated and defined to make sense of IT in organizational contexts, and how information services are designed to effectively support people in work contexts.

Historically, the complex relationship between organization and technology has been a key concern within Information Systems and Organization Theory (Kallinikos, 1996). The Information Systems discipline has relied heavily on social and psychological theories of organizational and human behavior, philosophical theories of human existence, and on technical or mathematical theories of computation and design. However, socio-technical theories have only to a limited extent been formulated to understand IT use in organizations (Orlikowski and Iacono, 2001; Benbasat and Zmud, 2003). Orlikowski & Iacono (2001) conclude from their analysis of the first ten years of publications in *Information Systems Research* that around a quarter of the papers did not have any explicit view of the IT artifact, and that there generally is a need to theorize IT artifacts in organizational contexts (see also Benbasat and Zmud, 2003). Greater interaction between studies of IT and studies of organizations can further our understanding of how organizational and technological choices co-evolve and shape each other. To achieve this effect, there is a need for theoretical contributions that allow organization studies to take the material properties of technologies more explicitly into account (Orlikowski and Barley, 2001).

For these reasons, we theorize information services as an increasingly important concept in organizational use of IT. Our objective is to outline a theory that can support understanding of practice, guide action, and prove helpful in continued efforts to develop new knowledge. We see information services from a socio-technical point of view emphasizing how configurations of people and IT artifacts interact to support work, communication, and decision-making inside organizations and across organizational boundaries. The proposed theory addresses, in this way, the IT artifact "*as the application of IT to enable or support some task(s) embedded within a structure(s) that itself is embedded within a context(s)*" (Benbasat and Zmud, 2003). In terms of Orlikowski & Iacono's (2001) discussion, the theory addresses IT artifacts as tools that substitute labor, enhance performance, help process information, and change social relations between actors involved in a specific work context (p. 124). We suggest that information services distinguish themselves from, but are intrinsically related to business services and software services. Business services (e.g. related to transactions and investments within the financial sector) are provided through business processes enabled by information services (e.g. about accounts, transactions and investment options). Information services are in turn enabled by software services provided through computational processes, e.g. to support human-computer interaction, retrieve data, or calculate results. Information services are hence enacted to enable business services to customers supported by different forms of software services and other forms of IT artifacts. As a special case, business services within certain industries (e.g. news and media) are themselves information services. The important differences between a systems and a services perspective on organizational information processing are summarized in Table 1. The systems perspective focuses mainly on how IT artifacts are designed and intended for use whereas the

services perspective focuses mainly on the everyday and at times idiosyncratic use of IT artifacts. Information systems provide generic support to execution of complex tasks across many different situations and they are configured as homogeneous packages of information processing capabilities; in contrast, information services offer responses to specific, often highly situated information processing requirements and are configured as heterogeneous portfolios of information processing capabilities. Finally, connections between information systems are typically established through strong and relatively permanent ties as systems are explicitly integrated through electronic interfaces; the connections between information services, on the other hand, are primarily established through weak and rather ephemeral ties that emerge as services are evoked and combined by organizational actors.

Systems	***Services***
♦ IT artefact design and intended use..	♦ Everyday use of IT artefacts.
♦ Generic support of complex tasks.	♦ Response to specific requirements.
♦ Homogeneous packages of capabilities	♦ Heterogeneous portfolios of capabilities
♦ Integrated with other systems.	♦ Instantiated with other services.

Table 1: Differences between information systems and services perspective

To summarize, *organizational information services*: (1) focus on organizational actors' everyday use of IT artifacts; (2) offer responses to specific, often highly situated information processing requirements to support work, communication, and decision-making inside organizations and across organizational boundaries; (3) are configured as heterogeneous portfolios of information processing capabilities enabled by people and IT; and (4) distinguish themselves from, but are intrinsically related to business services and software services. On this basis, we present below the arguments for and the outline of a theory of organizational information services. In Section 2, we establish the basic constructs about information processing and services that underpin the theory. Section 3 synthesizes these constructs into a contingency theory that distinguishes between computational, adaptive, networking, and collaborative information services. Section 4 applies the theory to an empirical analysis of a case of organizational information services and to a conceptual analysis of standardization and unintended consequences of information services. Finally, Section 5 discusses the contribution of this research and reviews the proposed theory against criteria for theoretical contributions (Bacharach, 1989; Whetten, 1989; DiMaggio, 1995; Weber, 2003). The argument is summarized in Section 6.

Establishing Basic Constructs

The proposed theory builds on a long-standing tradition for adopting information processing as an integrating concept in organization design (e.g., Burns and Stalker, 1961; Duncan, 1972; Robey, 1977; Tushman and Nadler, 1978; Huber, 1982; Leifer, 1988; Gresov, 1989; Miller et al., 1991). At the organizational level, complex relationships between the use of computers for information processing and organizational structure can be identified (Robey, 1977; Doty et al., 1993). These studies use information requirements to understand how execution of tasks can be supported by

information processing (Goodhue and Thompson, 1995) and they have been complemented by research into organizational information processing approaches (Weill and Olson, 1989; Iivari, 1992).

Our theory draws upon basic constructs that help us understand the design, consumption, and provision of information services. The aim of this section is to explicate these basic constructs and the rationale for adopting them, whereas the aim of the following Section 3 is to synthesize the constructs into a contingency theory. Below, Section 2.1 focuses on service design by presenting two fundamental information processing requirements, uncertainty and equivocality (Tushman and Nadler, 1978; Daft and Macintosh, 1981; Daft and Lengel, 1986). Section 2.2 focuses on service consumption by distinguishing between production and use of information (Ramaprasad and Rai, 1996); it argues that the uncertainty of a task determines whether to focus on use or production of information. Finally, Section 2.3 focuses on service provisioning by distinguishing between encounters and relationships (Gutek, 1995; Wegner, 1997; Mathiassen and Nielsen, 2000); it argues that the task equivocality determines whether to adopt an encounter or a relationship service.

Designing Information Services

Daft & Lengel (1986) suggest two basic requirements to organizational information processing, uncertainty and equivocality. Uncertainty is related to the availability and reliability of the information needed to execute a task (Galbraith, 1973; Mintzberg, 1983). Organizations facing low uncertainty can focus on processing the information that is known to be available during task execution. Organizations facing high uncertainty, in contrast, constantly have to ask questions and focus on producing the information needed to execute tasks (Daft and Lengel, 1986). Hence, some types of information processing focus on using readily available information in response to low degrees of uncertainty, for example, standard back-office procedures such as invoicing, payroll, or ordering. Other types focus on producing new information, for example, researching a new subject, innovating a product, or co-authoring a document.

Equivocality implies multiple and conflicting interpretations about a situation (Daft and Macintosh, 1981), available information cannot be processed in a straightforward and standardized manner, and it is difficult to identify the questions that will help produce the information needed to support task execution (Huber et al., 1975). High equivocality implies that involved actors have diverging or even conflicting interpretations. They therefore need to engage in close interactions and dedicated analytical efforts to resolve the problems they are facing, or alternatively allow individuals to stipulate a decision. Equivocal situations involve confusion, actors lack shared understandings, and standardized categories and procedures cannot serve as key sense-making devices (Daft and Lengel, 1986). For example, because of the inherent equivocality involved, medical professionals gather to discuss a scan or x-ray hoping to achieve better outcomes by drawing upon different opinions.

Daft & Lengel (1986) suggest that the feasibility of an approach to information processing does not change as the amount of information increases; such changes simply require additional

information processing capacity made available. An approach will, however, break down as information becomes more difficult to analyze or more uncertain; such changes require that the approach itself is adapted or changed. Low equivocality implies that organizations can develop standardized approaches across many tasks, whereas high equivocality implies approaches that help discover the unique characteristics of a situation. There is a need for processes supporting both efficiency and discretion (Huber, 1982). Similarly, low uncertainty implies that organizations can concentrate on processing the information that is known to be available for task execution. As uncertainty increases, the organization needs to adopt approaches that will help actors produce the information they need for task execution. These considerations provide the underlying rationale for our proposition for designing information services.

> ***Proposition 1****: Organizational actors need portfolios of information services that are suited to the uncertainty and equivocality profile they face.*

In one extreme, a micro-biologist seeking to explore the frontiers of knowledge will face both high uncertainty and high equivocality requirements and hence need extensive support for producing and analyzing large amounts of data as well as engage in discussions with peers concerning the conclusions to be drawn. In the other extreme, a typist entering paper-based forms into a computer will face unequivocal and certain information processing requirements unless the data to be entered is unreadable and the person who filled in the form is not available.

We have chosen to develop the proposed theory on Daft & Lengel's framework (1986) for a number of reasons. First, through the lens of tasks and information requirements we focus on the relation between IT and the social context in which it is used. Second, this approach builds on a tradition that already have proven useful in theorizing important issues related to organizational use of IT (Leifer, 1988; Weill and Olson, 1989; Iivari, 1992; Goodhue and Thompson, 1995). Third, the framework strikes a useful balance between comprehensiveness and parsimony (Bacharach, 1989; Whetten, 1989; DiMaggio, 1995; Weber, 2003). Focusing on equivocality and uncertainty offers a comprehensive, yet simple view of information processing in organizational contexts.

Consuming Information Services

Ramaprasad & Rai (1996) describe the information production-use-cycle as key to the performance of modern organizations (we adopt 'production' and 'use' to denote 'generation' and 'dissipation' in their theory). Actors produce information about business phenomena by deriving meaning from stimuli in the organization and its environment. Information is subsequently used when actors decompose it into stimuli that support and guide action. Information distinguishes, in this way, itself from data corresponding to how information services distinguish themselves from software services. Data refer to the symbolic representation of things and events that help actors produce and use

information. Information, in contrast, relate to changes in the actors mental representations as they interpret existing and produce new data during task execution (Daft and Macintosh, 1981).

Ramaprasad & Rai (1996) use the distinction between physical and logical work and between production of new information and the use of existing information to characterize organizational information processing: "*In an effective organization, there is a symbiotic relationship between physical work and logical work engendered by a symbiotic relationship between information {production} and information {use}*" (p. 182). "*Whereas {production} is the process of creating information about an organization, {use} is the process of creating organization from information*" (Ramaprasad and Rai, 1996, p.180). Based on these distinctions, they argue for the importance of balancing and positively reinforcing the production-use-cycle to support effective task execution and continuous learning.

According to Ramaprasad & Rai (1996), logical work is performed by people, by technology, or by configurations of people and technology, and they use the notion of agent to capture this diversity. Agents have the following characteristics: autonomy, temporal continuity, personality, communication ability, adaptability, and mobility (Ramaprasad and Rai, 1996). To capture the increasing integration and mutual dependency between people and IT artifacts, we adopt Ramaprasad & Rai's (1996) agent concept, but use the term 'actor' instead of 'agent' to distinguish our discourse from that of intelligent agents denoting fully automated software artifacts. Our conceptualization of actor as configurations of people and technology is similar to the sociological agency concept in Actor-Network Theory (Latour, 1991) and the actor concept applied in use-case diagrams (Jacobson et al., 1992; Mathiassen et al., 2000) to describe use of IT artifacts.

The distinction between use and production of information corresponds in many ways to the distinction between exploitation and exploration of knowledge (March, 1991). Exploitation is "*the use and development of things already known*" whereas exploration is the "*pursuit of new knowledge, of things that might come to be known*" (Levinthal and March, 1993). In a similar vein, use signifies the process of organizing based on information, i.e. transforming readily available information into action. The assumption is that the information required for task execution is available or there is a straightforward way to access it. Information services that focus on using information supports actors that *need-to-do-something*. This implies that the degree of uncertainty is low (Daft and Macintosh, 1981; Daft and Lengel, 1986). Production of information conversely signifies the process of creating information about an organization. The assumption is that the information required for task execution is not available or cannot be relied on. Information services that focus on producing information therefore supports actors that *need-to-know-something* corresponding to situations in which the uncertainty is high. These considerations provide the underlying rationale for our proposition for consuming information services:

> ***Proposition 2:*** *Information services are consumed by organizational actors to help produce and make use of information.*

For example, people who do not remember a colleague's telephone number can produce the information through one of several means, such as searching on the company intranet, asking another colleague in an SMS message sent to their mobile phone, emailing a colleague, or opening a spreadsheet with all contact details for employees. Similarly, a person calculating aggregated sales targets for next month may make use of available data from each individual departmental spreadsheet, copy and paste them onto a master spreadsheet to aggregate totals, and subsequently compare actual performance against estimated targets.

We have adopted Ramaprasad & Rai's framework (1996) on how information services are consumed for a number of reasons. First, it focuses on the fundamental relationship between information and organizational practices: creating information from organizational practices and turning information into organizational practices. This distinction is similar to the fundamental distinction between exploration and exploitation of organizational knowledge (March, 1991; Levinthal and March, 1993). Second, Ramprasad & Rai's framework considers agency in information services in terms of configurations of people and IT artifacts. This way, we do not make a priori assumptions about how people and technology are related and interact. Finally, the framework aligns itself well with Daft Lengel's framework (1986).

Providing Information Services

There is a substantial literature on service production, consumption, and management, for example within marketing, operations research, and management studies (Johns, 1999). Services are generally comprised of series of activities, rather than things, they are to some extent produced and consumed simultaneously, and the customer participates to some extent in the production of services (Grönroos, 2000). Lovelock et al. (1999) defines a service as "*an act or performance by one party to another. Although the process may be tied to a physical product, the performance is essentially intangible…Services are economic activities that create value and provide benefits for customers at specific times and places*". Services can hence be viewed as interactions between people, they are intangible and delivered in real-time, and the consumers of services are often themselves actively involved in the process (Gutek, 1995). The quality of services can be increased through standardization similar to efforts in manufacturing (Levitt, 1972) or through more intensive customer interaction (Chase, 1978). Classical types of services include production line services, such as the ones experienced in fast-food outlets; customer self-services, for example those offered by Internet banks; and personalized services, such as the ones experienced at an expensive hotel or restaurant (Rai, 2004). Services can display varying degree of the following characteristics: intangibility, inseparability of production and consumption, potential variability, perishability, and lack of ownership (Grönroos, 2000; Kaitovaara, 2004). While most of these characteristics apply to

information services in a relatively straightforward way, it is not always obvious that information services do not involve transfer of ownership, a unique characteristic of services as compared to products (Lovelock et al., 1999). It is, for example, more straightforward to consider calculations made in a spreadsheet as an information service when based on web-based, on-line spreadsheet services from Google, Zoho, or Thinkfree than when based on a product installed on your computer like Microsoft Excel, simply because the former does not imply transfer of ownership, whereas the latter does. However, where the enabling software services are residing is less relevant to our argument and it is in many cases also an issue that is subject to sliding boundaries between web-client, application, and server (Sørensen et al., 2001).

Gutek (1995) suggests a fundamental distinction between encounter and relationship services in line with Lovelock's distinction between discrete transactions and continuous delivery of services (1983), Coviello & Brodie's (2001) distinction between transactional and relational marketing practices, and Zuboff & Maxmin's (2002) distinction between transaction and relationship economics. An encounter is a straightforward, standardized service that spans a short period of time and has a predefined context. We engage in encounters when we enter a shop to buy milk and bread. Encounters ensure efficiency, speed, and uniformity of services. In contrast, relationships are characterized by context and duration and aimed at more complex service needs. Relationships serve the purpose of creating bonds of trust in evolving interactions between actors. Most people have a relationship with their doctor or their solicitor. Some persons also have a relationship with the hairdresser, while others use encounters for that purpose.

While the general notion of service applies directly to business-level services (Lovelock, 1983; Grönroos, 2000; Kaitovaara, 2004), the distinction between encounters and relationships (Lovelock, 1983; Gutek, 1995; Coviello and Brodie, 2001; Zuboff and Maxmin, 2002) need to be adapted and translated to information-level services. First, services in general focus on relationships between people in particular forms of business interactions. In the context of information processing, we adopt services to capture human interaction mediated by technology (e.g. email, repositories, mobile phones, video conferencing, and various forms of collaboration technology). Second, the distinction between encounters and relationships is quite similar to contemporary perspectives on information processing, e.g. Mathiassen & Nielsen's (2000) distinction between transformations and interactions and Wegner's (1997) distinction between algorithmic and object perspectives on information processing. Wegner (1997) defines the distinction as: "*Algorithms are 'sales contracts' delivering an output in exchange for an input, while objects are ongoing 'marriage contracts'. An object's contract with its clients specifies its behavior for all contingencies of interaction (in sickness and in health) over the lifetime of the object (till death do us part).*" Third, encounter and relationship information services apply directly to Daft & Lengel's notion of equivocality (1986). Information requirements must be simple and easy to understand if information services are to be organized similar to encounters. Relationship information services are, in contrast, highly situated and sensitive to the evolution of the interaction between the involved actors. When organizing information processing as services,

situations with low equivocality can therefore be addressed through encounters. However, as equivocality increases, relationships will allow the involved actors to develop shared experiences and mutual trust to generate and dissipate the information necessary to execute the task. These considerations provide the underlying rationale for our proposition for providing information services:

> ***Proposition 3:*** *Information services are provided by configurations of people and IT artifacts through encounter and relationship interactions.*

We have chosen to theorize information services based on the distinction between encounter and relationship services for a number of reasons. First, encounters and relationships represent a fundamental distinction within the economic and service literature (Lovelock, 1983; Coviello and Brodie, 2001; Zuboff and Maxmin, 2002). Second, service concepts in general apply across industries and segments of society, and they can be translated into the organizational information domain to mirror contemporary conceptions of information processing (Wegner, 1997; Mathiassen and Nielsen, 2000). Third, services in general address interactions between actors independent of organizational positions and can therefore be translated to cover information services both inside and across organizational boundaries. Fourth, the encounter-relationship dichotomy fits the simple and dualistic nature of Daft & Lengel 's framework (1986).

Synthesizing Basic Constructs

The following synthesizes the basic constructs into a theory of organizational information services. First, we apply contingency theory to describe the relationships between information services and work contexts. Second, we define and exemplify the resulting four archetypes of information services. The proposed theory applies to specific work contexts with a related set of tasks and a portfolio of information services. However, the theory can be applied to different levels of granularity. Focusing on a specific work context, the observer can shift to one particular part of that context and subsequently consider this as a different work context in itself. Also, an information service that supports a specific task within a work context can be viewed as a portfolio of more refined information services supporting different subtasks.

Applying Contingency Theory

Contingency theories have number of characteristic elements (Kickert, 1983; Drazin and Van de Ven, 1985; Iivari, 1992):

1. Contextual factors,
2. Information processing options,
3. Methodology,
4. Type of fit

a. Selection approach,
b. Interaction approach,
c. Systems approach,

5. Effectiveness criteria.

We have addressed some of these elements through the basic constructs and Daft & Lengel 's framework (1986), while others need further consideration. *Equivocality* and *uncertainty* requirements are the considered contextual factors. The identified information processing options focus on *use* versus *production* and they support *encounter* versus *relationship* services. The methodology used to develop the theory is conceptual and based on combining and translating existing frameworks (Daft and Lengel, 1986; Gutek, 1995; Ramaprasad and Rai, 1996; Wegner, 1997; Mathiassen and Nielsen, 2000).

Other elements have not been addressed yet. There are three types of fit between contextual factors and information processing options (Kickert, 1983; Drazin and Van de Ven, 1985; Iivari, 1992). The selection approach suggests that contextual factors determine the processing option that leads to the most effective response. Contextual factors are considered as given and processing options are adapted to their context through managerial selection. The interaction approach suggests that fit is achieved through design of appropriate relationships between specific contextual factors and processing options. A design influences not only how information is processed, but also the way in which information processing interacts with and shapes contextual factors. The systems approach suggests that fit represents the overall consistency between multiple contingencies, processing designs, and performance characteristics. There may, in the systems approach, be several equally effective and internally consistent patterns of context and information processing design.

We adopt a combination of a systems and interaction approach for a number of reasons. First, while the selection approach has dominated contingency theory research into information processing, the unidirectional causality implied seems too simplistic (Iivari, 1992). The other two approaches offer complementary views on the relationship between context and IT use that can account for more complex aspects of practice (see for example Leavitt, 1964; King, 1983; Markus, 1983; Ramaprasad and Rai, 1996). Second, the interaction approach offers a dialectic conception of causalities between pairs of factors and processing options. We apply this on the task level to characterize the fit between specific pairs of information services and tasks. Third, reference theories for Daft & Lengel's (1986) framework, such as Perrow (1967), Galbraith (1973) and Mintzberg (1983) have adopted systems approaches in which organizational designs evolve over time as a result of interactions with the environment (Iivari, 1992). An organization will, as a consequence, at each point in time consist of a complex mix of different design options. We apply this to the work context level to characterize the fit between portfolios of information services and the tasks they support.

Finally, the effectiveness criteria used to link factors to information processing options are largely determined through adoption of interaction and systems approaches to fit. Like other

contingency theories based on similar conceptions of fit, we reject the idea of one optimal design. Following Mintzberg (1983, p.2-3), information processing options "*should be selected to achieve an internal consistency or harmony, as well as a basic consistency with the organization's situation*". Well- designed information services and IT artifacts are hence characterized by absence of misfit on two levels. First, applying an interaction approach to the task level, there can be misfit between individual information services and the task they are designed to support. Such misfits are expressions of a limited capability to design information services consistent with the uncertainty or equivocality of the task under consideration. This type of misfit is expressed in the following two propositions derived from the discussions in Sections 2.2 and 2.3 respectively:

> ***Proposition 4:*** *Information services that help make use of information are well suited to low uncertainty requirements while information services that help produce additional information are well suited to high uncertainty requirements.*

> ***Proposition 5:*** *Information services based on encounter interactions are well suited to low equivocality requirements while information services based on relationship interactions are well suited to high equivocality requirements.*

Second, applying a systems approach to the work context level, there can be misfit between the portfolio of information services provided and the set of tasks they are designed to support. Such misfits are expressions of limited capability to implement portfolios of information services that enable effective and efficient responses to the equivocality and uncertainty profile of the tasks involved in a work context. A good fit requires an appropriate mix of encounter and relationship services (Lovelock, 1983; Gutek, 1995; Coviello and Brodie, 2001; Zuboff and Maxmin, 2002) as well as positively reinforcing cycles of information production and use services (Ramaprasad and Rai, 1996).

		Uncertainty	
		Low	**High**
Equivocality	**High**	*Adaptive service* **Use** of information **Relationship** service	*Collaborative service* **Production** of information **Relationship** service
	Low	*Computational service* **Use** of information **Encounter** service	*Networking service* **Production** of information **Encounter** service
		Need-to-do-something	*Need-to-know-something*

Figure 1: The diversity of organizational information services.

While the conceptual space addressed by the theory in this way covers four dimensions (production-use; encounter-relationship; high-low uncertainty; high-low equivocality) with a total of sixteen possible combinations, the theory expressed through Propositions 1-5 suggests only four different types of information services to satisfy these combinations. This parsimony is summarized in Figure 1 and it constitutes a core value of the proposed theory. In the following, we define and illustrate the four archetypes of information services suggested by the theory.

Defining Service Types

The four archetypes of information services express different approaches to information processing and service provisioning. Following Ramaprasad & Rai (1996), organizational actors produce information as they derive meaning from stimuli in the organization and its environment. Information production starts from consideration of phenomena in the real world and leads to information about these phenomena. In contrast, organizational actors use information as they transform information about the organization and its environment into stimuli. Information usage starts with information about organizational phenomena and creates stimuli that support and guide task execution.

Similarly, translating the general distinction between encounter and relationship services (Lovelock, 1983; Gutek, 1995; Coviello and Brodie, 2001; Zuboff and Maxmin, 2002) into the information processing domain (Wegner, 1997; Mathiassen and Nielsen, 2000), service encounters follow standardized and repeatable patterns of information processing across different work contexts to ensure efficient, speedy, and uniform responses. The required information is available and formalized and the variation between different enactments of a service is minimal. In contrast, service relationships are based on standardized patterns of information processing that are applied and tailored to a specific work context. Available information is combined with emerging information based on the involved actors' ability to interpret the particular work context. The variation between different enactments of a relationship service can be considerable. Huber (1982), characterizes similarly, the need for supporting efficiency and discretion. The four archetypes of information services are characterized based on these concepts and are exemplified in Figure 2.

Computational services rely on encounter services and support organizational actors in transforming available and formalized information into organizational stimuli by following standardized and repeatable patterns of information processing. Traditional transaction systems such as the account management system in a bank make computational services available for customers and employees. Information about transactions, accounts, customers, and financial advisors is readily available and unequivocal. A portfolio of standardized services - some computerized (e.g. insert amount on account) and some manual (e.g. through branch offices and helpdesk functions) - are available to support task execution. Bank employees and customers enact these services enabled by IT.

The withdrawal of funds from an account is a computational service in which the amount submitted to the bank is deducted from the account. The information is available and the process of deducting the amount from the account is unequivocal. Another example of a computational service is a simple, web-based e-commerce transaction that supports buying specific types of goods, for example a book on Amazon.com. Purchasing specific types of goods is an unequivocal task, and the information is readily available when the customer has decided on a particular book to purchase. The standardized process will be conducted the same way for any customer independent on what book they choose to purchase.

		Uncertainty	
		Low	**High**
Equivocality	**High**	*Adaptive service* Flexible Kanban production system. Complex Tesco transaction	*Collaborative service* Collaboration platform for distributed work. Advanced location-based service
	Low	*Computational service* Transaction bank system managing customer accounts. Simple Amazon transaction	*Networking service* Google search. Simple mobile (cell) phone query. Simple database query. Simple location-based service
		Need-to-do-something	*Need-to-know-something*

Figure 2: Examples of information services.

Adaptive services help actors interpret and transform available and emergent information into organizational stimuli by adapting standardized patterns of information processing to specific work contexts. Adaptive services rely on relationships and allow the involved actors to explore and debate interpretations during task execution. In tasks with many actors involved, unexpected combinations of events can make it necessary to negotiate interpretations before making local decisions (Schmidt and Simone, 1996). For example, in the case of the Kanban Just-In-Time production management system reported by Schmidt & Simone (1996), forklift drivers or production line staff sometimes overrode pre-programmed informational responses to adapt to emerging circumstances, for example disregarding the stipulated delivery of a certain batch of components and instead delivering an alternative batch to match a specific emergent situation when an order was being rushed through the assembly line ahead of schedule. Another example of an adaptive service is the negotiation of grocery deliveries at Tesco.com, an advanced UK on-line grocery store. The standard task of ordering groceries involves customers ordering from the website, paying for it with a credit card, and choosing delivery date and time. This normally implies using a computational service, but in several instances, the customer may instead evoke an adaptive service. For example, discrepancies between the items ordered on the Internet and those delivered to the door - caused by stock shortage or human error when picking goods - require negotiations to take place between the customer and the delivery person

or between the customer and an employee at a telephone call-centre. The increased equivocality requires the delivery van driver to negotiate preferences to ascertain if the customer wishes to accept the items or receive a refund.

Networking services help actors produce information about phenomena in an organization and its environment by following standardized and repeatable patterns of information processing. Networking services rely on encounters and they typically connect actors to relevant information sources through IT artifacts such as email systems, search engines, electronic libraries, mobile phones, and SMS messaging. These technologies offer readily available support by providing users with immediate access to relevant information sources. A simple search on Google offers a networking service in which a search term generates a list of ranked results according to the Google index. In a similar fashion, a phone call from one colleague to another asking a question and receiving an answer can be characterized as a networking service. There are also emerging types of Instant Messaging such as ICQ, AOL Messenger, Yahoo Messenger, and MSN Message Service, where groups of users can connect and carry out on-line text-based discussions (Whittaker et al., 1997; Nardi and Whittaker, 2000).

Collaborative services support organizational actors produce information about phenomena in an organization and its environment through interpretation of the specific work context. Collaborative services rely on relationships. The use of a networking service such as forwarding a simple and standardized inquiry on the telephone, for example about the account code for a project, may indeed turn out to be a much more equivocal task of debating practices for assigning account codes to projects. This equivocality implies engaging a relationship service to produce additional information by, e.g., searching the corporate intranet, exchanging individual documents as email attachments, and negotiating possible new principles for assigning account codes to projects. Platforms such as Lotus Notes and Microsoft Exchange Server offer the ability to set up collaborative services with shared workspaces, coordination mechanisms, and mutual awareness of ongoing activities (Sørensen, 2005; Sørensen and Pica, 2005).

Applying the Theory

This section provides applications of the proposed theory. First, we apply the theory to empirically analyze operational policing tasks based on ethnographic observation of officers and control room staff in a UK constabulary (Sørensen and Pica, 2005; Pica, 2006). Second, we apply the theory to a conceptual analysis of two key issues related to information services, one characterizing the diversity of IT-supported standardization, the other exploring unintended consequences of information services as four kinds of overload. The purpose of these analyses is to illustrate the utility of the theory as an instrument for academic inquiry – as a set of concepts guiding the investigation of real-life situations and key issues related to organizational information services.

Empirical analysis

Police officers in response vehicles attend to emergency calls and engage in a range of information processing utilizing a portfolio of diverse and heterogeneous information services (Manning, 1988; Manning, 2003; Nuldén, 2003; Sørensen and Pica, 2005). They have the following equipment to their disposal within the vehicle:

- The Mobile Data Terminal (MDT): This computer with a small color touch-screen is situated at the bottom of the center stack between the front seats. The terminal connects wirelessly to the control room, other response vehicles, the Police National Computer (PNC), and local police databases. It is equipped with an infrared keyboard for form intensive data-entry.
- Car-based and personal radios: Police officers are constantly connected with the control room through car-based as well as personal radios. In most vehicles these are two separate systems, whereas a few cars support routing the car-based to the personal radio when the officer leaves the vehicle.
- Car-based mobile (cell) phone: Each response vehicle is equipped with a standard mobile phone.
- Personal mobile phone: Police officers' private mobile phones are frequently used to reach officers during emergency calls because it can be difficult to anticipate in which car officers are located.

The core response vehicle task is to attend to and resolve incidents. For that purpose information is produced and used between officers, control room staff, and other involved persons to assess risks and develop resolution strategies (Sørensen and Pica, 2005). Response vehicles are prioritized to engage in rapid response to incidents and informed about an incident either through a police radio broadcast or through the queue of active incidents listed on the MDT screen. This active queue only contains sparse information such as the address, a short notice about the nature of the incident, and a classification of the seriousness of the incident. The dynamics of the work context is illustrated through the following example.

Officers Mary and John are on patrol. John is driving the response vehicle as they receive a broadcast about domestic violence in a block of flats over the radio. When they decide to respond to the request, John engages the blue lights and the siren. Throughout the journey at high speed down narrow English roads, Mary act as guide and she also gathers as much information about the incident as possible. She conveys this information to John using the radio or asking the control room to stream incident data to the MDT.

Mary reads the incident details aloud for John and they discuss the incident, their knowledge of the involved persons, the associated risks, and, the appropriate strategy for intervention. Apart from gathering information, Mary also uses the mobile phone to call the neighbor reporting the incident and John and Mary agree to crosscheck the address against the incident log. The mobile data terminal does not reveal a history of incidents at the address, but reveals that a woman is in distress and that

the control room has organized for an ambulance. John suggests asking for backup from other response vehicles and Mary communicates this request over the radio. The control room identifies other available response vehicles close to the incident.

When Mary and John arrive and make their way to the apartment, Mary calls the victim on her mobile phone, but the woman does not answer. Mary keeps updating hers and John's position to the control room through her radio. Once Mary and John are at the apartment, the ambulance and a backup response vehicle arrive. John repeatedly knocks on the door with the result that the neighbor reporting the incident emerges from her flat. She informs Mary and John that the male who allegedly attacked the woman has fled. In the meantime, the door to the flat slowly opens and Mary immediately updates the control room. A woman, clearly shocked and bleeding, steps out and confirms that she is on her own. The male attacker, who is the victim's partner, escaped using her car. John cautiously enters the apartment to verify that it is empty. Mary signals the paramedics to assist the victim, who provides Mary with the license plate number of the car. A warrant is immediately issued over the radio. Mary keeps updating the control room with the detailed description of the perpetrator via the radio and simultaneously takes notes.

After Mary and John leaves the incident heading for the police station, the MDT is turned off and the radio broadcasts new incidents. Mary and Jon later return to the police station to document the incident in the centralized reporting system.

Task Level Analysis

To understand how police officers produce and use information in this situation, we chronologically consider the tasks and information services enacted by the officers and the control room. Table 2 summarizes this task level analysis.

The first task is for the control room to continuously distribute new incidents to available vehicles. In the example, the control room staff uses a radio-based computational service to distribute information concerning incidents. The service is based on a standardized and repeatable pattern of broadcasting and communicates the type of incident, its seriousness, and the address to all police vehicles. The incident is also broadcast in an equally standardized and repeatable manner to all MDTs through the active queue. Due to the time and safety critical nature of responding to incidents, the efficiency of computational services is essential.

A second task is for response vehicle officers to learn about current incidents. They use various sources, such as continuously listening to the radio and observing changes to the MDT active queue, as well as generally being aware of the surroundings. The radio and active queue supports a collaborative service that allows officers to continuously receive information. In some vehicles the radio will be the main technology whereas others primarily rely on the active queue. The attention granted to the two media varies greatly from situation to situation.

Task	Equivocality	Uncertainty	Service and Technology Support	Service Type
1. Distributing incident information to response vehicles	Low	Low	Control room classifies urgency of reported incidents, updates the MDT active queue and broadcasts information to response vehicles via the radio using standardized codes	Computational
2. Obtaining information about current incidents	High	High	Officers continuously access and analyze up-to-date information by listening to the radio, monitoring changes to the MDT active queue, and, observing the environment	Collaborative
3. Negotiating and selecting incident to attend	High	Low	Officers pick and negotiate specific incidents depending on a range of factors and dissipate the chosen one to the control room through a standardized message on the radio or through selection on the active queue	Adaptive
			Officers and control room staff negotiate available and emerging information about the incident through ongoing radio contact	Collaborative
4. Assessing incident risk profile while getting to incident	Low	High	Officers call control room over the radio and request incident information streamed to the MDT. The streamed information is discussed by officers	Networking
			Officers and control room staff jointly negotiate available and emerging information through ongoing radio contact	Collaborative
5. Taking actions in preparing for incident	High	High	Officers contact relevant actors directly at the incident and remotely through the radio and mobile phone in order to discuss the situation, coordinate, and in hedge against risks	Collaborative
6. Engaging incident and coordinating efforts amongst actors	High	High	Officers engage the incident, continuously update the control room by radio, negotiate the situation with other actors, signal when to engage and disengage, and convey essential information to control room	Collaborative

Table 2: Tasks and information services for operational policing. Note that two tasks are supported by different types of information services.

A third task is the assignment of response vehicles to incidents. This occurs as Mary and John, after a brief discussion amongst themselves, report back to the control room that they will respond to the incident. They do so either through the radio using a standardized message reporting their vehicle ID, or by responding to the incident on the active queue of the MDT. Officers decide to engage based on a number of situational parameters, such as their location in relation to the incident, how serious the incident is, or if they are engaged in booking an arrested person. As the situations officers find themselves in continuously change over time, the decision cannot be made by the control room. Furthermore, as officers encounter the same people over time, the ability to choose what incident to engage in may facilitate more rapid resolution because of an officer's prior knowledge. This equivocality requires the unique character of the situation to be negotiated and conveyed through an adaptive service. An alternative to the adaptive service is to engage two-way radio communication between vehicle and control room. This collaborative service enables more substantial means of managing uncertainty regarding the incident but also occupies sparse radio frequency spectrum as well as officer attention.

A fourth task is for the officers to assess the incident and get there rapidly. Emergency response is inherently characterized by uncertain and equivocal information (Manning, 1988; Manning, 2003, p.213 and 217). The officers' assessment can essentially involve a range of information services depending on the situation. In the specific case, Mary chooses to use the MDT to quickly access centrally available information. This involves the control room streaming data directly

from their central system. Through this approach, Mary enacts a networking service with the control room to support the in-car collaboration with John to assess the involved risks. As an alternative approach, Mary and John could have chosen to engage in two-way communication about information in the police database with the control room assistant, and, to share relevant information with the control room they might have from previous incidents. Through this approach, Mary and John would enact a collaborative service with the control room. The choice of one approach over the other can be based on personal preferences, the urgency of the situation, and not least, the equivocality of the situation. For example, if there is doubt as to whether firearms are involved in the incident, John and Mary would wish to collaborate with the control room since incidents involving firearms are to be handled by specialized armed response units.

A fifth task is for the officers to take actions in preparation for the incidence. As part of this, Mary uses her mobile phone to contact the neighbor reporting the incident, and whose number she has received from the control room. She also requests backup over the radio because a woman is injured and there still is considerable uncertainty concerning the incident. In this way, based on the risk assessment, the two officers engage a collaborative service with the control room and other stakeholders involved to proactively hedge against serious risks and increase the likelihood of a successful engagement. This preparation unfolds interactively with the risk assessment as the two officers continue to produce information about the incident while at the same time making decisions that commit other stakeholders to support the engagement.

The sixth task is to engage in the incident and hopefully resolve it successfully. Throughout, Mary uses her personal radio and mobile phone to continuously produce information about the incident and update the control room of hers and John's position. This service also coordinates the safe arrival of the paramedics and provides additional details to the control room about the alleged perpetrator and the car he is driving. The equivocality of most actions and events and the uncertainty related to, for example, the identity of the fleeing person requires the engagement of a collaborative service that allows the officers, the control room, and other actors involved to negotiate the situation as it unfolds.

Work Context Level Analysis

During the described incident, officers, control room staff, and other actors engage in a portfolio of information services spanning the four archetypes (see Table 1). These services are enabled by a range of IT artifacts. Most tasks are characterized by high equivocality and high uncertainty calling for extensive use of collaborative services (cf. Propositions 2 and 3). However, the officers choose in this case to adopt both adaptive (cf. task 3) and networking services (cf. task 4) to help with limited aspects of the required information processing. In both instances, there were alternative collaborative services available. The specific configuration of information services is, in this way, to a large extent left to the discretion of the officers. Task 3 and 4 illustrate how portfolios of services can offer alternative combinations of services to yield satisfactory results. What for one crew is a natural way

of managing information may for others be cumbersome. Also, the specific characteristics of particular police constabularies can shape the choice of information services. For example, in the constabulary reported here much interaction from control room to patrol vehicle was conducted by streaming data to the MDT. This was attributed to the relatively low staff levels in this constabulary requiring officers to be more effective, whereas in a neighboring constabulary with better staff levels the radios were the preferred means of control-room to vehicle communication (Pica, 2006).

Effective and efficient information processing support for vehicle-based tasks is essentially based on each crew establishing their own practices for how to select and evoke information services depending on the situation and on where they are in the recurring response vehicle cycle, i.e., standing-by in car before incident; driving to an incident; taking action at the incident; driving from the incident; or, returning to police station to report (Sørensen and Pica, 2005). The discretion of each response vehicle crew is hence a primary mechanism for ensuring an appropriate balance between encounter and relationship services and positively reinforcing cycles of information production and use (cf. Proposition 1) in this particular work context.

Indeed, alternative portfolio designs with less officer discretion and more centralized allocation of incidents could easily lead to less effective incident engagements. In such alternative scenarios, the officers would, for example, be obliged to follow a more strict procedure for using information about the unfolding of each of their engagements to ensure that the control room could maintain a centralized up-to-date view of the situation of all officers and response vehicles (Sørensen and Pica, 2005). In the case of armed response officers, such a stricter code is applied to ensure due process of the officers obtaining authorization from their superiors to unlock the weapon safe and to draw weapons when engaging in the incident. An essential design criterion in this work context is, therefore, the availability of a variety of IT artifacts and information services and the ability for services to be selectively and rapidly evoked, leading in each specific incident to enactment of a portfolio of heterogeneous services that is tailored to the specific situation. This design allows officers to effectively move information services into the background when direct engagement with the incident calls for maximum attention. Also, despite the high equivocality and uncertainty of the tasks involved, it allows officers to not necessarily engage in collaborative services with control room staff.

In this work context, it is essential for officers to remain aware of important developments, and they will therefore continuously seek new information to manage the inherent uncertainty. Moreover, combining time and safety criticality with the equivocal nature of assessing incidents, coordinating efforts and resolving conflicts, imply that officers constantly must balance requirements for expedient action with the need to manage relationships to colleagues. Here, the personal radio serves as a crucial technology as officers engage in incidents, despite the availability of alternatives. The personal radio enables an open communication channel between officers and the control room allowing instant cycles of ad-hoc information production and use without being in the way of engaging with the incident (Sørensen and Pica, 2005). The inherent restrictions on bandwidth in two-way radio systems implies a strict culture of minimizing its use to produce and use information, and the officers therefore

apply short and highly codified messages. Also, the streaming of information directly from the control room to the MDT ensures efficient and targeted use-production cycles through a networking service where officers request information in a brief coded message. This is much more efficient compared to a collaborative service engaging control room staff and officers in ongoing conversations regarding the particulars of an incident. However, if increased equivocality and uncertainty calls for further discussion, there are collaborative services available as needed (cf. Propositions 4 and 5). In fact, operational policing tasks are, because of their time and safety critical nature, tightly coupled and therefore highly dependent on collaborative services configured and applied to specific contexts according to officer discretion (Perrow, 1984; Carstensen and Sørensen, 1996; Manning, 2003). It is, therefore, not surprising that the first civilian use of two-way radio systems was for operational policing (Agar, 2003).

While information processing has been innovated and cultivated over many years to effectively support operation policing in this UK constabulary, the question always remains of how practices in this particular work context could be further improved enabled by IT. Given the nature of the tasks involved in response vehicle engagement, the different archetypes of information services, as well as current trends in IT support for organizational information processing, we suggest consideration of three specific options. First, each individual officer could have a personalized, adaptive information service that would allow easy access to information related to earlier engagements and easy access to a network of other actors. Such a service would make it possible to further leverage the experience of each individual officer to successfully engage in new incidents. Second, new forms of wearable computing devices could help response officers have immediate and easy access to a variety of information services during engagement while still having primary attention focused on dealing with the incident and emerging events. Such technologies could include integration of voice-activated short-codes to directly call backup vehicles to establish computational service issuing orders or networking services requesting information. Finally, integrating services for reporting into the set-up in each vehicle, would allow officers to report while at the same time being visible on the streets waiting to engage in the next incident. Such services would, for example, require adaptive services supporting officers filling in and submitting incident forms; networking services for requesting unique incident ID centrally generated; and, possibly collaborative services supporting officers sharing information about recent incidents through discussion groups.

Conceptual analysis

Next, we apply the theory to the issues of standardization and unintended consequences. In doing so, we see how the proposed service archetypes distinguish themselves with respect to important issues related to organizational information processing. A summary of this exploration is summarized in Figure 3.

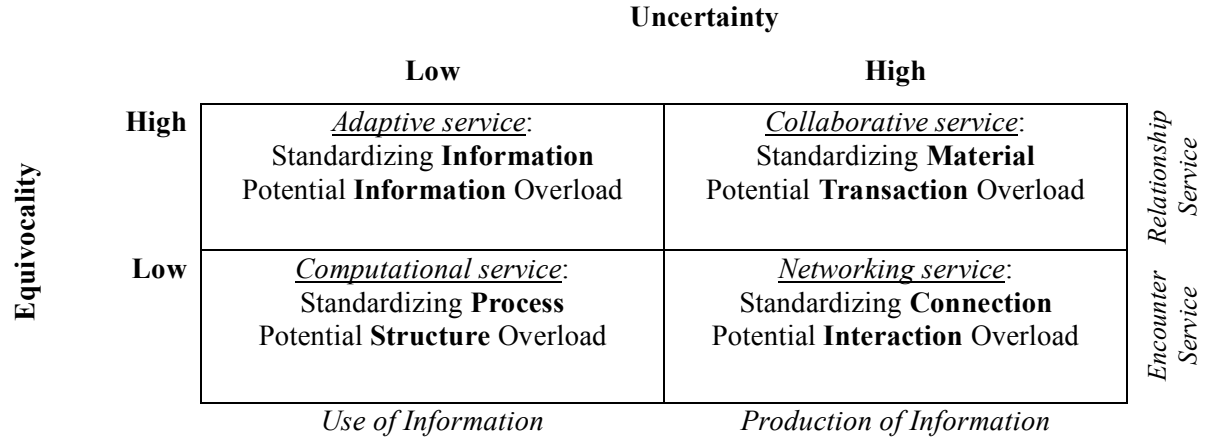

Figure 3: Standardization focus and unintended consequences related to information services.

Standardization Focus

Several authors have explored various forms of IT in terms of embedding and supporting standardization, for example, (e.g., Beniger, 1986; Zuboff, 1988; Yates, 1989; Bowker and Star, 1999; Yates, 2005). Latour (1991) goes so far as to argue "technology is society made durable". The use of technology hence requires some element of standardization that is sustained through organized patterns of work (Kallinikos, 1996). The question then becomes how different information services standardize or codify to support task execution (Sørensen and Snis, 2001).

Computational services support unequivocal tasks with stable information processing requirements. These services are organized as encounters where information mainly is used as opposed to produced. Efficiency, speed, and uniform delivery are achieved by programming the computerized and partly the human information processing involved. Computational services require, in this way, standardization of socio-technical information *processes* to provide standardized, repeatable responses across different work contexts. Hence, the computational encounter represents a service with a pre-defined process of input, computation, and subsequent output.

Adaptive services, on the other hand, are organized as relationships and executed by competent actors that cope with equivocal tasks through use of available information. Task execution is not standardized, because the specifics of each situation must be taken into account as they become clear. Still, information-processing requirements are, on a generic level, stable. It is therefore possible to provide IT-based support by standardizing the *information* involved in executing tasks. While computational services standardize both information and process, adaptive services mainly standardize information and leave it open how information is used in response to the situation at hand according to the unfolding relationship. Management of equivocal information through standardization of information is illustrated by the International Classification of Diseases (Bowker and Star, 1999) or by design groups that codify the representation of products to support the storage and retrieval of design specifications (Sørensen and Snis, 2001).

Networking services support tasks with uncertain, but unequivocal, information processing

requirements. These services are organized as brief encounters in which actors are linked to sources to identify and access relevant information as needed. Because of high uncertainty, it is not possible to standardize the information needed during task execution. Instead, these services standardize IT-enabled *connections* to a range of sources that might prove helpful in producing information during task execution. Email or mobile phone services offer such standardized connections enabling one to request information across distance and in the case of SMS messages and email even asynchronously. Web-based search engines offer similar standardizations of the interface between the user and a searchable index of links.

Finally, *collaborative services* are designed to support tasks with highly equivocal and uncertain information requirements. These services are designed as relationships that allow the involved actors to generate, share, and make use of information in response to emergent needs during task execution. Application of IT artifacts for these purposes requires standardization of the *material* that mediates information sharing and collaboration between the actors. Examples of such standardized material include digitized texts, plans, models, as well as complex multi-modal materials with mixtures of traditional data, images, and sound.

Unintended Consequences

As a second issue we consider unintended consequences of information services (Markus and Robey, 2004). These are likely to emerge if design assumptions for services do not fit the realities of use. Unintended consequences are influenced by the adaptive behavior of the involved actors. What might be perceived as inappropriate in one situation, may, in another situation or by another actor, be perceived as normal and useful (Schultze and Vandenbosch, 1998). There are many, complex issues related to unintended consequences of information services including quality, learning, security, privacy, gender, and organizational politics. We focus on unintended consequences experienced as some form of overload.

Traditionally, the focus has been on information overload (Eppler and Mengis, 2004). Information overload characterizes the last stage in the diffusion process that starts with the perception of potential benefits of adopting a specific information service, followed by the diffusion of the service so it becomes an integral part of everyday life. Subsequently, the service may be used so widely that its consequences may be different from the ones intended. Ljungberg and Sørensen (2000) argue that such information overload apply well to use of information, but less to interactions to produce new information. Consequently, they suggest interaction overload as a complement to information overload. Following this logic, we ask how information services can stress the involved actors.

Computational services are designed as support for simple and standardized tasks. However, relying on a computational service when the information processing requirements turn out to be more equivocal or uncertain than originally intended might result in *structure* overload. The consumer of a service might in these cases be subjected to structural constraints restricting or obstructing the

preferred flow of information usage. This can make it difficult to adapt the service to conditions that are different from those assumed by the designer. In the case of co-ordination tasks for distributed, interdependent work activities, the use of a computational service can lead to structure overload if increased equivocality or uncertainty requires negotiation and in-flight mutual adjustments between actors. In fact, scholars disagree on the extent to which work is amenable to formalization. Some claim that the contingent nature of everyday co-ordination activities imposes fundamental barriers for IT support (Suchman, 1994). Others argue that although strict automation clearly is not desirable, devising flexible and malleable co-ordination mechanisms is a viable option (Schmidt and Simone, 1996).

The application of *networking services* in response to uncertain yet unequivocal information processing requirements may result in *interaction* overload. This type of overload suggests a mismatch between the requests made to an actor to interact and the preferences of that actor. Networking services offer powerful connections to help actors produce information. Their use can, however, result in actors being requested to interact when it is experienced as inappropriate. Even when interaction is desirable, the modality of the interaction may be inappropriate for example when receiving a telephone call during a meeting. It is a design challenge to provide actors with information services that help them manage their networking engagements by, for example, prioritizing, excluding, postponing, or redirecting interaction requests (Ljungberg and Sørensen, 2000). In each instance of enacting a networking service, it is the actors requested to respond rather than the actor requesting a response that can experience interaction overload. However, as in the case of email and mobile phone usage, each actor will eventually find themselves in both roles and hence be subject to possible interaction overload.

When we engage in *adaptive services* there is an inherent risk that we experience *information* overload. Adaptive services are designed to support stable, but equivocal tasks where the primary challenge is to use information. Actors are hence constantly requested to engage in a relationship in order to negotiate available information and make the decisions required to execute the task. This situation represents the traditional concept of information overload (Eppler and Mengis, 2004). The challenge for designers of adaptive services is to strike a useful balance between flexibility and standardization of information. By standardizing key parts of the information involved in accomplishing a task, the involved actors are unlikely to experience information overload. By making the service flexible and allowing different interpretations, the involved actors are more likely to experience information overload.

Finally, use of *collaborative services* to support distributed, collaborative work amongst mutually interdependent actors, can result in the unintended consequence of *transaction* overload. In these situations, actors can experience information overload (due to task equivocality) and interaction overload (due to information production responses to uncertainty). In addition, however, users of collaborative services become engaged in equivocal work arrangements with constant renegotiation of commitments to agendas that represent multiple interests. Transaction overload is experienced as a

combination of an overwhelming amount of things to do and a sense of being confronted with tasks that are more demanding to execute than available resources allow. Transaction overload is the result of a misfit between, on the one hand, the design of the collaborative service, and, on the other hand, the equivocality and uncertainty of the task, the nature of the material involved in the collaboration, and the size, configuration, and distribution of the team that executes the task. In situations with transaction overload, actors become unproductive as they spend increasing resources renegotiating contracts and debating progress rather than resolving the tasks at hand. In such cases, the design challenge is to consider work arrangements based on a different mix of IT mediated and face-to-face interaction.

Discussion

The purpose of the proposed theory is to contribute to the understanding, assessment, and design of information services in organizational contexts. The theory is hence intended to support understanding of practice, guide action, and prove helpful in continued efforts to develop knowledge about organizational provision and consumption of information services. Demonstrating this in detail will be a project for future research. At this point, we can assess the theory based on criteria for theoretical contributions (Bacharach, 1989; Whetten, 1989; DiMaggio, 1995; Weber, 2003) and we can discuss its implications for research and practice as well as its limitations.

Bacharach (1989) defines a theory as a statement of relationships between variables, constructs, and relationships observed or approximated in the empirical world. For the purpose of assessing theories, Bacharach applies two criteria: falsifiability and utility of the proposed variables, constructs, and relationships. Falsifiability determines whether a theory is constructed such that empirical evaluation is possible. Utility refers to the usefulness of the theory. In addition, Bacharach emphasizes the importance of the underlying assumptions about values, time, and space that define the boundaries of a theory.

We have defined the boundaries of our theory through definition of basic constructs and adoption of existing theoretical contributions. The key constructs are task, actor, work context, information processing requirement, information processing, and information service. The theory links information requirements of organizational tasks to the provision of suitable information service portfolios. As such it facilitates an "opening of the black box" of managerial choice and technological options for information services in organizational contexts. This is an important endeavor as social interaction and collaboration increasingly is mediated by IT-based services both within and across organizational boundaries (Kallinikos, 1996; Schmidt and Simone, 1996; Sørensen, 2005). The variables suggested are: task equivocality and uncertainty, information production and use, and encounter and relationship services. Propositions 1-5 specify the relations between the theoretical constructs and variables. Table 3 summarizes the proposed theory based on Bacharach's framework (1989).

Theory element	Proposed theory elements
Boundaries	Definition of basic terms and adoption of existing theoretical contributions
Constructs	Task, actor, work context, information processing requirement, information processing, and information service.
Variables	Equivocality, uncertainty, production, use, encounter, and relationship.
Relations	Proposition 1-5

Table 3: Summary of proposed theory based on Bacharach's framework (1989).

Regarding falsifiability, the theory is based on established constructs within Information Systems (Daft and Macintosh, 1981; Daft and Lengel, 1986; Ramaprasad and Rai, 1996) and on general notions of services (Lovelock, 1983; Gutek, 1995; Coviello and Brodie, 2001; Zuboff and Maxmin, 2002). The choice of Daft and Lengel's (1986) contingency theory and Ramprasad` and Rai's (1996) theory of organizational information processing are supported by several sources (e.g., Leifer, 1988; Weill and Olson, 1989; March, 1991; Iivari, 1992; Levinthal and March, 1993; Goodhue and Thompson, 1995). Relating these constructs and translating them into the information service domain proved relatively straightforward. The choice to adopt the fundamental distinction between encounter and relationship services is supported by distinctions within computer science (Wegner, 1997), systems research (Mathiassen and Nielsen, 2000), business studies (Zuboff and Maxmin, 2002), and service research (e.g., Lovelock, 1983; Gutek, 1995; Coviello and Brodie, 2001). While the general notion of service assumes a consumer-provider interaction primarily between human actors, we have adapted the constructs and translated them into the organizational information processing domain. First, there is within this domain not as clear-cut a distinction between providers and consumers. Organizational actors engage in networks of interactions in which they typically participate in providing information services while at the same time consuming them. Second, services in general are enabled by technology, but they are primarily social in nature. In the information processing domain, IT plays an important role in enabling information services, and we have therefore adopted an abstract notion of actors to capture the socio-technical nature of these interactions (Latour, 1991; Jacobson et al., 1992; Ramaprasad and Rai, 1996; Wegner, 1997; Mathiassen et al., 2000). In summary, we have attempted to create a clear and well-founded conceptual basis for the theory by combining and translating established theoretical constructs into the information services domain. The conceptual foundation is complemented with explicit relations between the constructs in the form of Proposition 1-5 and the theory provides in this way a comprehensive foundation for future empirical evaluations and theoretical explorations.

Regarding the utility of the theory, we have offered illustrations of how information services apply to contemporary organizational information processing; we have applied the theory to analyze complex organizational tasks in work contexts; and, we have explored how the theory applies to key issues related to standardization and overload. These deliberations provide a first basis for assessing the theory's utility. Most importantly, the theory offers to researchers as well as practitioners a language for understanding and discussing information services portfolios. Applying this vocabulary

can help expand the debate on the role of information services for organizational innovation beyond simplistic assumptions. For example, Broadbent et al (1999) characterizes the diversity of technological capabilities as: sending messages; accessing information; performing simple transactions; and performing complex transactions. Similarly, Carr (2003; 2004) portrays information services in terms of a simple transactional model in which the role of information services is to collect, store and distribute data: "*Despite millions of powerful microchips, the endless miles of fiber-optic cable, and the billions of lines of intricate code, the commercial IT infrastructure is not really all that complicated at a conceptual level. It requires mechanisms for storing digital data in large quantities, for quickly transporting the data to where it's needed, and for enabling users to access and process data to accomplish the various practical tasks to run the business. At some point, the existing hardware and software will be sufficient – they will carry out most of the necessary functions well enough for most purposes – and further advances will appeal to ever narrower slices of users, providing even finer and more fleeting advantages*" (Carr, 2004, p. 60). While Carr's polemic arguments prompted much debate in industry, we suggest that a more informed debate could emerged if based on a deeper understanding of how organizational information processing links human activities and technological capabilities. In terms of Wegner's (1997) distinctions, Carr mainly adopts a Turing perspective on information services emphasizing the prominent role played by interactivity and stored data and as a consequence ignoring the collaborative services offered by for example YouTube and Wikipedia or the adaptive recommender engine at Amazon. By clearly distinguishing between technologically mediated encounters and relationships, we offer design directions to ensure efficiency and effectiveness through encounters when faced with unequivocality while at the same time harnessing and supporting ongoing relationships as essential when faced with equivocal requirements.

The proposed theory can be applied to study information services portfolios across a variety of organizations and situations to expand and improve existing classifications of technologies and organizational arrangements, e.g. as offered by Leifer (1988) and Broadbent et al. (1999). Through its core reliance on equivocality and uncertainty, the theory may also be suitable for studying information service portfolio types across different work domains with varying degrees of need for individual discretion. Some domains, like process industries, manufacturing, financial services firms, and the retail sector, rely on recognition of shared definitions of business processes as an essential means for improving organizational performance. Other domains, like professional firms such as law firms, management consultancies, and universities, will often be operated under the assumption that the business process is embodied by the professionals and cannot be subjected to externalization and optimization as work crucially relies on professional discretion. The proposed theory could be further developed and elaborated to help understand how such differences impact information service design.

While the proposed theory in these ways offers a rich, yet parsimonious basis for investigation and debate, it also has clear limitations that call for further research. Managerial decisions about information and information processing are, for example, made in contexts shaped by intentionality,

power, and organizational politics. Similar decisions in different contexts will therefore most likely lead to different outcomes. Canada and Great Britain have, for example, decided on two radically different information strategies to support application for a skilled worker visa. The Canadian approach is highly streamlined based on a transparent self-assessment system whereas the British system relies on careful assessment of each individual case. The Canadian self-assessment form (http://www.cic.gc.ca/english/immigrate/skilled/assess/index.asp) represents a computational service that defines a process of compiling points based on individual information. If more than a certain number of points are scored the case is considered straight-forward. This makes the decision process more transparent for applicants and significantly less time-consuming for administrators. Although the British approach is less efficient through its reliance on labor-intensive adaptive services where each application is scrutinized, it does so by design to allow for discretion in the decision process. Thus, we see how two contradictory design criteria are in play between making organizational decision making efficient and transparent versus ensuring that decision-making processes allow for localized adaptability. Such observations bring important limitations of the proposed theory into the foreground. While the theory provides a strong and constructive focus on how information services efficiently and effectively respond to information requirements enabled by IT, it does not address issues related to the political and cultural context in which information services are designed and managed.

Another particularly delicate and important question relates to the design of how organizational information services are enacted: What is in a given context the most feasible way to configure people and IT-artifacts to support information services? Gutek (1995) argues generally that organizations may attempt to convince people that a relationship is provided, where in fact most aspects of the relationship is taken care of by automatic or semi-automatic facilities, thus providing what she terms a "pseudo-relationship". It is, indeed, seldom transparent how information services are supported through configurations of human and technological agency. The Chess-Playing Turk (Standage, 2004) sparked in the 18th and 19th Century a debate on the limits of machine intelligence as it could beat major chess masters in the world. Standage's book reveals the Chess-Playing Turk as a clever illusion with an expert chess player hidden inside a machine. It was a case of human agency masked as machine agency. By the same metaphor, we can reflect on contemporary information services in organizations. Quite often, organizational efficiency and uniformity of service provision is achieved through codification of decision processes that are executed by people employed in call-centers. Callers engage in conversations with a human being and they therefore take for granted that there is some room for adaptability and discretion according to the specific circumstances of the situation. However, callers are in fact often playing chess with a machine disguised as human being as the operator is under strict instruction to follow a pre-determined, non-negotiable script. Information services are complex socio-technical phenomena and it is not trivial to explicate in each case how human agency and technology interact or should interact in the enactment of particular services. The proposed theory offers an abstract view of this complex reality that allows for continued deliberations

without making a priori assumptions about particular forms of agency.

Conclusion

The proposed theory is a response to Orlikowski & Iacono's (2001) challenge to theorize the IT artifact. The key contribution is a parsimonious framework that can help complement our current focus on information systems with an understanding of information services in order to better capture the interactive, aggregated, and highly diversified nature of contemporary IT usage in organizations. The presented theory relates four ideal types of organizational information services - computational, adaptive, networking, and collaborative services - to different types of organizational tasks and work contexts defined by their level of equivocality and uncertainty. We have illustrated how the theory can be used to analyze organizational information processing, and we have discussed implications of the theory for understanding key issues related to standardization and overload.

The research is argumentative in nature and more research needs to be done in several areas. Firstly, we need to relate the theory more closely to the research on task-technology fit and IT usage. Secondly, further empirical explorations should use the theory to characterize the use of IT as portfolios of information services in order to test its validity. Thirdly, efforts based on design science research should explore how the theory can inform practical design of useful organizational IT artifacts. Finally, we must continue to explore how the theory can be further developed and refined.

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