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In Pursuit of Systems Theories for Describing and Analyzing Systems in Organizations

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Research paper

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Abstract

This research essay illustrates how the IS discipline might pursue systems theories with the goal of understanding IS in new ways, generating innovative and useful systems theories, and achieving more impact in the world. It discusses recent articles that compare different perspectives and expectations related to theories and theorizing in the IS discipline. It uses the term domain-specific systems theory (DSST) to accentuate the difference between general systems theory (GST) and specific systems theories. It provides examples illustrating how DSSTs can illuminate important concerns that variance and process perspectives do not address directly. It shows how work system theory (WST) and several of its extensions are DSSTs that provide useful lenses for understanding, analyzing, and theorizing about systems in organizations. It concludes by summarizing ways in which the IS discipline might welcome systems theories more wholeheartedly.

Keywords: Systems theory, Systems Perspective, Variance theory, Process theory, Work system theory

1 Why Should the IS Discipline Pursue Systems Theories?

The visibility and application of systems theories in the IS discipline have not come close to achieving the promise implied by the name of discipline. Here are recent published views of this issue:

> *"Our field's forefathers were systems theorists" …"the systems perspective should be a natural fit for IS because of our interest in systems." … "but its influence dissipated in the late 1980s as researchers began to focus mainly on the variance perspective."* (Burton-Jones et al., 2015)

> *"Most IS researchers [have] used the term 'system' or 'systems' to refer to just about anything that involves electronic information processing."... The conflict between the [IS] discipline's espoused theory of itself as a systems discipline and its theory-in-use of itself as a non-systems discipline has the obvious detrimental consequence in which much information systems research does not qualify as truly information systems research." (Lee, 2010, pp. 339 and 341).*

> *"Many of the key insights from general systems thinking have become part of the IS lexicon. While the links back to GST as a source for these ideas may be neglected, IS remains enriched due to its adoption and absorption of many of [those] tenets.." (Robey and Mikhaeil, 2017, p. 128)*

> *"The reality is that the field of information systems as a whole has never seriously entertained systems theory in the first place. We have noted a few individual exceptions like Checkland (2000) and Alter (2001), but there has existed no overall body of literature indicating a systems movement in the field of information systems to which they or others have contributed." (Demetis and Lee, 2017, p. 164).*

Goal. This research essay describes a path forward by which the IS discipline might pursue systems theories in order to understand IS in new ways, generate innovative and useful systems theories, and achieve more impact in the world. Enabling the IS discipline to do more justice to its own name would be nice, but that is not a compelling reason to invest effort in trying to move beyond the convergence of much current research that has been noted many times (e.g., Grover and Lyytinen, 2015; Liu et al. 2016; Stein et al., 2016). A compelling reason is to pursue real opportunities in an area that has little visibility and often seems tangential to most IS research interests despite the field's name.

Organization. The next section identifies sources of inspiration for this paper, a 2016-2017 dialogue about crafting requirements for systems theories and current articles related to limitations of current research perspectives in IS. The term *systems theory* is defined to distinguish it from general systems theory (GST) and to recognize domain-specific systems theories (DSSTs) that can serve as lenses for many purposes. Work systems theory (WST) and several of its extensions are presented as examples of DSSTs. Briefly summarized applications of those DSSTs illustrate the kinds of potential benefit from could come from developing other DSSTs. The conclusion summarizes ways in which the IS discipline might welcome systems theories more wholeheartedly.

2 Current Viewpoints that Inspired this Paper

This paper was inspired by a dialogue in *Information and Organization* about requirements for systems theories in IS (abbreviated as the RST dialogue). That dialogue started with "Crafting theory to satisfy the requirements of systems science" (Demetis and Lee, 2016), included three insightful responses (Mingers, 2017; Robey and Mikhaeil, 2017; Schultze, 2017), and provided a further response by the original authors (Demetis and Lee, 2017). The RST dialogue addressed the question at hand by discussing systems theorizing, systems thinking, and fundamental limitations of systems approaches to IS and organizations, but did not define the concept of systems theory. It mentioned several researchers who developed systems approaches but discussed no specific examples of systems theories. It treated General Systems Theory (GST) not as a theory, but as a synonym of systems science, which it characterized using a list of properties identified by Skyttner (2005) including interrelationships and interdependence of objects, holism, goal seeking, transformation process, inputs and outputs, regulation, hierarchy, differentiation, and equifinality and multifinality. Other system properties mentioned in the RST dialogue include goal state, equilibrium, system architecture, emergence, autopoiesis, communication, and self-reference. Adams et al. (2014) expressed similar ideas in *Systems Engineering* by describing "systems theory" in terms of the linkage of axioms called the centrality, contextual, goals, operational, viability, design, and information axioms.

The RST dialogue provided many interesting ideas and arguments but I found it incomplete. Why debate the nature of requirements for systems theories without mentioning specific systems theories (if they actually exist) and explaining how they would be clearer, more inclusive, more valuable, or otherwise better if they met the proposed requirements for systems theories?

The treatment or omission of systems theories in recent articles about perspectives or approaches in IS research provided an additional impetus to discuss systems theories in a more direct and specific manner. Burton-Jones et al. (2015) compares variance, process, and systems perspectives in IS research, each of which represents "a researcher's choice of the types of concepts and relationships used to construct a theory." It notes that papers comparing theoretical perspectives tend to "emphasize the variance/process dichotomy without mentioning the systems perspective." It describes an unproductive tendency to keep the different perspectives separate and proposes ways to combine aspects of variance, process, and systems approaches. Along similar lines, Ortiz de Guinea and Webster (2017) proposes combining perspectives through different types of hybrids of variance and process approaches in IS research. It did not mention systems theories but leads to wondering what hybrids of systems theories might look like. Grover and Lyytinen (2015) discusses limitations of the IS field's dominant "mid-range script" that leads to producing minor variations on theories such as TAM (Davis et al., 1989) and UTAUT (Venkatesh et al., 2003). They argue, "we need to move beyond Benbasat and Zmud's (2003) focus on putting the IT construct in the central place within a nomological net." (p. 287). Their proposal of "permitting IS scholarship that more fluidly accommodates alternative forms of knowledge production." (p. 271) resonates with this paper's goals.

A final motivator for this paper is the minimal presence of systems theories in the IS Theories Wiki (Larsen and Eargle, 2015). The word *system* appears in the names of only in five of the theories as of November 2017: GST, hedonic-motivation system adoption theory, multi-motive systems continuance model, soft systems theory, and work system theory (WST). GST purports to be a transdisciplinary theory that identifies properties shared by all systems (see above). The next two use the term system as a rough synonym for a tool that is adopted or liked. Soft systems theory is really an alternative name for soft systems methodology, less a theory and more a system-oriented method for problem identification and problem solving. WST will serve as this paper's primary example for illustrating the potential of systems theories in IS. The IS Theories Wiki did not include several widely used systems theories that that will be mentioned later, i.e., activity theory, sociotechnical systems theory, and the viable systems model.

3 What is a Systems Theory?

The concept of systems theory unfortunately combines two terms, system and theory, that have proven problematic in the IS discipline.

System. The definition of *system* is surprisingly elusive. Skyttner (2005, pp. 56-57) mentions ideas such as "anything that is not chaos" (Boulding, 1964), "a structure that has organized components," (Churchman, 1979), and "a set of variables sufficiently isolated to stay constant long enough for us to discuss it." (Ashby, quoted by Skyttner), ultimately concluding, "To qualify for the name system, two conditions apart from organization have to be present: continuity of identity and goal directedness." (p. 59). "A system is a set of interrelated elements. … Each of a system's elements is connected to every other element, directly or indirectly." (Ackoff, 1971, p. 662). Demetis and Lee (2016, p. 117) cite Skyttner's (2005, pp. 49-50) formulation of Hegel's definition: "The whole is more than the sum of the parts, the whole defines the nature of the parts, the parts cannot be understood by studying the whole, and the parts are dynamically interrelated or interdependent." Skyttner (2005, pp. 56-57) notes that a system is not something presented to an observer; rather, it is something to be recognized by an observer. Different observers might perceive different systems in the same situation.

Separate from those definitions, Demetis and Lee (2017) say that "Apart from the few individual exceptions noted, the term "systems" in information systems has been an empty honorific, where the phrase "information systems" is largely interchangeable with "information technology" or even just "the computer." Beyond their interpretation, *system* sometimes refers to a sociotechnical system that contains human participants (as in Sarker et al., 2013) and sometimes refers to technology used by such a system. For example, the IS success model (Delone and McLean 1992, 2003) treats system quality as an independent variable affecting IS usage and user satisfaction. (If an IS a sociotechnical system rather than a tool, how can its own system quality be treated as an independent variable that affects its own usage?) Regardless of those confusions in the IS discipline, computer scientists and engineers find it both natural and meaningful to see hardware/software configurations as systems.

Theory. The nature of theory has been discussed extensively but inconclusively in the IS discipline and in social science, e.g., Markus and Robey 1988; Sutton and Staw 1995; Weick 1995; Gregor 2006; Colquitt and Zapata-Phelan 2007; Weber 2012; Straub 2012; Avison and Malaurent 2014; Grover and Lyytinen 2015. A common issue in IS (e.g., Weber 2012; Niederman and March 2014) is whether proper theories must be variance theories stated in terms of independent and dependent variables. Addressing that topic in a general way, Gregor (2006) identifies five different types of theory, theories for analysis (I), for explanation (II), for prediction (III), for explanation and prediction (IV), and for design and action (V). The systems theories discussed in this paper tend to exhibit aspects of several of Gregor's categories instead of residing within only one category.

Systems theory. The term *systems theory* is problematic because it often appears as a synonym for general systems theory (GST), which itself is less like a well-articulated theory and more like a list of properties that apply to many systems, as mentioned earlier. The introduction mentioned propositions in the form of axioms (Adams et al. (2014) that turn out to be similar to Skyttner's (2005) list of system properties. Demetis and Lee (2016) proposes requirements for systems theories because it views systems theories as different from GST. It proposes requirements for systems theories but neither defines systems theory nor provides clear examples of systems theories.

This paper defines systems theory based on Schatzki's (2001, pp. 12-13) very general view of theory related to social phenomena, "social things," and sociality. Its definition of system theory mirrors the form and reflects the spirit of Schatzki's definition: A *systems theory* of X is an abstract account of X that might take a variety of forms such as typologies, conceptual frameworks, models, metamodels or other descriptions or propositions and that is developed expressly for depicting systems or systems phenomena within its domain. System phenomena are related to the system nature of systems in the domain, and are described in relation to those systems or their system properties. Examples include:

- interactions or relationships between a system and its environment, which includes entities that receive or use its outputs
- interactions or relationships between a system's components,
- capabilities related to obtaining or receiving inputs from a system's environment,
- transformations that create outputs that are transferred outward into a system's environment,
- regulation of a system's operation,
- maintenance of a system's capabilities
- system responses to internal and external conditions that change over time
- relationships to subsystems and supersystems.

Domain-specific systems theory. Colquitt and Zapata-Phelan (2007, p. 1281) discusses two disparate definitions of theory that both emphasize the importance of identifying a theory's domain (Campbell (1990, p. 65; DiMaggio, 1995). A clear domain is especially important for systems theories due to the ambiguity of systems theory as a synonym of GST versus systems theories about specific types of systems. This paper follows Demetis and Lee (2016) by treating GST as a set of properties that apply to all or most systems. In contrast, a *domain-specific systems theory* of X (a DSST) is an abstract account of X that applies within a clearly delimited domain and that might take a variety of forms such as typologies, conceptual frameworks, models, metamodels or other descriptions or propositions developed expressly for depicting systems or systems phenomena within its domain. A variance theory in the same domain would focus on correlations between independent and dependent variables.

Analysis and synthesis using a systems theory. Effective use of systems theories combines holism and attention to components and their interactions. A systems theory can support the steps in Laszlo and Krippner's (1998, pp. 56-57) method for analysis and synthesis based on a systems approach.

- **Embedding context**. "Identify the 'embedding context' and phenomena under consideration."
- **Sub-wholes**. Describe "'sub-wholes within the embedding whole': identifiable discrete entities existing on their own right within the larger framework of the overall ensemble."
- **Specialized parts.** Look at "specialized parts within the identifiable wholes, with emphasis on understanding the structures, their compositions and modes of operation."
- **Integration of the results of the previous steps**. Refocus "on the embedding context, integrating the perspective obtained at each of the preceding steps in an understanding of the overall phenomenon, including its internal and external context."

Systems theories versus systems thinking and a systems perspective. Systems theories should be distinguished from systems thinking and systems perspectives because it is easy to slide between those three terms. DSSTs express a systems perspective and support systems thinking. The converse is not may not apply because systems perspectives and systems thinking are used widely without explicit reference to systems theories. For example, systems analysis and design (SA&D) may or may not use explicit systems theories even though it is hard to imagine analyzing systems without using a systems perspective or performing systems thinking.

Hybrids of systems theories with variance theories, process theories, or other types of theories. A final point about systems theories is the counterproductive nature of insisting that systems theories must be completely distinct from variance theories, process theories, design theories, or other types of theory. Both Burton-Jones et al. (2015) and Ortiz de Guinea and Webster (2017) argue against being overly concerned about purity in research perspectives or theory types. "A good theory may well lack an element of one of the perspectives we have outlined, or combine elements of multiple perspectives. What matters is whether a theory helps address one′s research question, not whether it complies with the ′rules′ of a pure process, variance, or systems perspective" (Burton-Jones, 2015, p. 671). Ortiz de Guinea and Webster (2017) expresses a similar thought. "There are several compelling reasons for combining process and variance approaches. … researchers construct theories to help explain phenomena observed in the 'real' world…[which] is not made of variables, processes, or constructs; … When we develop theories we make choices about how to represent the real world."

Those ideas are relevant to DSSTs in several ways. First, DSSTs may refer to some but not all of the systems properties mentioned in the RST dialogue. For example, a DSST may focus on interactions between systems without mentioning feedback or emergence. Second, a DSST may combine aspects of variance, process, or design theories, as will be illustrated later. Third, it might be possible to develop a "systemicity" index that tries to quantify the extent to which a specific theory includes most of the properties associated with GST. Ranking DSSTs using such an index and then comparing higher and lower ranked DSSTs might lead to new insights about the nature of systems theories. On the other hand, that type of ranking should not be misused in a way that Burton-Jones et al. and Ortiz de Guinea and Webster would find counterproductive. It should not be used to support claims that certain DSSTs are somehow superior to other types of DSSTs in general (i.e., mirroring debates about the nature of theory and whether Gregor Type IV theories are somehow more genuinely theory-like than Gregor's other types).

4 Systems Theories as Lenses for Multiple Purposes

Most DSSTs that I am familiar with can be viewed as "lenses" for visualizing situations that involve systems. In optics, a lens puts certain things in focus and therefore leaves other things out of focus. Kenneth Burke's phrase "A way of seeing is a way of not seeing" expressed the same general idea in relation to social situations and language. "Even if a given terminology is a reflection of reality, by its very nature as a terminology it must be a selection of reality; and to this extent it must function also as a deflection of reality" (Burke, 1966, p. 45). This implies that the use of language, "reveals while it also conceals. Even the most precise terms leave out much more than they include. But more importantly, as we select the terms for the debates, we not only select and deflect reality; we also – through our selection – predetermine the possible directions of the debate at hand" (Sumner and Weidman, 2013, p. 866, quoted by Roets, et al. 2015). Thus, viewing a DSST or any other theory as a lens automatically implies that it illuminates certain topics while downplaying or ignoring other topics. As defined earlier, DSSTs try to illuminate the system nature of situations rather than focusing primarily on relationships between variables that may or may not be related to system phenomena.

This paper uses the term *lens* instead of the common but currently diffuse terminology of sensemaking and sensegiving. A 69-page literature review in the *Academy of Management Annals* (Maitlis and Christianson, 2014) says that scholars have approached sensemaking in various ways and in various contexts. "Sensemaking is often invoked as a general notion, without an associated definition. Even when sensemaking is defined, it is given a variety of meanings." (p.62). Some explanations of those definitions also refer to sensegiving. "Both sensemaking and sensegiving are closely related to narratives. In fact, many scholars have treated sensemaking/ sensegiving as interchangeable with constructing narratives." (Sonenshein (2010, p. 479) cited by Maitlis and Christianson (2014)). In a similar manner, use of systems theories as lenses often is tantamount to constructing narratives.

Examples of DSSTs as lenses. Assume that an action researcher wants to make sense of various facts and observations related to how an organization serves its customers while also maintaining itself. The five subsystems in Beer's (1981) viable systems model constitute a lens for starting to understand and organize those facts and observations. The various rules and principles within that model provide a way to visualize the situation in more detail, even with the possibility that some of the observations may not fit the model. The same model can help in framing those understandings for communication with others (sensegiving). The viable systems approach (Mele et al., 2010) points in the same general direction. In another example, a systems dynamics model that describes outsourcing in a general way might be seen as a systems theory of outsourcing (e.g., Nan, 2011) that could be used to understand outsourcing at a particular firm. The model might be treated as a lens for understanding outsourcing in general and for communicating with others about a specific outsourcing situation. A researcher looking at the relationship between resources and IT capabilities in a firm might consider exploring a biological analogy by using Miller's (1978) living systems theory to identify different functions that need to be accounted for. A researcher who wants to understand methods or practices such as agile development might find that sociotechnical systems theory (Trist, 1981; Mumford, 2006) or activity theory (Engeström et al., 1999) could serve as systems theories that support a holistic framing. Likewise, researchers trying to understand abstractions such as sociomateriality or actor network theory might find another systems theory useful as a point of reference for visualizing and/or explaining how the abstractions compare with other abstractions.

The special benefit of using DSSTs in all those cases is that the DSST identifies primary concepts and organizes those concepts through a holistic framing that is useful for understanding and explanation. A variance theory that focuses on one or more relationships between several variables within a system would not provide holistic support for the inquiry at hand even if it related several independent variables to a dependent variable such as intention to use an IT innovation or success of an intervention. Similar issues apply for a process model focusing on a sequence of activities.

This discussion of DSSTs emphasizes usefulness in understanding and analyzing real world situations rather than theory-related questions that seem more prominent in the IS literature, such as what is a proper theory (e.g., Weber, 2012), what are the types of theories (e.g., Gregor, 2006), how to test a model or theory (e.g., Chin, 1998), theory as a primary form of knowledge production in IS (Grover and Lyytinen, 2015), whether theory is a fetish (Avison and Malaurent, 2014), how to differentiate or hybridize different research approaches or perspectives (e.g., Burton-Jones et al., 2015; Ortiz de Guinea and Webster, 2017), and how to produce a theoretical contribution (Hirschheim, 2008; Rivard, 2014). Building on the theme of usefulness for understanding real world situations, the next section summarizes WST and uses published examples to illustrate how that relatively new DSST and its DSST extensions can be applied as lenses in many diverse situations.

5 Using Work System Theory and Its Extensions as Lenses

Earlier sections of this paper describe how recent literature supports the impression that the current IS discipline pays too little attention to systems perspectives and systems theories. This gap may reveal significant opportunities, or, alternatively may exist because that approach has limited publication potential in the academic IS discipline due to current expectations and practices.

This section uses WST and some of its extensions to illustrate the significant potential of systems theories to address important IS topics and issues. It summarizes WST based on previously published sources such as Alter (2006, 2013). Repetition of that content is necessary for making sense of published examples that illustrate WST's potential value as a lens for research and practice.

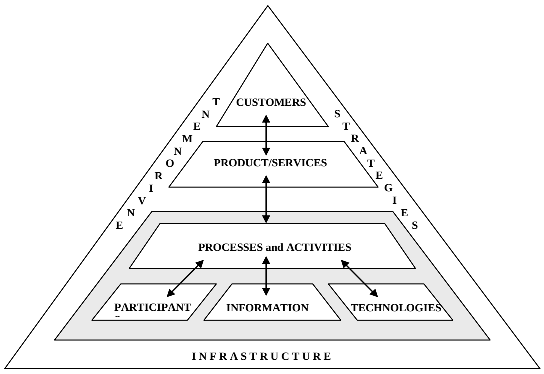
This section ignores questions that could be discussed at length elsewhere, such as whether WST fits cleanly into established categories of theories (not really) or whether it can be considered scientific knowledge in the IS discipline (depends on one's definition of science). Neither WST nor most of the extensions mentioned here fit within "Luhmann's conceptualization of systems" which Demetis and Les (2016) present as a basis for their six requirements for systems theories. In contrast to key aspects of that approach, WST and its extensions do not assume that work systems are either social systems or "self-referential autopoetical systems" or communication systems. To the contrary, given the pervasive importance of totally- and semi-automated systems that may or may not be social systems or communication systems, a fundamental requirement in developing WST was that it should apply to every sociotechnical or totally automated work system (which may not be autopoetical and may not be a communication system).

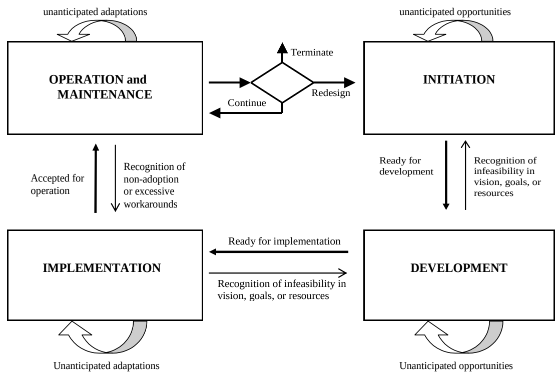
5.1 Summary of Work System Theory

WST is a holistic conceptual lens that outlines a basic understanding of a work system using the three components shown in Figure 1: the definition of work system, the work system framework (WSF), and the work system life cycle model (WSLC). The WSF identifies nine elements of a basic understanding of a work system's form, function, and environment during a period when it is relatively stable, even though incremental changes may occur during that period. The WSLC represents the iterative process through which work systems evolve through a combination of planned change (formal projects) and unplanned (emergent) change via adaptations and workarounds.

Domain. WST is a DSST whose domain is work systems that are small enough to be understood using the definition of work system in Figure 1 and large enough to be worth analyzing, e.g., typical work systems such as designing products, hiring engineers, providing after-sale service, or producing accounting summaries. WST is much less useful for analyzing an entire large enterprise, such as Toyota Motors or the British Government, whose thousands of participants perform thousands of activities that are not linked directly. (A work system metamodel that extends WST might be useful for enterprise modeling under some circumstances.) Clarifying the domain, the concept of work system is not a synonym of ecosystem, network, platform, digital world, and many other business-related ideas that are discussed frequently. A business ecosystem is not a work system even though it may contain many separate work systems that interact directly or indirectly. Some work systems can be viewed fruitfully as networks, but many networks cannot be viewed fruitfully as work systems.

1) Definition of work system: A work system is a system in which human participants and/or machines perform work (processes and activities) using information, technology, and other resources to produce specific products/services for specific internal and/or external customers





2) Work system Framework (WSF) 3) Work system life cycle model (WSLC)

Figure 1. Three components of work system theory (Alter, 2013)

The *and/or* in the definition of work system implies that it includes both sociotechnical work systems and totally automated work systems. An IS is a work system whose activities are devoted to capturing, storing, retrieving, transmitting, manipulating, and displaying information. Including totally automated systems makes WST's domain broader than the domain for IS that assumes that an IS is a sociotechnical system. Including totally automated IS and other totally automated work systems in WST's domain is important in today's world of increasing automation and new types of person/computer systems that can be decomposed into sociotechnical subsystems and totally automated subsystems. Notice also that software is a static representation that is not a work system because it cannot perform work by itself (Alter, 2016). A computer program running on a computer can be viewed as a totally automated work system, but use of WST for analyzing and designing software is less effective than other approaches designed for that purpose.

Work system framework. The WSF in Figure 1 identifies and organizes nine elements of even a basic understanding a work system's form, function, and environment during a period when it is relatively stable. A work system's identity remains unchanged during such periods of stability even though incremental changes such as minor personnel substitutions or technology upgrades may occur within the same version of the same work system. Processes and activities, participants, information, and technologies are completely within the work system. Customers and product/services may be partially inside and partially outside because customers often participate in the processes and activities within work systems and because product/services take shape within work systems. Environment, infrastructure, and strategies are largely outside the work system even though they often have direct effects within work systems and therefore are part of a basic understanding of those systems.

Figure 1 places the customer on top because work systems exist for the purpose of producing product/services for customers. For sociotechnical work systems this leads to trade-offs between internal management concerns about efficiency, morale, and vulnerability, versus customer concerns about the total cost to the customer, quality, and other characteristics of the product/services that they receive. Different internal vs. external trade-offs apply to totally automated systems.

The arrows inside the work system framework express the system nature of WST by saying that the elements of a work system should be in alignment. For example, the knowledge, skills, interests, and motivation of the participants should fit with the processes and activities within the work system.

Conversely, the processes and activities should be appropriate for attributes of the participants. Changes in the processes and activities may require related changes in the participants ranging from additional training or new incentives all the way through changing participant roles, replacing some participants with others, or automating parts of the work, thereby rendering some roles unnecessary. Similar alignment issues apply for all pairs of elements that are linked by arrows.

Work system life cycle model. The WSLC represents the iterative process by which work systems evolve over time through a combination of planned change (formal projects) and unplanned (emergent) change via adaptations and workarounds. Those changes may include changes in any work system component. The WSLC represents planned change as projects that include initiation, development, and implementation phases. Initiation is the chartering of a work system creation or improvement project. Development involves creation or acquisition of resources required for implementation of desired changes in the organization. This may include software development or acquisition, software configuration, creation of new procedures, documentation, and training materials, and acquisition of other resources needed for implementation of the new work system. Implementation refers to implementation in the organization, not implementation of algorithms on computers. A full iteration from one operation and maintenance phase to the next might be viewed as a transition from a previous version of the work system to a subsequent version.

5.2 Applications in Analyzing Work Systems

WST summarizes and clarifies ideas that have been used for several decades as the basis of various versions of the work system method (WSM), a flexible systems analysis method designed for use by business professionals who need to understand a work system, but who might not care about details and nuances of technologies that are used. Alter (2013, pp. 113-116) explains how WSM was developed as a lens (although that term is not used there) for understanding systems. Many hundreds of MBA and Executive MBA students have used various versions of WSM for visualizing work systems in their own organizations and producing management briefings related to proposed improvements (Truex et al. 2010, 2011; Alter, 2013). The many versions of WSM share the same general flow: Identify the main problems or opportunities; identify the smallest work system that has those problems or opportunities (plus relevant constraints, key incidents, and so on); use the WSF (Figure 1) to summarize the "as is" work system; analyze the situation to whatever depth is needed; recommend a proposed "to be" work system; explain why the proposed IT-enabled work system is likely to exhibit better performance than the existing work system. (Alter, 2006, 2013).

The next two sections illustrate direct uses of WST as a DSST plus additional application as a foundation for other DSSTs that are based on WST but are distinct from it. Published examples in each subsection demonstrate different ways in which DSSTs can prove valuable.

5.3 Other Applications of the Work System Framework

The WSF has been used in a number of settings other than production of management briefings by MBA and Executive MBA students. Here are published examples:

- **A lens for communicating in a real world IS project**. When the technology in DHL's mission-critical data warehouse was becoming obsolete, a senior enterprise architect at DHL used a slightly modified version of the WSF to organize discussions with country representatives across Europe in a major refurbishment project. The WSF helped in organizing discussions and negotiations that produced business-oriented requirements for the new data warehouse. (Koehler and Alter, 2016)
- **A lens for software engineering education**. An experiment involving 165 undergraduate students in India concluded that students learning about the scrum approach to agile development produced significantly fewer invalid user stories in their initial requirements if they summarized the situation using a work system snapshot, a central tool from WSM. That research needs to be repeated in a different way to see whether similar effects obtain for experienced analysts (Bolloju et al. 2017).

- **A lens for understanding a real world system in an action research project**. Wong (2018) used WST to summarize a delivery firm's customs clearance operations. Wong reports presenting a formatted one-page summary at a field communication meeting and hearing employees whispering "he really knows our work in great detail." A VP said "the work system snapshot coherently detailed the important activities…..We can hire you to work for us immediately."
- **A lens for organizing big data capabilities**. Dremel et al. (2017) used WST as a kernel theory for creating a coherent model organizing 34 big data capabilities identified in interviews with experts.

5.4 Systems Theories that are Extensions of WST

The ideas in the WSF proved useful for the above examples even though they provide insufficient detail, nuance, or insight in many other situations that call for additional concepts, relationships, and theories. That limitation of WST led to the idea of separating WST (the three components in Figure 1) from a series of extensions of WST that depend directly on various aspects of WST. That approach maintains a coherent core for WST, ideally maximizes usefulness, and avoids the GST problem of appearing to be a poorly bounded assemblage of ideas that matter in some situations but not others.

Below are brief descriptions of selected extensions of WST that are based directly or indirectly on the WSF and/or WSLC and that are DSSTs in their own right. These additional DSSTs can be used to test the requirements for systems theories that the RST dialogue discusses without reference to specific DSSTs. There is also a question of whether their content and nature seem true to the aspirations of the IS discipline or whether they seem to protrude outside of the domain of IS in what Benbasat and Zmud (2003) would call an error of inclusion (perhaps yes in some cases).

Work system metamodel. This graphical metamodel, now in its sixth version, reinterprets elements of the WSF in a more rigorous way This type of representation takes over after the WSF has clarified the scope of the system that has the problems or opportunities. It can be used as a lens for looking at a work system in substantially more detail than is afforded by the WSF.

- **A lens used in combination with other theories**. Atiq et al. (2017) combined an earlier version of the metamodel with other ideas in the service literature to create an experience-based service system model that explicitly includes consumer participation in the service design process
- **A lens related to possible linkage between methods.** Alter and Bolloju (2016) used the metamodel to explore for links between WST/WSM and object-oriented analysis and design.
- **A lens for extending BPM research use cases.** Alter and Recker (2017) used the metamodel to bridge between WST and BPM viewpoints, thereby facilitating comparisons between WST concepts and technically-oriented BPM concepts and also identifying new possibilities for BPM.
- **A lens linking work system ideas and service logic.** Alter (2017a) used the metamodel to define and compare operational meanings of co-production and value co-creation.

Service value chain framework. The SVCF is a DSST that augments the WSF in situations where services are co-produced by providers and customers. It separates provider and customer activities, includes generic service stages of set-up, request, fulfillment, and follow-up, includes interactions between providers and customers, represents lines of visibility separating what is visible vs. invisible to providers or customers, and expresses the idea that both providers and customers capture value across their interactions throughout instances of service provision. (Alter, 2008)

- **A lens for service modeling**. Tan et al. (2011) introduced the idea of service responsibility tables (SRTs) based on the SVCF. Salihu and Selamat (2016) proposed "improvements for transforming the SRTs to activity diagrams and sequence diagrams ... [and found] that SRTs can improve user participation in a requirements determination process."
- **Lens for developing a service definition language**. Oberle et al. (2013) developed a formal, UML-based "unified service definition language" (USDL). The SVCF contributed to some of their

thinking: "Alter (2008) was one of the first to realize that the concept of a service system is not well articulated in the service literature. Therefore, he contributes three informal frameworks as a first attempt to define the fundamentals of service systems. The work of Ferrario et al. (2011) can be seen as a continuation and formalization of Alter's approach." (p,158).

Theory of workarounds. This DSST is based on hundreds of examples found through searches of Google Scholar. Its goal was to elaborate on the inward-facing (adaptation) arrow in the WSLC's operation and maintenance phase. Its definition of workaround applies to work systems as defined by WST rather than just to technologies, and it assumes that workarounds may involve any of the elements of the WSF. Its graphical representation (Alter, 2014, p. 1056) combines aspects of a process theory and aspects of an influence diagram (in essence a hybrid theory). It identifies steps in designing and executing workarounds along with common factors that affect perceived needs for workarounds and decisions about which workarounds will be designed and executed.

- **Lens for visualizing workarounds in software development**. Yli-Huumo et al. (2015) used a qualitative case study to explore "benefits and consequences of workarounds in software development projects." They found that workaround decisions "to resolve a technical issue are often intentional and forced by time-to-market requirements. … Stakeholders [may be unfamiliar] with "negative consequences of taking workarounds, like additional hours, costs, and poor quality."
- **Lens for research on workaround modelling**. Röder et al. (2015) applied aspects of WST and the theory of workarounds to propose "workaround aware business process modelling" which extends BPMN by treating workarounds as a separate BPMN lane. In a health care case in Germany "the modeling of workarounds helps in understanding the overall business process."
- **Lens for summarizing workarounds**. Beerepoot (2017) cited Röder et al. (2015) and went further by producing and testing a "workaround snapshot approach." It was applied to 12 workarounds in a Dutch hospital and helped the organization make well-informed decisions

Theory of IT innovation, adoption and adaptation. This DSST tries to illuminate IT innovation, adoption, and adaptation from a systems perspective. Unlike variance theories for related topics such as TAM, UTAUT, and IS success, its holistic focus assumes that the entity that is adopted, adapted, or improved is a work system, not just technology that a work system uses. Each element of the WST is a potential driver or obstacle to change; stages of IT-enabled innovation are linked to the WSLC; the innovation is evaluated from multiple viewpoints; noncompliance may occur; and so on.

- **Lens for seeing IT innovation, adoption, and adatation in a new light.** Alter (2018) introduces the theory and shows how each part has implications for research and practice.

Work systems design principles and work system axioms. Both of these research streams are about creating theory-based guidelines for design decisions. The initial research on work system design principles (Alter and Wright 2010) used the WSF as a basis for organizing 24 work system principles produced by an iterative project that built upon Cherns' (1976) sociotechnical principles. Employed Executive MBA students evaluated these principles by saying whether each principle seemed appropriate for most work systems they were involved with (average 6.0 out of 7) and whether each principle described how most work systems operated in their firm (average of 4.5 out of 7). A recent attempt to identify fundamental ideas underlying WST produced a lengthy series of axioms (Alter, 2016) that seem to apply to all purposefully constructed activity systems - a synonym of work system. Use of the term *axiom* mirrored use of that term in service-dominant logic (Vargo and Lusch, 2016). A statement can be treated as an axiom if it is true for every system in the domain and if it expresses an idea that is not expressed by other axioms. An axiom can be challenged easily with counterexamples. Both the integrated set of axioms and the integrated set of design principles can be viewed as DSSTs because they focus on describing multiple aspects of operational work systems.

- **Lens for comparing guidelines in the literature**. Comparable sets of sociotechnical principles appear in Berniker (1996), Clegg (2000), Majchrzak and Borys (2001), and probably elsewhere.

WSF and the WSLC could be used to organize all of these principles to identify overlaps and contradictions and to produce a better set of principles after more literature search and discussion.

- **Lens for systems analysis and design** Each of the service system axioms in Alter (2017b) is accompanied by two or more directly related questions that are based on a work system lens and can be modified slightly to be relevant to the analysis and design of almost any work system, including service systems and information systems. Starting from fundamental axioms might provide a theoretical basis for new systems analysis and design methods.

6 Discussion and Conclusions

This paper contributes to ongoing discussions related to theoretical perspectives in general and systems perspectives and systems theories in particular. It defines the terms systems theory and DSST, thereby moving beyond associating "systems theory" and general systems theories with little more than sets of properties related to GST. It presents WST as a DSST along with WST extensions that are also DSSTs. It uses published examples to illustrate the nature of DSSTs and their application in constructing holistic narratives that help in describing, analysing, and theorizing about work systems. Overall, it shows that systems theories exist in the IS discipline (in the form of DSSTs) and could be a source and a direction for innovations related to both theorizing and application in practice. Related research is underway in several other areas.

WST and the other DSSTs mentioned in Section 5 are systems theories because they are abstract accounts related to systems phenomena or systems entities within a clearly delimited domain. The domain in five of the six extensions includes all work systems whereas the work system design principles are restricted to sociotechnical work systems. WST and the related systems theories are all DSSTs that focus on some aspect of work systems, but they show substantial variety of form and content. WST and three of the other DSSTs are represented graphically (one as a combination of a process sequence and an influence diagram), two take the form of organized lists of axioms or principles, and one contains a number of related parts that can be used in combination or separately. None of these DSSTs can be explained in a straightforward sentence or mathematical relationship that can be evaluated using hypothesis testing techniques. All are much better suited for supporting construction of holistic narratives. By developing such narratives, users of any of these DSSTs might gain insights for explaining or predicting phenomena or results related to work systems. All of these DSSTs fit Gregor's (2006) categories I (theories for analysis) and/or V (theories for design and action). Most could provide insight or at least reminders related to Gregor's other categories, explanation, prediction, and explanation and prediction.

6.1 How the IS Discipline Might Welcome Systems Theories More Wholeheartedly

This paper's prime inspiration was Demetis and Lee's (2016) proposal of requirements for crafting systems theories in IS. While that was the impetus, articles about theories and perspectives that were cited several times lead to concluding that a more important issue is how the IS discipline should try to welcome systems theories instead of dismissing them as non-scientific or as mere models and frameworks that do not "rise to the level of theory." Those are criticisms that WST and most of the related DSSTs received at one time or another (e.g., see Alter, 2015, pp. 496-498). Based on the previous sections, the IS discipline might welcome systems theories more wholeheartedly if it moved in the following directions:

Expecting clear definitions of the domain and key concepts. While any theory should be clear about its domain and definitions of its concepts, DSSTs should be especially careful about terms that take different meanings in different contexts, such as system, theory, information system, IT artifact, service, implementation, user, and success. Ideally, a description of a DSSTs domain should identify areas of greatest relevance, areas of diminishing relevance, and areas of irrelevance in contexts where some of the same terms (system, IS, and so on) may not make sense in the same way.

Evaluating systems theories in relation to support of narratives. The affordances of most DSSTs differ from the affordances of most variance theories. Statistical testing that is appropriate for variance theories is inappropriate for DSSTs that support holistic views of situations and are stated in terms of components and interactions rather than variables. Potential usefulness of DSSTs both in research and in practice is more important than accuracy or mathematical precision. DSSTs should be evaluated based on whether they plausibly serve as lenses for understanding and analysis in significant situations within the domain. For example, when compared to a variance theory that focuses on correlations between variables, a DSST would be more likely to support or organize an understandable narrative about a situation.

Avoiding *a priori* requirements for systems theories. The IS discipline should avoid creating requirements or checklists for systems theories based on interests of specific authors or specific journals. The requirements for systems theories proposed by Demetis and Lee's (2016) apply only to certain types of social systems and would disqualify DSSTs related to totally automated systems, an area that is increasingly important. Any widespread acceptance of *a priori* requirements for systems theories might create obstacles that would prevent publication of potentially valid DSSTs that do not fit a particular set or requirements that are favoured by particular authors. Consider what happened in the IS discipline after Hevner et al. (2004) and other researchers appropriately encouraged IS researchers to develop new artifacts and not just study IT-related work done by others. Somehow, those worthwhile intentions transmuted into what sometimes seems like mechanistic checklists that authors use to organize their papers and that reviewers treat as bureaucratic hurdles for evaluating acceptability. Those practices discourage creation of new and interesting artifacts.

Adopting a more open spirit. As stated well by Burton-Jones et al. (2015, p 676): "IS researchers should revisit and move beyond existing norms for conceptualizing theoretical models. Norms are rarely held by all researchers. By definition, the most innovative researchers will generally not be following them. … Researchers should treat theoretical perspectives more flexibly than they have in the past … guided by the dual principles of conceptual latitude and conceptual fit."

6.2 Next Steps

Here are several possible steps toward creating new systems theories in IS and making them visible.

Compile DSSTs. This paper mentioned over 10 DSSTs. Others surely exist in IS. Compilation and review of DSSTs would be a starting point, followed by careful inspection of ways in which they are they genuinely holistic, useful, and well justified by realistic examples.

Compare DSSTs. At the risk of unnecessary quantification, it would be possible to create an index of theory "systematicity" that could be used to compare the extent to which different DSSTs exhibit properties associated with GST or a definition of systems theory. Using a systematicity index to organize and compare theories might lead to greater clarity about the nature of systems theories and the ways in which they potentially contribute to describing and analysing systems and producing additional theories.

Create DSSTs. Burton-Jones et al. (2015, p. 672) illustrated how a variance perspective on IS success might be represented as a systems perspective on that topic. That same approach might be applied in trying to represent other variance or process theories or models from a systems perspective. Descriptions from a systems perspective might be amenable to transformation into new DSSTs that address old topics in new ways. A more direct approach, however, would simply involve looking for significant situations that call for holistic understandings and trying to create DSSTs that could serve as lenses in those situations.

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