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Using a Work System Perspective to Expand BPM Use Cases for Research

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Abstract:

Business Process Management (BPM) has developed as a research field centered within the computer and information systems sciences – but also touching other fields as well. Recently, van der Aalst (2013) analyzed the results of some of these research efforts and identified a set of research topics in the form of a series of BPM use cases that primarily emphasize technological and computational challenges and solutions in BPM academia. Ideally, however, BPM should also address managerial and organizational challenges that are not fully reflected in the existing use cases identified by van der Aalst (2013).

We propose drawing on work system theory (WST) to expand van der Aalst's use cases and to identify additional BPM use cases and new research directions. After comparing a WST perspective on basic BPM topics with the BPM perspective expressed in van der Aalst (2013), we present new research topics that extend existing BPM use cases. We also present new research directions that go beyond those use cases. Taken together, the extensions of the existing use cases and the new use cases lead to a more balanced BPM research agenda that blends technical and managerial challenges more fully.

Keywords: Business process management, Work system theory, BPM use cases, BPM research agenda

1 Toward Expanding the Scope and Managerial Value of Technically-Oriented BPM Use Cases

The term "Business Process Management" (BPM) sounds as though it refers to a management discipline, but in research practice often seems more like a branch of computer science. This divergence starts from the way different scholars operate from different views of what BPM is. On the one hand, Rosemann and vom Brocke (2015) identify six "core elements" of BPM: strategic alignment, governance, methods, information technology, people, and culture. The names of those core elements make BPM sound like a study of work systems (Alter 2013a), organizational systems (Pentland 2003) or even a branch of general management systems. Scholars working from this perspective conduct research on process improvement methods (e.g., Bolsinger, Elsäßer, Helm, and Röglinger 2015), BPM culture (e.g., vom Brocke and Sinnl 2011), and related topics. In contrast, scholars more attuned to the approach expressed in (van der Aalst 2013) suggest that BPM is an extension to workflow management, ranging broadly in scope from process modeling, process automation, and process analysis to operations management and the organization of work. Research from this perspective often focuses on formalized abstractions, BPM languages, and computerized methods. Most of it pays little attention to management concerns related to process operation, such as establishing and maintaining productivity and quality, satisfying customers, and organizing and motivating people. While both perspectives are important, neither is complete.

The divergence between these two veins of BPM research is also evident elsewhere. Table 1 uses two current sources to illustrate the divergence between computer science-oriented and management-oriented views of BPM issues. The first column is the categories of BPM use cases that organize a discussion of "BPM key concerns" in the recent review article about BPM (van der Aalst 2013), which our paper responds to. The other column lists "hot topics" advertised for Gartner's Global BPM Summit in June 2015 (Gartner Group 2015). The difference in emphasis is striking. Key concerns from the review article makes BPM look like a branch of computer science. The Gartner conference makes BPM look like a management topic. The wide gulf between the two approaches begs for ideas that begin to bridge the two approaches.

Table 1. BPM Key Concerns and "Hot Topics"

BPM key concern from van der Aalst (2013)	Hot topics in BPM (Gartner Group, 2015)
• Process modeling languages	• Defining the value of BPM to business and IT
• Process enactment infrastructures	• Managing change as you improve processes
• Process model analysis	• Making process governance work
• Process mining	• Developing key roles and skills for process improvement
• Process flexibility	• Measuring business outcomes in a process context
• Process reuse	

This paper draws on work system theory (WST) to show how many of the 20 technically-oriented use cases discussed by van der Aalst (2013) can be expanded and augmented to provide bridges toward topics and concerns of the types mentioned in Table 1 as Gartner's hot topics. This paper mentions managerially-oriented BPM publications, such as the edited volumes by vom Brocke and Rosemann (2015a; 2015b), but does not focus on past BPM-related research that addresses managerial issues directly or indirectly. Instead, it focuses on the question of how a WST perspective can broaden the scope of van der Aalst's (2013) BPM use cases. Moving in that direction increases the breadth and integration of BPM. It provides ways to increase the scope of BPM while also recognizing that technically-oriented research continues to generate important results.

This paper's goal is thus to produce a conceptual contribution to BPM research by providing a response to (van der Aalst 2013). It builds on WST to support a more managerial view of BPM than is apparent in the current set of BPM use cases for research. It shows how this perspective could address additional important aspects of business process management in ways that seem beyond the current scope of much

of the BPM research that has appeared in journals and conference proceedings. This paper addresses the following research questions:

1. Can a WST perspective meaningfully expand the scope of BPM concepts?

2. Can a WST perspective expand existing use cases for technically-oriented BPM research?

Addressing those research questions contributes directly to the mission of the *Journal of Information Technology Theory and Application,*[1] which invites papers that "start new research streams which may be on the boundaries of the IS discipline". This paper endeavors to ignite BPM research streams that are on the boundaries of what leading BPM scholars believe to be the discipline, using the viewpoint offered by van der Aalst (2013) specifically. We set out to show how the core of BPM, as expressed by van der Aalst (2013), can be expanded systematically by adding a work system overlay. The advantage in our approach is that it provides a systematic way to expand BPM research use cases deductively, instead of inductively adding to them one at a time. It explains directions for incremental extensions of the BPM discipline, thereby maintaining its coherent core while also integrating other important topics from related disciplines.

This paper unfolds as follows. It summarizes BPM use cases discussed by van der Aalst (2013) and then illustrates key concepts of WST. It shows how aspects of a WST viewpoint compare with key assumptions and viewpoints about BPM in the van der Aalst (2013) review article. It then explains how the WST view generates both new extensions of existing BPM use cases and new use cases. Its conclusions summarize this paper's contributions.

Contribution:

Most current BPM use cases identified in a review of BPM research (van der Aalst, 2013) emphasize

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[1]   http://aisel.aisnet.org/jitta/aimsandscope.html, current as of 2 February 2016/

technical and computational perspectives and deemphasize managerial perspectives.

We draw on work system theory (WST) to offer an expanded view of BPM use cases that explicitly incorporates managerial and organizational research issues and opportunities. Application of a work system perspective leads to new and expanded topics for BPM research that may have significant impacts on technical as well as managerial aspects of BPM. Our expanded research agenda for BPM includes extensions of 20 research use cases identified by van der Aalst (2013) plus 17 additional use cases that go beyond that categories presented in that paper. These extensions provide more balance between technical and managerial challenges and outline a new, holistic research approach for future BPM scholarship. The extensions also identify overlooked or under-researched elements in BPM (such as the customer and product/services) and draw analogies to research and ideas in other, related fields (such as service science) that have addressed those issues. This contributes to BPM research by bringing it closer to other disciplines while retaining its own core.

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2   Background

2.1   BPM Use Cases

This paper's purpose is to stimulate future research in BPM. We wrote it as a response to van der Aalst (2013), a recent BPM review article that tried to provide structure for a growing research discipline. That article uses the term "use cases" to reflect "how, where, and when BPM techniques can be used" (van der Aalst 2013, p. 28). It uses both graphical visualizations and textual description to explain 20 BPM use cases for research. These are divided into six categories:

- ***Use cases to obtain models***. These include (1) design model, (2) discover model from event data, (3) select model from collection, (4) merge models, and (5) compose model.

- *Use cases involving configurable models*. These include (6) design configurable model, (7) merge models into configurable model, and (8) configure configurable model.

- *Use cases related to process execution*. These include (9) refine model, (10) enact model, (11) log event data, (12) monitor, and (13) adapt while running.

- *Use cases involving model-based analysis*. These include (14) analyze performance based on model and (15) verify model.

- *Use cases extracting diagnostics from event data*. These include (16) check conformance using event data and (17) analyze performance using event data.

- *Use cases producing new models based on diagnostics or event data*. These include (18) repair model, (19) extend model, and (20) improve model.

Van der Aalst (2013) applied those use cases as a lens for reflecting on prior research on BPM as published in the BPM conference series. They also served a generative purpose of highlighting gaps in the shared attention of the BPM community. For instance, van der Aalst (2013, p. 29) suggests that use cases related to improving the performance of processes are largely neglected. We also view performance improvement as a central issue if BPM is to live up to its name, business process management.

Our interpretation of van der Aalst (2013) is that the use cases are meant as a lens to reflect on the entire "BPM discipline", thereby providing a comprehensive view, analysis, and set of recommendations for all researchers interested in BPM. We believe the viewpoint expressed by the six categories of BPM research use cases is *accurate* and *useful*. However we also believe that it is unnecessarily limited in *coverage* and therefore unnecessarily limited in potential *impact*. It pinpoints existing research and identifies recognized gaps in knowledge, but with an intended or unintended focus on the computing sciences. It says little about either existing or future research from perspectives outside the computing sciences – and therefore it cannot provide a bridge that connects and integrates managerial BPM research and technical BPM research. A comprehensive and integrative perspective would facilitate linkages to existing knowledge from discourses other than the "BPM discipline". Such linkages are useful for any research stream because adjacent discourses can act as reference disciplines (Baskerville and
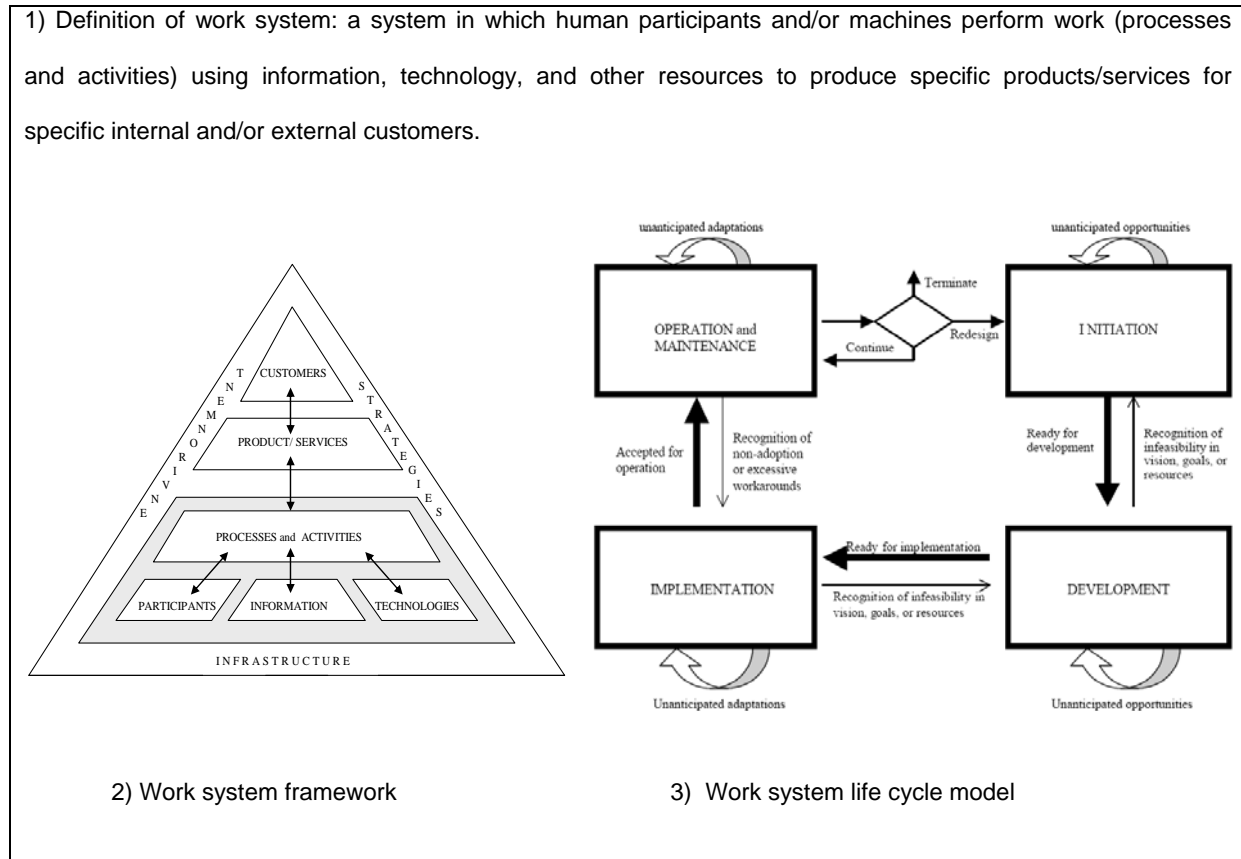
Myers 2002) and may inspire novel conceptualizations and alternative views within any one discipline. Moving in that direction could facilitate expansion of the BPM discipline by establishing clearer linkages to related fields of inquiry, while also strengthening its own core. Furthermore, building such a bridge could create more coherence for the existing, divergent streams of BPM research and could help the field achieve higher impact and avoid isolation and starvation (Recker and Mendling 2016). We provide a step toward building that bridge by using WST to propose an extended view of BPM use cases.

This response commentary extends existing BPM use cases and demonstrates the unnecessarily restricted nature of the view of BPM expressed in van der Aalst (2013). It also suggests that the preponderance of research under the BPM umbrella may focus on topics that do not fully reflect the long-term possibilities for maximizing BPM's impact – an argument that van der Aalst (2013) also makes. We offer a new, organized way of expanding existing BPM research use cases in order to provide a new pathway to maximizing the impact of BPM. WST serves as a theoretical framework that allows developing this extension in a systematic, deductive way.

2.2   Work System Theory

Work system theory (WST) is the basis of our expanded view of BPM, which covers organizational process systems that may – or may not – use BPM software. Because we expect readers may not be fully familiar with WST, we summarize it here and cite references to articles that explain it in more depth. Figure 1 presents three components of WST as defined by Alter (2013b). While there is some disagreement about whether WST is a proper theory (Niederman and March 2014), for our purposes it suffices to say that WST consists of the three components in Figure 1, i.e., the definition of work system, work system framework, and the work system lifecycle model. WST is the basis of various versions of the work system method (WSM), a systems analysis method designed to support the needs of business professionals (Alter 2006). Experience with WSM demonstrated needs for various extensions of WST that build on the core ideas in Figure 1. Among others, the extensions to date include work system principles, work system design spaces, and various versions of a work system metamodel that reinterprets and elaborates concepts in the work system framework (Alter 2013b).

A work system metamodel, a WST extension that appears in Figure 2, forms a bridge between a basic WST viewpoint and a technically oriented BPM viewpoint. The next section will use this metamodel to facilitate comparisons between WST concepts and technically-oriented BPM concepts. In the following we briefly explain key components of WST. To minimize redundancy, additional observations about WST and the metamodel will be deferred to the section that compares WST and BPM viewpoints.

1) Definition of work system: 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   3) Work system life cycle model

Figure 1. Three Components of Work System Theory (Alter 2013b)

Definition and nature of work systems. 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 product/services for internal or external customers. Enterprises that grow beyond an improvised start-up phase consist of multiple work systems such as work systems that procure materials from suppliers, produce products, deliver products, find customers, create financial reports, hire employees, coordinate work across departments, and perform other functions. Many work systems include automated subsystems whose work is performed by software. Information systems are a special

case of work systems, i.e., work systems that are devoted to processing information. Many work systems do other things as well.

WST's default assumption is that work systems are sociotechnical, i.e., that human participants perform activities within those work systems and therefore are integral parts of the systems (not just users of technology). By saying that work is performed by human participants and/or machines, this definition accommodates work systems that are totally *social* (making no significant use of technology), *sociotechnical* (with human participants who make significant use of technology), or entirely *automated* (such as automated services that operate autonomously once triggered by people, automated entities, or external conditions).

Work system framework. The work system framework on the left side of Figure 1 identifies nine elements of a basic management understanding of a work system. For example, even a basic understanding of a work system includes knowledge about the internal/external customers, the product/services produced by the work system, and the environment within which the work system operates (such as organizational culture, competitive situation, and regulations). The arrows inside the framework say that those elements should be aligned. Importantly for this paper, the technology in a work system may or may not include BPM software. Of the nine elements in the work system framework:

- Processes and activities, participants, information, and technologies are viewed as 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 the work system and because product/services take shape within the work system.
- Environment, infrastructure, and strategies are viewed as largely outside the work system even though they have direct effects within the work system.

Work system life cycle model. The diagram on the right side of Figure 1 represents iterations through which work systems evolve over time via a combination of planned and unplanned change. The planned change may or may not involve BPM software. If BPM software is used, the operation and maintenance

phase of the work system life cycle may include software reconfiguration and/or adaptations and workarounds to overcome shortcomings of the software or other perceived obstacles to achieving organizational goals.

Work system metamodel. Figure 2 is the sixth version of a metamodel that addresses limitations in the work system framework by reinterpreting each of its nine elements in a more detailed way. The work system framework is useful for summarizing a work system and achieving mutual understanding of its scope and nature, but is less effective for detailed analysis. To support more detailed analysis, the metamodel treats information as informational entities of various types, technology is divided into tools and automated services, activities are performed by three types of actors, and so on.

Representation decisions in the metamodel try to maximize understandability while highlighting areas where frequently observed omissions from evaluation, analysis, or design processes might occur. The bottom of Figure 2 notes that many attributes of each entity type are hidden in the one-page representation of the metamodel. Analysts using the metamodel would consider and apply the hidden attributes while defining the problem or opportunity, evaluating the "as is" work system, and justifying proposed improvements that would appear in the "to be" work system. The customer work system is represented in the upper right because a complete understanding of a work system necessarily includes understandings or at least explicit assumptions about how customers attain value by using the product/service offerings that the work system produces. Also important for BPM is that the metamodel reveals relationships between a provider's human, informational, and technical resources and the value-in-use of the product/service offerings that are produced.
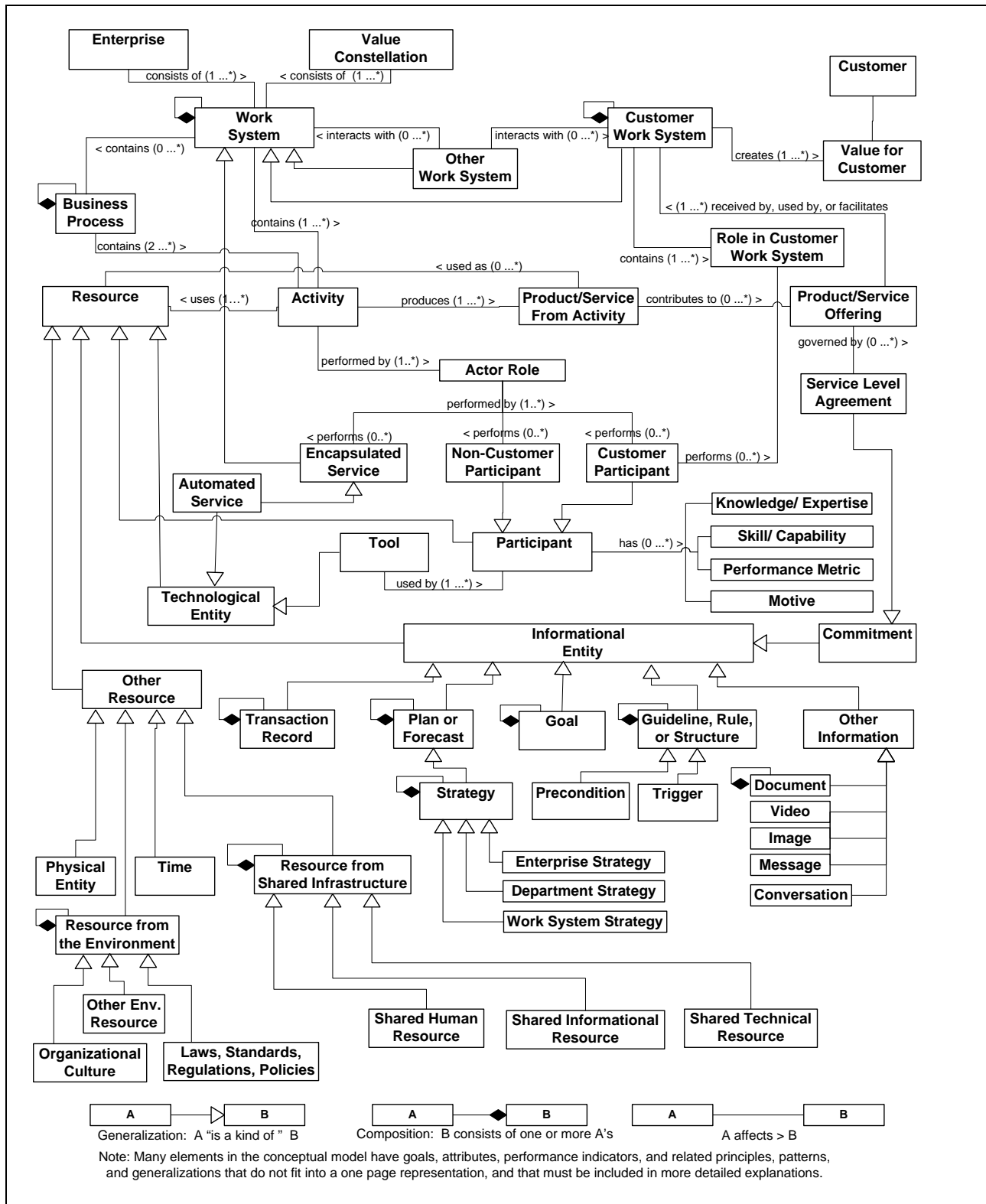
Figure 2. Work System Metamodel –Sixth Version

Diagram labels:

Enterprise
Value Constellation
Customer
Work System
consists of (1 ...*) >
< consists of (1 ...*)
Customer Work System
< interacts with (0 ...*)
interacts with (0 ...*) >
Value for Customer
creates (1 ...*) >
Other Work System
< contains (0 ...*)
Business Process
< (1 ...*) received by, used by, or facilitates
Role in Customer Work System
contains (1 ...*) >
contains (1 ...*) >
contains (2 ...*) >
< used as (0 ...*)
Resource
< uses (1…*)
Activity
produces (1 ...*) >
Product/Service From Activity
contributes to (0 ...*) >
Product/Service Offering
governed by (0 ...*) >
performed by (1..*) >
Actor Role
Service Level Agreement
performed by (1..*) >
< performs (0..*)
< performs (0..*)
< performs (0..*)
performs (0..*) >
Encapsulated Service
Non-Customer Participant
Customer Participant
Automated Service
Knowledge/ Expertise
Skill/ Capability
Performance Metric
Motive
Tool
Participant
has (0 ...*) >
Technological Entity
used by (1 ...*) >
Informational Entity
Commitment
Other Resource
Transaction Record
Plan or Forecast
Goal
Guideline, Rule, or Structure
Other Information
Strategy
Precondition
Trigger
Document
Video
Image
Message
Conversation
Physical Entity
Time
Resource from Shared Infrastructure
Enterprise Strategy
Department Strategy
Work System Strategy
Resource from the Environment
Other Env. Resource
Organizational Culture
Laws, Standards, Regulations, Policies
Shared Human Resource
Shared Informational Resource
Shared Technical Resource

Legend:
A ▷ B Generalization: A "is a kind of" B
A ◆ B Composition: B consists of one or more A's
A — B A affects > B

Note: Many elements in the conceptual model have goals, attributes, performance indicators, and related principles, patterns, and generalizations that do not fit into a one page representation, and that must be included in more detailed explanations.

3 Comparing a WST Perspective with a BPM Perspective

The foregoing summary of WST served as an introduction to this section, which explains more about WST in the context of comparing typical BPM and WST views of important concepts relevant to both. This section is divided into four parts. The first covers general concepts including business process management, system, model, and automation. The second focuses on WST's view of business processes. The third mentions the eight other elements of the work system framework. The fourth mentions work system change and evolution.

To identify typical BPM views we draw primarily on quotations from van der Aalst (2013). As explained earlier and discussed in some length in Recker (2014), we also note that some researchers in the BPM scholarly community pursue research following other views, e.g., the view offered by Rosemann and vom Brocke (2015) or by researchers who focus on "processes" in fields such as operations management (Armistead and Machin 1997), software process improvement (Müller, Mathiassen, and Balshøj 2010) or organizational design (Pentland 2003). We do not cover all these viewpoints or research efforts in our paper. Our use of a recent and coherent single source makes it easier to illustrate general differences between WST views and the views inherent in most technically-oriented use cases for BPM research. It also allows us to add a more managerial view to the types of research efforts analyzed and addressed by van der Aalst (2013). The WST view is based on Alter's (2013b) coverage of WST, its applications, and its extensions. That article does not discuss BPM topics directly.

3.1 BPM and WST Views of Key Concepts

What is business process management? Van der Aalst (2013, p. 1) states that BPM "combines knowledge from information technology and knowledge from management sciences and applies this to operational business processes." BPM contains four key activities that focus on process models that "capture the different ways in which *a case* (i.e., process instance) can be handled" (van der Aalst 2013, p. 2). Those activities include: creating a process model to be used for analysis or enactment, using a process model to control and support concrete cases, analyzing a process using a process model and/or

event log, and management as the sum of all other activities such as adjusting the process, reallocating resources or managing large collections of process models. Van der Aalst (2013, p. 2) also mentions that a data perspective, time perspective, and function perspective "are essential for comprehensive process models."

A WST approach focuses on operating and managing entire work systems, i.e., not only processes and process models. WST implies that a business process cannot be managed without managing the work system because *processes and activities* is only one of nine elements of the work system framework (Figure 1). For example, the same process model enacted in two different locations or at two different times may generate completely different results if the human participants, information, technology, or customer demand differ significantly, and sometimes even when those elements are quite similar.

What is a system? Van der Aalst (2013, p. 5) says "there is an abundance of BPM systems. These systems are generic software systems that are driven by explicit process designs to enact and manage operational business processes." … "Business processes can be classified into human-centric and system-centric, or more precisely into person-to-person (P2P), person-to-application (P2A) and application-to-application (A2) processes." The distinction between human-centric and system-centric seems to imply that the term *system* is treated as a synonym of software.

While BPM software – and any other software – can be viewed as a system with inputs, processing, and outputs, from a WST viewpoint the system of primary interest is a work system, not the software systems it uses. A work system's human participants usually perform some activities that involve software and other activities that do not. Both receive attention.

What is a model? Van der Aalst (2013, p. 2) states, "the notion of a *process model* is foundational for BPM. A process model aims to capture the different ways in which *a case* (i.e., process instance) can be handled." Van der Aalst (2013, p. 6) further states that models may be descriptive, normative, and/or executable. Regarding types of models, van der Aalst (2013, p. 3) states, "most of the contemporary BPM notations and systems use token based semantics adopted from Petri nets." Most organizations currently use process models created with a grammar called BPMN (Recker 2010).

WST-inspired approaches treat process models as part of work system models. To date, modeling based on WST has been largely descriptive and far less formal than modeling in BPM. WST ideas also can be used in normative models that describe how future work systems should operate and also provide a path toward executable models.

WST does not call for any particular modeling notation. It assumes that deep analysis of any work system will probably start with relatively informal textual models that are easy to use for collaboration. In contrast with most highly formalized graphical or mathematical models, textual models based on WST tend to have very low extraneous cognitive load because they are based on familiar ideas and do not require use of overly rigorous concepts that are difficult for most people to understand. Later, as the analysis proceeds in more depth, it should apply whatever rigorous notations and modeling tools are useful. Those modeling tools might include models expressed through BPM software, but also might include service blueprinting (Bitner, Ostrom, and Morgan 2008), value stream mapping from Six Sigma (Snee and Hoerl 2003), BPMN modeling (Weske 2012), or other techniques.

What is automation? Van der Aalst (2013, p. 1) states that BPM "can be seen as an extension of Workflow Management (WFM). WFM focuses primarily on automation of business processes."

The WST view of automation assumes that a process or activity is automated if it is executed completely by a machine. In relation to WST, initiation, control, and tracking of process steps by BPM software is basically about control and recordkeeping, and is not about automating the steps themselves.

3.2   WST and BPM Views of Business Processes

A key difference that is fundamental to this paper is the definition of *business process*. The common definition by van der Aalst and others (2003, p. 4) defines business processes as "operational processes involving humans, organizations, applications, documents and other sources of information. … Processes at the strategic level or processes that cannot be made implicit are excluded from the BPM focus." Van der Aalst (2013, p. 5) updates that view by distinguishing between unframed, ad hoc framed, loosely framed, and tightly framed processes: "A process is said to be *unframed* if there is no explicit process

model associated with it [as in collaborative processes supported by groupware systems]. … A process is said to be *ad hoc framed* if a process model is defined a priori but only executed once or a small number of times before being discarded or changed [as in projects where the initial plan often is revised]. …A *loosely framed* process is one for which there is an a priori defined process model and a set of constraints, such that the predefined model describes the "normal way of doing things" while allowing the actual executions of the process to deviate from this model (within certain limits) [as in case handling systems]. … A *tightly framed* process is one which consistently follows an a priori defined process model. Tightly framed processes are best supported by traditional WFM systems."

A WST-inspired classification of business processes is about the nature and details of the work, not the framing of the steps. The work system framework uses the term *processes and activities* instead of business processes, thereby covering a range of possibilities in the extent to which activity sequences and content are explicit, formalized, prescribed or generative. This view is more open and integrative than the BPM view described above. For instance, it acknowledges that some processes and activities may be ostensive routines while others may be generative (Pentland 2003). It also acknowledges that some activities are artistic rather than procedural in nature and hence should not or cannot be modeled or managed (Hall and Johnson 2009). This view also acknowledges that processes and activities within work systems may be specified to varying degrees, for example, along the following dimension:

- *largely unstructured creative processes* (such as many design and management processes) that might use tools but that have no pre-specified sequence and may involve extensive iteration guided by concerns and abilities of people performing the work,
- *semi-structured knowledge processes* (such as medical diagnosis or legal analysis) that use tools and procedural knowledge but also have no pre-specified sequence and may involve extensive iteration,
- *workflow processes* (such as invoice verification or reimbursement) with a prescribed sequence but whose individual steps may be treated as black box subroutines whose details are unknown or are viewed as unproblematic,
- *highly structured processes* (such as pharmaceutical and semiconductor manufacturing) where both workflow sequence and details of each step must be specified and followed precisely.

Applying this view suggests that the first two types are outside of the scope of most current BPM research (Becker, Rosemann, and Kugeler 2003; van der Aalst, ter Hofstede, and Weske 2003) even though there are some exceptions. For example, some BPM researchers have studied creative processes (e.g., Hall and Johnson 2009; Seidel, Müller-Wienbergen, and Becker 2010), and others have focused on knowledge-intensive processes (e.g., Massey, Montoya-Weiss, and O'Driscoll 2002). Also, declarative approaches have been developed and studied (e.g., Zugal *et al.* 2015), which in principle can handle loss of structuredness in business processes. Despite these and other exceptions, the prevalent view appears to remain that BPM is basically an extension of workflow management (van der Aalst 2013, p. 1) – which applies to the third of the four types of processes mentioned above. The fourth category is more related to process aware information systems (PAISs), which "include traditional WFM systems and modern BPM systems, but also include systems that provide more flexibility or support for specific processes." (van der Aalst 2013, p. 1) The commonality among such systems (e.g., ERP, CRM, rule-based systems, call center software, and high-end middleware) is that they use an explicit process model even though they may not control processes through a generic workflow engine.

3.3   WST and BPM Views of Other Elements of the Work System Framework

This section explains how business process management in the WST sense requires consideration of the eight elements of the work system framework other than *processes and activities*. This coverage leads to many of the new or extended BPM use cases that will be mentioned in subsequent sections. The characterization of BPM views in the current section is based on van der Aalst (2013) and may not be consistent with views inherent in other BPM research.

Customers. Work systems exist to produce product/services for their internal and/or external customers. Thus, managing a work system requires focus on customers, who also may be work system participants, e.g., a user representative participating in software development or a patient in a medical exam. None of the 20 BPM use cases in van der Aalst (2013) mention customers.

Product/services. All work systems exist to produce one or more product/services that their customers receive, use, or experience. (The term product/service is used because unresolved debates about general

distinctions between products and services are unimportant for understanding, analyzing, or designing work systems.) The metamodel in Figure 2 shows that each activity inside a work system produces at least one product/service that may go to a customer or may be received and used by other activities within the same work system, as happens in assembly lines and value chains. None of the 20 BPM use cases explicitly focus on product/services.

Participants. Participants are people who perform work system activities. In contrast to BPM, WST treats participants as part of a work system rather than just users of software. It does this because their skills, knowledge, ambition, and attention are key determinants of a work system's efficiency, consistency, and resilience, and of the quality and reliability of product/services that it produces. The metamodel explicitly says that customers may play actor roles in work system activities (e.g., a patient in a medical diagnosis work system, a student in an educational work system). None of the 20 BPM use cases focus on participants in an explicit way.

Information. The metamodel identifies many different types of informational entities, all of which are important in at least some work systems. Consistent with observations by many social scientists, it assumes that relevant informational entities may or may not be computerized. The metamodel treats business rules (e.g., those that might be managed by a business rule engine) as a type of information that can be a resource for performing work system activities and that might be changed by work system activities. The 20 BPM use cases assume that information will pass between process steps and that information will be recorded in event logs, but do not focus on information used within process steps.

Technologies. The metamodel represents technologies in two forms, as tools used by work system participants (e.g., a knife used by a chef), or as automated services (e.g., a search engine) that perform work autonomously once launched by a triggering event or message. The metamodel says that automated services can be viewed as totally automated work systems. This is a step toward linking the business view of work systems with the computer science view of service-orientation as architecture. The metamodel says nothing about BPM software, but would treat it as technology that might be used in

launching or executing work system activities. The 20 BPM use cases do not speak specifically about technologies other than BPM software.

Environment, infrastructure, and strategies. The other three elements of the work system framework appear in some BPM studies, e.g., those that deal with context-awareness (Rosemann, Recker, and Flender 2008) and have some coverage in BPM textbooks, e.g., under strategic alignment (Rosemann and vom Brocke 2015), but are not a mainstream focus in BPM research.

3.4   WST and BPM Views of System Change and Evolution

The notions of change and evolution are fundamental to both BPM and WST because both are concerned with improvement and adaptation. We will look at two related topics.

What is a life cycle? Figure 4 in van der Aalst (2013, p. 5) shows an iterative BPM life cycle that focuses on BPM software and contains three phases, viz., (re)design, implement/configure, and run and adjust. The focus of this life cycle is a process model and how it may be changed through decisions made about that process model when requirements change.

The work system life cycle model (in Figure 1) focuses on a work system's evolution through iterations of planned change interspersed with unplanned change including adaptations, experimentation, and workarounds. It avoids the software-centric focus of the "system development life cycle," which is about producing and implementing software that meets requirements rather than about a work system's evolution through iterations of planned and unplanned change.

What is an unplanned change? Historically, much BPM research builds on the assumption that process specifications are accurate representations of business processes and will be followed. Exceptions are handled as deviances that should be eradicated (e.g., Dumas and Maggi 2015). More recently, process mining has been used to challenge the assumption that a process model describes how a process actually operates (van der Aalst, Weijters, and Maruster 2004).

WST assumes that a work system's evolution includes both planned and unplanned change. Planned change occurs through formal projects that may or may not involve BPM software. Unplanned change occurs because work system participants may or may not follow business process specifications. In some instances, the nonconformance is accidental. In others it is an application of human agency (Eisenhardt 1989), such as where work system participants design workarounds to overcome generic ERP or CRM processes that they see as unnecessarily cumbersome. In some cases, workarounds are temporary, but in others workarounds turn into a form of unplanned change (Alter 2014).

3.5   Similarities and Overlaps of WST and Managerial BPM

Before explaining how a WST perspective suggests directions for augmenting technically-oriented BPM use cases, it is useful to reinforce the foregoing introduction to the WST perspective through a comparison with a managerial perspective on BPM.

This section treats Rosemann and vom Brocke (2015) as an exemplar of that perspective. Figure 3 uses two dimensions to compare the positioning of WST with the positioning of three other viewpoints. The two dimensions are the extent of focus on process models vs. general management issues and the extent of focus on managerial issues vs. technical issues. General management is in the lower left because it may focus on work systems or on other management topics, such as organization of work, personnel issues, strategic decisions, or company culture. Next is WST, which focuses specifically on work systems, not general management, and which has more of a managerial flavor than a technical flavor even though it provides a path toward technical issues, as will be illustrated in Figures 4 and 5. Managerial BPM focuses specifically on process management and process improvement, almost always through the use of BPM software. Finally, van der Aalst's technical use cases are primarily about process models and generally have a highly technical emphasis.

Focus on process models			van der Aalst's technical use cases
Focus on process management and process improvement		Managerial BPM	
Focus on work system analysis, design, improvement	Work system theory		
General management	Management of work and other management concerns		
	Focus on managerial issues		Focus on technical issues

Figure 3. Framework for comparing WST, managerial BPM, and van der Aalst's technical uses cases

Overall, Figure 3 suggests that WST has a broader, more managerially focused view than the process-focused view of managerial BPM, and that van der Aalst's (2013) use cases are more specific and focus more on process models than managerial BPM. Based on the positioning in Figure 3, adding aspects of a WST perspective to either managerial BPM or the technical use cases would tend to illuminate issues that are more in the direction of management and hence would be described as being more fully about the management of business processes.

To compare WST and managerial BPM in some more detail we look at the six "core elements" of BPM in the managerial BPM view described by Rosemann and vom Brocke (2015): strategic alignment, governance, methods, information technology, people, and culture.

Strategic alignment. Rosemann and vom Brocke (2015) says that "strategic alignment (or synchronization) is defined as the tight linkage of organizational priorities and enterprise processes enabling continual and effective action to improve business performance. Processes have to be designed, executed, managed, and measured according to strategic priorities in specific strategic situations (e.g., stage of a product lifecycle, position in a strategic portfolio)." Strategies is also an element of the work

system framework (Figure 1). An underlying assumption of the work system approach is that the structure and operation of a work system should be consistent with enterprise strategy and department strategy. That is why the metamodel in Figure 2 includes enterprise strategy, department strategy, and work system strategy. It is worth noting, however, that WST focuses on specific work systems and does not assume that every work system has strategic importance or genuinely needs to be considered from a strategic perspective. Some work systems are strategically important. Others are not, but still need to be created, operated, and managed in order to produce internally or externally directed product/services that are needed for one reason or another.

Governance. Rosemann and vom Brocke's (2015, p. 111) says, "BPM governance establishes appropriate and transparent accountability in terms of roles and responsibilities for different levels of BPM, including portfolio, program, project, and operations." WST does not include a separate governance component because it assumes that governance itself is actually a work system and can be analyzed as such. The metamodel outlines a step toward accountability by identifying actor roles for each activity in the work system. Thus, while there is no disagreement about the importance of work system governance, WST says nothing specific about the separate governance of work systems, business processes or BPM.

Methods. Rosemann and vom Brocke (2015, p. 111) says that "methods in the context of BPM are defined as the set of tools and techniques that support and enable activities along the process lifecycle within enterprise-wide BPM initiatives…. Examples are methods that facilitate process modeling or process analysis and process improvement techniques. … Six Sigma is an example [of] a BPM approach that has at its core a set of integrated BPM methods." Alter (2013b, p. 99) treats Six Sigma as an example of "methods and tools that are typically viewed as external to the IS discipline" but "are certainly applicable when thinking about IT-reliant work systems. Such methods should be used wherever they might provide insight and where the required data is available or can be collected." In other words, there is no disagreement about using tools and methods that are applicable for analyzing or designing processes. The same tools and methods that Rosemann and vom Brocke (2015) cite as examples are equally relevant to analyzing many operational work systems.

Information technology. Rosemann and vom Brocke (2015, p. 111) says "IT-based solutions are of significance for BPM initiatives. With a traditional focus on process analysis (e.g., statistical process control) and process modeling support, BPM-related IT solutions increasingly manifest themselves in the form of process-aware information systems (PAIS, see Dumas, van der Aalst, and ter Hofstede 2005). Process-awareness means that the software has an explicit understanding of the process that needs to be executed. Such process awareness could be the result of input in the form of process models or could be more implicitly embedded in the form of hard-coded processes (like in traditional banking or insurance applications)." WST makes no conceptual or categorical distinction concerning whether a work system contains BPM software or whether it is "process-aware." WST assumes that any type of technology may play a role in a work system. WST says nothing about "process-awareness" because it is usually impossible to manage a work system effectively unless its participants and their managers are aware of how its quality-sensitive processes operate. In other words, process awareness is a basic assumption of WST.

People. Rosemann and vom Brocke (2015, p. 111-112) says that "people as a core element of BPM is defined as individuals and groups who continually enhance and apply their process and process management skills and knowledge in order to improve business performance." WST views work system participants as everyone, sometimes including customers, who plays an actor role in one or more activities in a work system. The metamodel notes the importance of participants' knowledge/expertise, skills/capabilities, performance metrics, and motives, all of which may apply to specific BPM concerns and to any other concerns that are relevant to the work system.

Culture. Rosemann and vom Brocke (2015, p. 112) says that "culture incorporates the collective values of a group of people. …Culture is about creating a facilitating environment that complements the various BPM initiatives. Research has identified specific organizational values supportive for BPM as well as methods to measure and further develop a BPM-supportive organizational culture." WST takes a broader view of culture that includes organizational culture and national culture. Thus, it treats culture as more than those collective values and beliefs related to BPM philosophy (vom Brocke and Sinnl 2011). "Environment" is the related element in the work system framework. A work system's environment

surrounds the work system, often affects its performance, and sometimes constrains its structure. A work system's environment includes the relevant organizational, cultural, competitive, technical, regulatory, and demographic environment within which the work system operates. Organizational aspects of the environment include organizational culture, stakeholders, policies and procedures, and organizational history and politics, all of which are relevant to the operational efficiency and effectiveness of many work systems.

A final point in the comparison of the WST view and the six core elements of the managerial BPM described by Rosemann and vom Brocke (2015) is that those six core elements (strategic alignment, governance, methods, information technology, people, and culture) are not sufficient for managing operational work systems. The work system framework also calls for attention to customers, product/services, information, and (human, informational, and technical) infrastructure, which are not highlighted directly in the six core elements. Instead they are the subject of refinement to each of the core elements, for instance, in the method and technology components.

3.6   Work System Metrics and Characteristics

While BPM focuses on business process structure and its implications for performance, WST is about the structure and performance of work systems. Analysis and design of a work system necessarily calls for attention to metrics for evaluating how well an existing or proposed work system will operate. Common internal metrics for managing the operation of work systems include production cost, efficiency, speed, consistency, rework, and extent of stoppages, which are the same kinds of metrics that are used in process analysis (Dumas, La Rosa, Mendling, and Reijers 2013). Common external metrics for customer concerns related to product/services include total cost to customers, quality perceived by customers, responsiveness to customers, and so on. Work systems and each of their elements may also have other metrics, any of which may be important in some situations and unimportant in other situations.

Work system characteristics may also be important in analyzing and designing systems. Commonly cited work system characteristics include scalability, flexibility, resiliency, degree of scriptedness, complexity, degree of automation, extent of co-production with customers, degree of customizability, and visibility to

customers. Many of these characteristics are about more than the business process because characteristics of work system participants and technologies performing essentially the same business process lead to different degrees of scalability, flexibility, and resiliency.

4   Using a WST Perspective to Extend the BPM Use Cases

This section discusses two ways to use WST to extend BPM use cases. First, it explores *additional ideas for the existing* six technically-oriented categories of BPM use cases mentioned in van der Aalst (2013). Second, it identifies *novel BPM research use* areas where a WST perspective might point to under-explored topics and issues.

In effect, we develop new theory about BPM use cases by drawing on the more general WST as a framework. The process of developing our framework and conceptualization was iterative and interactive in nature. It mirrored basic principles that govern qualitative research inquiry (Klein and Myers 1999). We used principles of dialogical reasoning extensively in our discussions to establish a shared account of our understanding of BPM as well as WST. We used principles of suspicion to question each of our viewpoints and to tease out biases and distortions in constructing our approach. We applied both principles in developing and revising the new use cases we describe. Overall, our approach was consistent with general discussions of theory development and production of conceptual papers that have appeared in leading IS journals such as *JAIS* (Hirschheim 2008; Weber 2012), *EJIS* (Rowe 2012), and *MIS Quarterly* (Rivard 2014), and also in other leading journals such as *Academy of Management Review* (Weick 1999; Corley and Gioia 2011). Moreover, our approach was consistent with Grover and Lyytinen (2015) who explain why methodological scripts should not be expected in theory development research.

4.1   Using WST to Extend BPM Use Cases

Van der Aalst (2013, pp. 6-12) organizes 20 BPM use cases in six categories. This section shows how a WST-inspired approach addresses some of those topics in the broader and less software-centric context of work systems. Areas of overlap are places where current BPM topics are also work system topics. Areas of divergence may provide topics for an expanded form of BPM.

Category 1: Obtaining models. Both BPM and WST need to define processes and activities. The work system framework (Figure 1) supports a simple type of textual modeling called the work system snapshot (e.g., Figure 4) that many hundreds of Bachelor, MBA and Executive MBA students have used as a step in producing management briefings related to potential improvements of work systems in their own business organizations (Truex, Alter, and Long 2010; Recker and Alter 2012; Alter 2013b). In another process-oriented discipline, Sowan (2015) describes how work system snapshots were used by 117 nursing graduate students during 2013 - 2015 as a required part of business process reengineering assignments.

This type of non-graphical modeling is useful for clarifying the scope of the work system at the beginning of an analysis and design effort without committing to a particular formal notation. The basic idea for this type of model is to summarize a work system on one page by identifying its customers, product/services, major activities and processes, participants, information, and technologies. This type of model does not attempt to specify detailed process logic. Instead, it suffices to summarize the process in the approximate order of activities, without great concern about whether some activities occur in parallel. Obviously, more detailed types of modeling will be necessary to specify precise process flows, but that degree of specificity is not necessary for attaining general agreement about the identity and scope of the work system being analyzed.

Customers		Product/Services	
• Hiring manager • Larger organization (which will have the applicant as a colleague • HR manager (who will analyze the nature of applications)		• Applications (which may be used for subsequent analysis) • Job offers • Rejection letters • Hiring of the applicant	
Major Processes and Activities			
• **Hiring manager** submits request for new hire. • **Staffing coordinator** defines the parameters of the new position. • **Staffing coordinator** publicizes the position. • **Applicants** submit resumes. • **Staffing coordinator** selects shortlisted applicants and sends the list to the hiring manager. • **Hiring manager** identifies applicants for interview by browsing applicant resumes.		• **Staffing coordinator** sets up interviews. • **Hiring manager** provides feedback from the interviews. • **Staffing coordinator** or **staffing assistant** sets up additional interviews with other employees. • **Hiring manager** makes hiring decisions. • **Staffing assistant** sends offer letters or rejections. • Successful **applicant** accepts or rejects job offer.	
Participants	Information		Technologies
• Hiring managers • Staffing coordinator • Applicants • Staffing assistant • Other employees who perform interviews	• Job requisition • Job description • Advertisements • Job applications • Cover letters • Applicant resumes	• Short list of applicants • Information and impressions from the interviews • Job offers • Rejection letters	• New HR portal that is being built • Word processor • Telephones • Email

Figure 4. Typical work system snapshot of a hiring work system (Alter, 2013b)

Figure 5 illustrates that the work system metamodel in Figure 2 provides entity types that can be used for more detailed modeling of the same situation that was summarized in the work system snapshot in Figure 4, but again without relying on conventional formalized process models. The more detailed tabular model in Figure 5 adds some of the information that appears in a typical use case narrative, such as triggers, preconditions, and post conditions for specific activities.

The structured text and tabular modeling examples in Figures 4 and 5 illustrate two simple points. First, whereas many managers become overwhelmed in complex diagrams and notations, relatively simple tables of information related to business process steps similar to Figure 5 can be tailored for specific discussions and can be used easily. For example, analysts and managers can use tables based on selected columns in Figure 5 and possibly columns based on other entity types in the metamodel for clarifying topics and issues that would not be apparent in a work system snapshot. Examples include triggers and preconditions for activities in which customers perform actor roles, activities that use particular types of resources, information used by activities that are performed automatically, and so on. Once again, this level of modeling is useful for clarifying a number of issues even though it does not attempt to specify the detailed logic of the process flow that would have to be documented using tools such as BPMN. Second, the issue here is not about formalization but about usability and relevance. Several studies show that most process documentation used in practice are not formalized or graphical, but instead consist of textual and tabular representations. For example, a global study of process modeling initiatives by 130 companies (Patig and Casanova-Brito 2011) showed that 55.9% of organizations documented their processes as texts and 31.5% as tables. By contrast, the most popular formalized notations in use included Business Process Model and Notation (BPMN) 21.3% and Unified Modeling Language (UML), 15.0%. Those results imply that BPM research needs to draw attention to the relevant forms of obtaining models used in industry. Some such efforts are now underway, e.g., (Figl and Recker 2016; Saldivar *et al.* 2016).

Thus, in relation to the first use case category, "obtain models," WST and the metamodel may facilitate producing or identifying initial models that may be sufficient for many managerial BPM purposes in real world practice. Usage of that type may lead to more formalized process modeling wherever it is necessary to specify process details in more depth.

Activity	Actors	Information used, created, updated, or deleted	Technology	Trigger	Preconditions	Post conditions (including product/ services produced)
• Submit request for new hire.	• Hiring manager	• Hiring budget • Job requisition	• HR portal	• Need for new employee	• Sufficient hiring budget	• Job requisition exists
• Define parameters of the job.	• Staffing coordinator	• Job requisition • Job description • Hiring policies	• Word processor • HR portal	• Job requisition	• Job requisition	• Job description •
• Publicize the job opening	• Staffing coordinator	• Experience with advertising media • Advertisement	• HR portal, • Web site for selected media	• Job requisition, Job description	• Job requisition, Job description	• Advertisement displayed on web sites
• Submit application •	• Applicant	• Job description, Cover letter, • Job application, • Resume	• HR portal	• Advertisement displayed on web sites	• Advertisement displayed on web sites	• Receipt of cover letter, job application, resume
• Select shortlist •	• Staffing coordinator	• Job application Short list of best applicants	• HR portal	• Deadline for job applications	• Availability of job applications	• Short list available to hiring manager
• Identify applicants to interview	• Hiring manager	• Short list of best applicants • List selected for interviews	• HR portal	• Short list available to hiring manager	• Short list available to hiring manager	• List selected for interviews
• Set up interviews •	• Staffing coordinator	• Schedules of interviewers • Interview schedule	• Employee calendar system, • HR portal	• List selected for interviews	• List selected for interviews	• Interviews schedule
• Perform interview	• Hiring manager • Other interviewers	• Job description • Job application Interview impressions	• HR portal	• Interview schedule	• Interview schedule	• Interview impressions
• Make hiring decision	• Hiring manager	• Interview impressions • Hiring decision	• HR portal	• Completion of interviews	• Completion of interviews	• Hiring decision
• Send offer letters or rejections.	• Staffing assistant	• Hiring decision • Job offer • Rejection letter	• HR portal	• Hiring decision	• Hiring decision	• Job offer, • Rejection letter
• Accepts or rejects job offer.	• Applicant who was selected	• Job offer, • Applicant's response to	• HR portal	• Job offer	• Job offer	• Applicant's response to offer

		offer				

Figure 5. Summary of a hiring work system based on entity types in the metamodel

We will say a bit more about the potential application of WST and the related metamodel to each of the use cases within the category, "obtain models." To keep track of the use cases we will reuse the 1 to 20 numbering of use cases that was introduced earlier.

- *(1) Design model.* Figures 4 and 5 illustrate types of models that were designed based on WST and the metamodel. The tabular format in those figures empowers business professionals in general, rather than trained BPM experts or researchers, to create and discuss new or improved models.

- *(2) Discover model from event data.* Application of this use case depends upon the existence of data. For example, if an organization kept records of which resources were used in particular processes or when producing particular product/services, it might be possible to use a more elaborate version of process mining to reconstruct aspects of a work system model by examining event logs that include identification of the resources used by each event, i.e., not just the occurrence of events. Some of the existing process mining research includes such a possibility but limits 'resources' to the process participants involved. In contrast, the WST metamodel is designed to recognize the essential role of broader resource categories that include various types of technological entities, informational entities, participants and other resources. Such distinctions are overlooked in most BPM research use cases. A step in that direction is research that mines data to construct affordance networks, for instance, and can show variations in actors and technologies in the execution of processes (Pentland, Recker, and Wyner 2015).

- According to the metamodel, these resources fall into four categories, participants, informational entities of various types, technological entities (tools or automated services) and other resources such as physical entities, time, organizational culture, laws, standards, regulations, and policies.

- *(3) Select model from collection.* This use case can be pursued in a variety of ways that build on the approach mentioned in van der Aalst (2013, p. 7). "Large organizations may have repositories containing hundreds of process models. There may be variations of the same model for different departments or products. Moreover, processes may change over time resulting in different versions…." Any organization that has a repository of process or work system models could use that repository to find starting points for creating new models or reinventing old ones. This would require a way to search the existing models to find the ones that are relevant.

- *(4) Merge models and (5) Compose model.* Expanded versions of these two use cases can start from the same type of repository. Assume that only process models existed. The analysts would select and combine relevant process models and then would expand them using whatever entity types in the metamodel are relevant for the purpose at hand. Parts of the initial expansion would require no research for an experienced analyst, because a first approximation to many of the details could be filled in based on business experience. The analyst would then check with subject matter experts to verify the initial assumptions. This could be a good way to attain benefit from existing models in a corporate setting.

Category 2: Configurable models. Use cases in this category include (6) design configurable model, (7) merge models into configurable model, and (8) configure configurable model. Pursuit of those use cases would occur similarly to pursuit of the use cases mentioned under the first category, obtain models. In the instance of configurable models, however, configuration parameters would receive special attention. For example, tables with the general format of Figure 5 could include a column for configuration parameters. Alternatively, in cases with multiple parameters, it probably would be better to use a decision tree or decision table that identifies situations where specific configuration parameters are relevant and that provides links between specific configuration parameters and specific submodels.

Category 3: Process execution. Van der Aalst (2013, p. 9) states, "the initial focus of WFM [workflow management] systems was on process automation and implementation, and not on the management, analysis, and improvement of business processes." The related use cases in this category include the following:

- **(9) Refine model.** From a WST viewpoint, refining a model involves the same types of thinking and methods that are relevant in all of the previous use cases. In other words, refining a model calls for starting with a model specification, finding areas for improvement, and modifying the model accordingly.

- **(10) Enact model**. The preconditions, triggers, and postconditions in the metamodel (Figure 2) provide a basis for controlling the initiation of activities. This can be done using an "enactment service" that "takes care of control and execution" (van der Aalst 2013, pp. 15, 17). The enactment service monitors the status of all process or activity instances and initiates work system activities based on the status of each activity's preconditions and triggers. The broader scope of WST and the metamodel (e.g., explicit inclusion of resources such as customer and noncustomer participants, various types of information, technologies, and other resources) provides an expanded basis for defining and evaluating preconditions, triggers, and postconditions. In addition, the metamodel treats business rules as informational resources for executing specific activities.

- **(11) Log event data**. The metamodel identifies many entity types that provide a much richer view of event occurrences than is possible from a simple event log listing only the time that each event occurred for each process instance. The main limitation of a WST viewpoint in this area is the extent to which data is logged, preferably automatically, for the various entity types that are relevant for each activity.

- **(12) Monitor**. Similarly, the many entity types identified by the metamodel outline a much richer view of what actually happens as a process executes within a work system.

- **(13) Adapt while running**. The metamodel provides a number of informational entity types that can be adjusted as a way to implement "adaptation while running." For example, the execution of a particular process step might generate a post condition that calls for changing a business rule, either temporarily (e.g., in a bottleneck situation) or over a longer time span. The main challenge for implementing this expanded use case is to identify and test the relevant business rules, triggers, preconditions, and other parameters that might be changed in the adaptation calculations.

The metamodel might be especially valuable for resolving resource conflicts, an extended version of "adapt while running." Coordination theory (Crowston, Rubleske, and Howison 2006), the theory of constraints (Goldratt 1990), and other techniques related to scheduling and dispatching deal with

prioritization related to use of resources and recognize that people and other resources often cannot be involved in two different activities simultaneously. Conflict resolution may occur informally, as happens in most operational business processes. This also can be formalized in business rules for an automated enactment service that controls the execution of processes and activities.

Category 4: Model-based analysis. BPM use cases in this area include (15) analyze performance based on model and (16) verify model. Both work system snapshots (e.g., Figure 4) and tables in the general form of Figure 5 can be used for analyzing performance based on inspection, discussion, and largely manual analysis methods. The work system method (WSM) that was mentioned earlier operates in that way. It proceeds by identifying the smallest work system that has a problem or opportunity, summarizing the "as is" work system using a work system snapshot, drilling down as needed, e.g., by identifying performance gaps and structural issues related to various aspects of the work system, identifying and analyzing alternative possibilities for improvement, selecting a preferred alternative, summarizing the "to be" work system, and explaining why its performance will probably be better than the performance of the "as is" work system.

Thus, WSM addresses some of the issues in use cases (15) and (16), but starts with less precise models and data than are generally associated with those use cases. The general nature of those use cases is expressed by van der Aalst (2013, p. 10) as follows: "Instead of directly hard-coding behavior in software, models can be analyzed before being put into production." For example, "executable process models can be used to analyze the expected performance in terms of response times, waiting times, flow times, utilization, costs, and so forth."

While WST supports the less precise approach in the initial phases of WSM, the related metamodel can serve as the basis of mathematical analysis that goes into greater depth. Assume that an instantiation of the metamodel provides the basis of an agent-based simulation that includes not only a process specification, but also specification of all of the major resources that are required and all preconditions, triggers, and business rules. Multiple runs of the agent-based simulation would take into account many factors beyond a process specification, including interactions between factors, such as conflicts between

different processes that require the same human or physical resources. The metamodel-informed simulations could include and use parameters related to any entity type in the metamodel. The simulation analyses would use a version of the enactment service mentioned above. It would be augmented by another process that would feed new cases to the enactment service based on likely statistical distributions of the timing of the new cases and also their characteristics (e.g., quantities and special requirements of pre-defined types). In addition to estimated timing parameters, the simulation runs could use estimates or distributions of other parameters such as yield percentages, rework rates, and equipment outages. Those parameters would be attached to specific work system activities within processes or could be attached to specific resources (e.g., distribution of skill levels of human participants or distribution of accuracy of information). As noted at the bottom of Figure 2, those attributes and distributions are not visible in the one page representation of the metamodel.

Category 5: Extracting diagnostics from event data. Van der Aalst's (2013, p. 10) two use cases in this area are (16) check conformance using event data and (17) analyze performance using event data. The related discussion of extracting diagnostics from event data seems to imply that BPM does not include other traceability and performance measurements that are essential both for operational management and for explaining variations that might be discovered through process mining.

The metamodel assumes that each execution of a work system activity is an event that changes the status of a particular case or instance and often changes the status of resources that are affected or consumed. Each such event can be recorded in a transaction database along with information that might be used for subsequent activities and for analyzing important aspects of performance. The transaction database would include a timestamp for each event. It also would provide informational resources for subsequent activities and for after-the-fact analysis by managers. Both requirements call for metrics such as efficiency, resources used, deviations from desired accuracy, rework, error rate, and other forms of waste. Collecting and using whatever execution-related information might be linked to root causes of problems or deviations could provide an expanded version of process mining than can be supported by chains of time-stamped events that contain no other information about event details.

Category 6: Producing new models based on diagnostics or event data. Van der Aalst (2013, p. 10) notes, "diagnostic information and event data can be used to repair, extend, or improve models." The use cases here include (18) repair model, (19) extend model, and (20) improve model.

Tracking within a WST perspective supports a broader version of the same general purpose. The information would be used to repair, extend, or improve work systems through typical management interventions or through automated means. For example, business rules within a service enactment function could support adaptive modifications of the business rules in a business process that is being monitored.

4.2   Implications of WST for New Use Cases

In addition to extending existing BPM use cases, WST also has implications for new use cases that are outside of BPM's current scope as expressed in van der Aalst (2013). This section mentions possible use cases related to processes and customers, processes and product/services, processes and participants, processes and technologies, and processes and workarounds. Other conceivable use cases are not discussed here. Using the same numbering convention that was used thus far, the new use cases will be identified as follows:

- *Use cases related to processes and customers*. These include (21) design provider processes from customer processes, (22) merge provider and customer processes, and (23) configure customer processes based on provider processes.
- *Use cases related to processes and product/services*. These include (24) configure product/service based on process, (25) select process based on product/service, (26) verify product/service based on process (and vice versa), and (27) improve product/service through process improvement.
- *Use cases related to processes and participants*. These include (28) check fit of process to participants (and vice versa), (29) design process for participants, (30) analyze process performance based on participant, and (31) merge processes for benefit of participants.

- *Use cases related to processes and technologies.* These include (32) design process for technology (and vice versa), (33) merge technologies for process, and (34) analyze process by technology.

- *Use cases related to processes and workarounds.* These include (35) identify foreseeable workarounds, (36) design in relation to foreseeable workarounds, and (37) incorporate foreseeable workarounds into documentation.

Processes and Customers. A central concern in the emerging discipline of service science involves whether and to what extent a provider's activities can facilitate value for customers, often through co-production of services and even co-creation of value (e.g., Vargo and Lusch 2008; Grönroos 2011). Bringing BPM into the entire discussion of operational service systems (i.e., not just service-oriented computing architectures) calls for extending BPM use cases into situations in which both customers and providers perform actor roles in business processes that provide service. Some research has examined private processes as the customer's counterpart (Rosemann 2014), but a WST-inspired approach could go further.

Possible BPM research use cases include (21) design provider processes from customer processes, (22) merge provider and customer processes, and (23) configure customer processes based on provider processes. Use case (21) draws attention to the design of operational business processes in explicit alignment with processes enacted by customers outside of the boundaries of the provider organization. An example would be creating business processes for handling medical insurance claims by drawing on the personalized medical treatment processes encountered by a patient. Use case (22) focuses on the intricate interconnectedness between many modern operational business processes in an organization and the frequently informal and under-specified processes of customers. Today's network-based businesses such as AirBnB, Uber, and others operate in that type of situation. Use case (23) suggests customizing individual, private activities of customers in alignment with the operational processes of a provider. An example is providing recommendations for building a house guided by an architectural firm's process for executing such projects.

Processes and Product/Services. Research use cases in this category refer to process activities that are designed in explicit recognition of the product/services being produced. A variety of research in areas such as service science and engineering can serve as input to further research related to these use cases. For example, some of this research combines customers, products and processes into service systems, which interact with other such systems to create value (Maglio, Vargo, Caswell, and Spohrer 2009). This research typically examines these service systems as a black box, whereas WST would allow decomposing the service systems that interact into their constituent components including their processes. In BPM, existing research on product-based workflow design has attempted at least one related use case: *design process model from product* (Reijers, Limam, and van der Aalst 2003).

The WST metamodel identifies other relationships between processes and product/services that suggest new research use cases such as: (24) configure product/service based on process, (25) select process based on product/service, (26) verify product/service based on process (and vice versa), or (27) improve product/service through process improvement. Use case (24) calls for formalizing the notion of process-based design that is implicit in approaches such as TRIZ (Savransky 2000). Use case (25) introduces provider choices between multiple feasible processes based on the product/services that are offered. Use case (26) is supported by some quality management methodologies such as TQM (Powell 1995) and is based on evaluating or even changing product/service attributes within the design process. Use case (27) explores how product/service improvement can occur through process improvement.

Processes and Participants. These research use cases typically focus on reallocation of resources to tasks (zur Muehlen 2004). WST suggests also considering participant characteristics in BPM. Potential use cases in this category include: (28) check fit of process to participants (and vice versa), (29) design process for participants, (30) analyze process performance based on participant, or (31) merge processes for participants. All of these use cases assume that fit between the process and the participants matters and therefore belongs within the scope of BPM concerns. For instance, use cases (28) and (30) suggest that some processes may be better suited for participants with particular attitudinal, cognitive, or other personal characteristics. An example is the way in which participants who require clear direction and guidance may need detailed process models to guide their work whilst others thrive under conditions of

freedom and empowerment. Use cases (29) and (31) address ways in which processes could or should be tailored or combined depending on personal characteristics, e.g., one's ability to multi-task or one's ability to make consequential decisions without extensive rules or frequent management review.

Processes and Technologies. Most BPM use cases in van der Aalst (2013) say little or nothing about technology used in the execution of specific process steps despite the widespread recognition that technology can enable profound changes in work practices and business transactions. For example, the linkage of BPM and technology was subject to much BPM research several decades ago in the literature on ERP systems (e.g., Curran, Keller, and Ladd 1997; Scheer 1997; Jarrar, Al-Mudimigh, and Zairi 2000). It also remains a core theme in software engineering research, typically in the form of deriving software requirements from process models (e.g., Pohl 1996; Berki, Georgiadou, and Holcombe 2004; Rodríguez, Fernández-Medina, and Piattini 2007).

WST and its extension imply that a work system's performance depends on all of its components, including technologies. A WST lens suggests BPM use cases related to matching processes and technologies. That goes further than exploring processes within the context of the technologies on which they run, or (re-) designing either technology or process to fit the other, which has been the focus, for example, for much of the research on ERP-enabled process reengineering (Keller and Meinhardt 1994; MacArthur, Crosslin, and Warren 1994). The research use cases related to processes and technologies include: (32) design process for technology (and vice versa), (33) merge technologies for process, and (34) analyze process by technology. Use case (32) can be seen to some extent in the adjustment of online offerings based on type of device, e.g., using a simpler process for smartphones. Still, there is little extant research that examines process change based on technology rather than process change based on product (Reijers, Limam, and van der Aalst 2003). Use cases (33) and (34) recognize that the choices among alternative technologies (and availability of shared technological infrastructure) may have a variety of impacts on process design or performance. The related research could identify and evaluate traditional processes that cannot be adapted readily to modern technologies. One approach for that research challenge could apply process virtualization theory (Overby 2008), which asks whether information-

intensive business processes (e.g., postal mail, banking transactions) can be converted to online modes without loss of performance or acceptance.

Processes and Workarounds. The previous use cases focused on combinations of elements in the work system framework. Recent extensions of WST suggest several additional use cases related to the frequent occurrence of workarounds, a form of unplanned change that appears in the work system lifecycle model (Figure 1) as a type of unanticipated change. "A workaround is a goal-driven adaptation, improvisation, or other change to one or more aspects of an existing work system in order to overcome, bypass, or minimize the impact of obstacles, exceptions, anomalies, mishaps, established practices, management expectations, or structural constraints that are perceived as preventing that work system or its participants from achieving a desired level of efficiency, effectiveness, or other organizational or personal goals" (Alter 2014, p. 1044). By contrast, an adaptation (such as the mechanism in the original use case "adapt while running") usually refers to dynamically changing the details of the process for doing the work. Workarounds appear frequently in everyday work practices. Some workarounds are attempts to overcome transient malfunctions or exception conditions that are obstacles to completing work successfully. Others are work system participants' attempts to bypass aspects of business processes that seem cumbersome, over-constrained, or no longer aligned with current realities. Yet others are basically deviant behavior that is largely or totally related to personal goals rather than organizational goals. A theory of workarounds (p. 1056) identifies a number of factors related to whether and how workarounds will be designed and executed.

Despite the frequent occurrence of workarounds, most BPM research to date seems to assume that processes will be executed as designed and that deviances can be identified and eliminated, e.g., (Dumas and Maggi 2015). A more realistic assumption is that conformance to business processes is contingent on many factors that are only partially knowable in advance, and further that beneficial workarounds may overcome obstacles to meeting business objectives just as failure to design and execute workarounds may be detrimental to meeting business objectives. Also, some deviances could produce performance improvements to the original process and should form the basis for new process models (Mertens, Recker, Kummer, Kohlborn, and Viaene 2016).

Potential use cases related to workarounds include (35) identify foreseeable workarounds, (36) design in relation to foreseeable workarounds, and (37) incorporate foreseeable workarounds into documentation. Use case (35) could be pursued through extensions to current analysis and design processes. As a possible starting point for use case (36), a proposed workaround design system (Alter 2015b) would use previously compiled and organized examples of typical workarounds to make it easier to identify likely workarounds along with conditions under which they would be viewed as beneficial noncompliance or detrimental compliance (Alter 2015a). Research use case (37) involves developing methods and notations for including likely workarounds in process documentation. Research use cases in those areas could be of substantial practical value.

5   Conclusion

This paper was motivated by the disconnect between what business process management means to managers and executives who do not know about BPM software versus what it seems to mean to BPM researchers, and also divergence in what it seems to mean to different BPM researchers. This paper proposed a way to move beyond our interpretation of van der Aalst's (2013) view of BPM as focusing on the creation, discovery, use, and management of formal, computerized process models. While process models are a very important research topic where substantial progress continues to occur, a WST-based view of BPM would address current BPM topics along with many management concerns that are currently beyond the scope of most BPM research.

5.1   Contributions

This paper's main contribution was introducing a WST-based path for expanding the scope of BPM. That path answered the two research questions posed at the outset:

1. Can a WST perspective meaningfully expand the scope of BPM concepts?

2. Can a WST perspective expand existing use cases for technically-oriented BPM research?

Seeing typical BPM topics in the broader context of work systems rather than just models of business processes potentially makes BPM even more valuable. This paper showed how a WST-based perspective suggests potentially valuable extensions to the 20 existing use cases identified by van der Aalst (2013). It also identified a set of 17 new use cases that illustrate how a WST perspective suggests new pathways toward addressing important process management issues that are beyond the current scope of technically-oriented BPM. The main implications can be summarized as follows:

Management of work systems, not just process models. In real world settings, the management of business processes concerns the design, operation, and improvement of operational work systems whose human participants, computerized and non-computerized information, technologies, product/services, and customers also must be understood and analyzed. Viewing BPM as the management of process models rather than the management of operational work systems limits the potential value of the entire BPM discourse. Adding a WST perspective to existing BPM uses cases provides a path toward a broader view of BPM research along with greater potential value in the world of practice.

More than the sequence of activities. The management of business processes necessarily includes designing, implementing, monitoring, and managing both the sequence of activities and the execution of activities. The related deliberations and communication should recognize the four types of processes mentioned earlier. Ideally, processes should be specified with appropriate degrees of interpretive flexibility, consistent with (Cherns 1976, p. 155) sociotechnical principle of minimum critical specification, i.e., "no more should be specified than what is absolutely essential."

Consideration of actual work practices and performance. A broader version of BPM should consider actual work practices and actual performance results, not just process models. Process mining research is certainly a step in that direction, but it is possible to go much further through BPM research that explicitly recognizes work system issues of everyday work life, such as:

- varying degrees of conformance or non-conformance to documented business processes,
- unanticipated exceptions and contingencies
- variability in the skills and motivation of human participants

- accuracy or inaccuracy of information used and created by business processes

- reliability or unreliability of technology

- obstacles and uncertainties related to the surrounding environment and the shared infrastructure that business processes rely upon.

Thus, a WST perspective extends the focus beyond what we see as an unnecessarily limited technical view of BPM as primarily about the management of business process models. Management of operational business processes requires a work system view – or something like it – because managers of operational systems need to understand and manage or respond to every element in the work system framework. Even when BPM software is involved, the focal point for managers is the work system, not just the process model and certainly not just the BPM software. This paper's WST-inspired extensions of existing use cases and articulation of new use cases could lead to new BPM research topics and new ways to achieve real world value from BPM.

5.2   Limitations

In concluding, we also need to mention some of this paper's limitations.

Deductive versus inductive approach. We chose a deductive approach over an inductive approach in proposing extensions to research use cases in van der Aalst (2013). We believed a deductive approach based on WST would make our theory development effort more systematic and also would provide more clarity about boundary conditions and scope. It is possible that inductive approaches might generate different results.

Basis in work system theory. The selection of WST as a theoretical basis can be construed as a limitation because alternative theories or frameworks might offer different pathways for developing expanded or new use case. We turned to WST because the linkage between WST and BPM had been suggested previously (Alter 2013b; 2013a) - but not in relation to van der Aalst's review of BPM research. We recognize that our article is but one way of viewing and extending a perspective on BPM use cases. In

turn, we welcome papers that respond to our view of BPM use cases with alternative models, much as we responded to van der Aalst (2013) in this article.

Views of several researchers. We recognize that our application of WST to the development of use cases is inherently linked to our own interpretation of both WST and BPM. We also realize that some researchers will not agree with our views nor with our interpretation of BPM research. We developed our interpretation as a response and thus crafted our paper in ways that highlight differences rather than commonalities in views. To allow readers to follow our interpretation and argumentation, Section 3 summarized our understanding of relevant concepts and terminology from both areas, including the metamodel (Figure 2) that provided a basis for the approach we used. Still, we acknowledge the possibility that a different interpretation of BPM or WST, a different metamodel, or an altogether different theory might have generated different results.

Interpretation of the literature. We illustrated our set of revised and new use cases based on our interpretation of the literature in BPM and other fields. This effort does not equate to a systematic review of the literature. We also do not claim that our paper represents a comprehensive understanding of all BPM research. Our paper is in itself a response to such a systematic literature review (van der Aalst 2013). Also, a number of systematic and thematic literature reviews exist in the BPM literature (Sidorova and Isik 2010; van der Aalst 2013; Recker 2014; Recker and Mendling 2016). Given the recent publication of these reviews, it seemed unnecessary to reiterate the same content, especially since doing so would have expanded the paper's length significantly and probably would not have led to more or better suggestions for improving or extending the previous BPM research use cases.

Acknowledgments

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