11-30-2009

A Theory of Clinic-EHR Affordance Actualization

Diane M. Strong
Worcester Polytechnic Institute, dstrong@wpi.edu

Olga Volkoff
Simon Fraser University, ovolkoff@sfu.ca

Sharon A. Johnson
Worcester Polytechnic Institute, sharon@wpi.edu

Lori R. Pelletier
Worcester Polytechnic Institute, pelletier@wpi.edu

芽|Sprouts Working Papers on Information Systems ISSN 1535-6078

A Theory of Clinic-EHR Affordance Actualization

Diane M. Strong
Worcester Polytechnic Institute, U.S.A.

Olga Volkoff
Simon Fraser University, Canada

Sharon A. Johnson
Worcester Polytechnic Institute, U.S.A.

Lori R. Pelletier
Worcester Polytechnic Institute, U.S.A.

Isa Bar-On
Worcester Polytechnic Institute, U.S.A.

Bengisu Tulu
Worcester Polytechnic Institute, U.S.A.

Nitu Kashyap
Fallon Clinic, U.S.A.

John Trudel
Fallon Clinic, U.S.A.

Lawrence Garber
Fallon Clinic, U.S.A.

Abstract
To build theory about how to achieve expected benefits from a system implementation, we conducted a longitudinal study of the implementation of an electronic health record (EHR) system at a multi-site clinic using grounded theory methods and a critical realist perspective. We developed a mid-level process theory of how clinics actualize affordances arising from the implementation of an EHR. In so doing we complement the work of Markus and Silver (2008) in their application of Gibsonâ s Affordance Theory to the understanding of IT effects on organizations. Specifically, we replace the DeSanctis and Poole (1994) concept of appropriation with a new concept, actualization, and show how the individual level journeys of users as they actualize affordances as perceived from their various personal perspectives result in the organizational level outcomes. In building this mid-level theory, we identify the central affordances pertaining to the clinic-EHR relation and in so doing, provide an example of how to define affordances and how to conduct empirical studies using an Affordance Theory lens. Our theory should prove useful to practitioners implementing such systems.

Keywords: Electronic health records, affordances, critical realism, grounded theory

Permanent URL: http://sprouts.aisnet.org/9-47

Reference: Strong, D. M., Volkoff, O., Johnson, S. A., Pelletier, L. R. , Bar-On, I., Tulu, B. , Kashyap, N., Trudel, J., Garber, L. (2009). "A Theory of Clinic-EHR Affordance

Actualization," Proceedings > Proceedings of JAIS Theory Development Workshop .
Sprouts: Working Papers on Information Systems, 9(47). http://sprouts.aisnet.org/9-47

EHR Affordance-Actualization Theory

Diane M. Strong

Center for eHealth Innovation and Process Transformation
Worcester Polytechnic Institute, Worcester, MA, U.S.A.

Olga Volkoff

Simon Fraser University, Burnaby, B.C., Canada

Sharon A. Johnson

Center for eHealth Innovation and Process Transformation
Worcester Polytechnic Institute, Worcester, MA, U.S.A.

Lori R. Pelletier

Center for eHealth Innovation and Process Transformation
Worcester Polytechnic Institute, Worcester, MA, U.S.A.

Isa Bar-On

Center for eHealth Innovation and Process Transformation
Worcester Polytechnic Institute, Worcester, MA, U.S.A.

Bengisu Tulu

Center for eHealth Innovation and Process Transformation
Worcester Polytechnic Institute, Worcester, MA, U.S.A.

Nitu Kashyap

Fallon Clinic, Worcester, MA, U.S.A.

John Trudel

Fallon Clinic, Worcester, MA, U.S.A.

Larry Garber

Fallon Clinic, Worcester, MA, U.S.A.

Prepared for
JAIS Theory Workshop at ICIS 2009

Corresponding author:
Diane M. Strong
dstrong@wpi.edu

A Theory of Clinic-EHR Affordance Actualization

Abstract

To build theory about how to achieve expected benefits from a system implementation, we conducted a longitudinal study of the implementation of an electronic health record (EHR) system at a multi-site clinic using grounded theory methods and a critical realist perspective. We developed a mid-level process theory of how clinics actualize affordances arising from the implementation of an EHR. In so doing we complement the work of Markus and Silver (2008) in their application of Gibson's Affordance Theory to the understanding of IT effects on organizations. Specifically, we replace the DeSanctis and Poole (1994) concept of appropriation with a new concept, actualization, and show how the individual level journeys of users as they actualize affordances as perceived from their various personal perspectives result in the organizational level outcomes. In building this mid-level theory, we identify the central affordances pertaining to the clinic-EHR relation and in so doing, provide an example of how to define affordances and how to conduct empirical studies using an Affordance Theory lens. Our theory should prove useful to practitioners implementing such systems.

Key words: Electronic health records, affordances, critical realism, grounded theory

A Theory of Clinic-EHR Affordance Actualization

Introduction

Organizations invest in information technology (IT) to achieve a variety of benefits, such as greater efficiency or improved quality, yet too often outcomes fall short of expectations (Ashurst et al., 2008). The concept of "affordances" from ecological psychology provides a lens for examining IT effects in organizations (Markus and Silver, 2008; Zamutto et al., 2007). In this paper we argue that the affordance lens is key to analyzing the connection between IT and benefits realization. In particular, understanding how affordances are "actualized" can help us diagnose and treat problematic relationships between technology and organizations.

In our longitudinal study of an Electronic Health Records (EHRs) implementation in a multi-site medical group practice, we used grounded theory methodology to identify salient affordances embedded in the EHR-health care provider relationship. We then explored how these affordances were actualized and identified key components of actualization that should be consciously managed during EHR implementation.

In the following sections, we discuss several definitions of the affordance concept, and the Markus and Silver (2008) proposals for how it should be used in the study of IT effects. We then examine the concept of "actualization" before presenting our research site, our methodology, the data and our findings.

Affordances

Gibson's (1979/1986) concept of affordances, arising from his study of what and how animals perceive their surroundings, reflected his belief that animals do not perceive a collection of minute details about an object and then mentally compute its collective

utility, but directly and holistically perceive what the object will enable them to do. Affordances, then, are what is offered, provided, or furnished to someone or something by an object (Gibson, 1986). For some years after Gibson proposed this concept other ecological psychologists debated the details of its definition, in particular where affordances reside. According to some, they are properties of an object in the environment (Michaels, 2000; Stoffregen, 2000; Turvey, 1992). For others, they belong to neither the object nor the animal, but rather are "relations between the abilities of [animals] and features of the environment" (Chemero, 2003, p. 189). This latter definition has been winning support (Hutchby, 2001; Stoffregen, 2003) and, like Markus and Silver (2008), it is the definition we embrace.

Until recently, in IS research the concept of affordances was confined to human-computer interaction (HCI) studies and built on Norman's (1988) "perceived" affordances extension of Gibson's original conception (Norman, 1999). Two recent papers call for IS researchers to embrace Gibson's original version and employ it more broadly to study IT in organizations (Markus and Silver, 2008; Zamutto et al., 2007). Markus and Silver's (2008) award-winning paper proposes using the affordances concept as the basis for analyzing IT effects. They build on the concepts of spirit and structural features from Adaptive Structuration Theory (DeSanctis and Poole, 1994) and, taking a critical realist perspective, replace them with three concepts, namely technical objects, functional affordances, and symbolic expressions. A "technical object" is an IT artifact and its component parts. It has features that give rise to affordances, but those affordances are not a property of the object alone. "Functional affordances" are defined as the possibilities for goal-oriented action afforded to specified user groups by technical

objects (Markus and Silver, 2008, p. 622). Those possibilities are not infinite – certain possibilities are made available, but others are not, and in that sense affordances are not only enabling, but also constraining (Hutchby, 2001). Furthermore, it is not necessary for a user to have realized or *actualized* the affordance for it to exist, but some user who could actualize it must exist (Chemero, 2003).

Markus and Silver's (2008) third concept, symbolic expressions, is defined as the communicative possibilities of a technical object for a specified user group, specifically indicating how the technical object is to be used, and the goals and values of designers and users. It captures some of what DeSanctis and Poole (1994) included in their notion of a system's "spirit", but moves the focus from the object to the relation between the object and the user. It does not have a direct counterpart in Gibson's theory, largely because affordances are traditionally viewed as already incorporating values. According to Heft (2003, p. 155), "affective and motivational qualities are intrinsic to affordances. Awareness of affordances typically is an intertwining of knowing, feeling, and acting." Our study supports this view; in our data we could not easily separate opportunities for goal-oriented action from their associated meanings and values. For that reason, we do not distinguish between functional affordances and symbolic expressions, and refer to the two together simply as affordances.

Actualization

The existence of an affordance is not, however, enough for a user to derive benefits; the user must take action. Markus and Silver (2008) utilize the DeSanctis and Poole (1994) term "appropriation" to describe this process, and because this concept has been well discussed in the literature, they do not explore it further. The problem is that

appropriation focuses on system features, and whether or not users employ those features in a manner that is "faithful" to design intentions. There may, however, be no relationship between degree of faithfulness and the achievement of benefits (Majchrzak et al., 2000). In place of "appropriation", we propose the concept of "actualization", or the active engagement of a user with an affordance in pursuit of specific goals as made possible by the affordance. Thus, instead of looking back at the technical object and its features and spirit, we look forward to the desired outcomes and explore actualization, the process of attempting to achieve those outcomes.

This paper makes several contributions. First, from our data we develop a grounded process theory of how health care (HC) clinics actualize affordances arising from the implementation of an EHR. Because affordances are specific to the relation between a particular technical object and a specified potential or actual user, we have developed a mid-level rather than a grand theory; for practitioners this may be more useful. That said, our mid-level theory has elements that provide a template for other mid-level theories, or a higher level theory regarding the process of actualizing affordances. Second, we operationalize the theoretical definition of affordances by providing guidelines for researchers and specific examples of affordances in our study. Third, in describing how we uncovered the salient affordances and the components of the actualization process we provide an example of how empirical studies of affordances can be conducted. Finally, in examining the specific actions taken at our research site, we offer practitioners insights into how they may derive benefits from their EHR.

Methodology

In conducting our study we took a critical realist perspective, the same perspective underlying the Markus and Silver (2008) discussion of affordances. In fact the definition of affordances presumes a realist position: affordances exist even when they are not perceived or enacted (Hutchby, 2001; Chemero, 2003). They do not come into existence at the moment of system use (as assumed in constructivist perspectives), but exist prior to use. This aspect of the definition of affordances is well aligned with critical realism (CR) which posits that structures exist prior to being used, and that new structures may emerge after actions have been taken (Bhaskar, 1978; Archer, 1995).

CR also asserts that there are three nested domains: real structures or mechanisms that exist independently of our perception of them, actual events that those mechanisms could possibly (but may not) generate, and empirical events, the subset of the actual events that have been observed or experienced (Bhaskar, 1998; Mingers, 2002). Affordances are the "real" structures. As researchers we do not observe them directly, but they are the causal mechanisms that have the potential to produce a variety of events. Through "retroduction" (Mingers, 2004; Wynn and Williams, 2008), we work backwards from what we observe to create hypotheses regarding the mechanisms that must exist to have generated the empirical observations. The grounded theory methods we use are well suited to this process of working backward from observations because they are designed to uncover underlying social processes from empirical observations. Specifically, we use grounded theory methods to reveal the real structures/mechanisms, namely affordances, and the processes for actualizing them, from empirical data collected via interviews of HC providers and their support staff. The primary purpose of grounded

theory procedures is to generate theory, especially mid-level theory, based on interviews or observations of actions (Glaser, 1978; Glaser and Strauss, 1967; Locke, 2001).

Field Site

Our field site is a multi-site group medical practice located in the northeast U.S., with about 250 physicians and 1,500 other employees. It serves 200,000 patients with over one million patient visits per year. Each of its 25 clinic locations is responsible for its own performance and operates semi-independently, but there is also a strong central administration and regular communication and coordination across clinics.

This group practice is implementing a well-respected commercial EHR package providing features to support ambulatory care clinics across all its clinics, in several phases. The phase we observed implemented computers in the exam room, where HC providers enter data into each patient's electronic health record and generate orders for prescriptions and lab tests. The previous phase implemented electronic messaging to support communication among providers and to record phone interactions with patients. Each phase involves a gradual roll-out of the software by clinic site.

Data Collection

Data collection involved three rounds of interviews. First, we conducted baseline interviews shortly before the EHR went live in the exam room. These interviews focused on what work (tasks) individuals performed during a typical day and their initial impressions of how the EHR would affect their work. Alvarez (2008) refers to this time before actual use as the time of the imaginary IT when future users form impressions of the new system and anticipate its effects. These impressions are based on what

management and others informed about the implementation are saying, system demonstrations, and possible use of a training system.

Second, we conducted interviews about six weeks after the new system went live in the exam rooms. These second round interviews asked interviewees about what EHR features they used, what they most and least liked about the EHR, and how the EHR changed the way they did their work. At this time, users were highly aware of how the EHR was changing how they worked.

Finally, we conducted interviews one year after go-live, a point when users were likely to be proficient with the EHR. At this time, users had integrated the EHR into their work processes, and may have made significant changes in those work processes. Two researchers were present at each interview. Interviews were recorded and transcribed.

For each interview round, we interviewed primary care physicians and the associated staff (a practice manager, nurse, medical assistant, and non-clinical support person). That is, we conducted five interviews for each participating physician. Physicians were selected jointly by the clinic and the researchers to cover large and small locations, long established and newer physician practices, the three medical areas that comprise primary care (internal medicine, family medicine and pediatrics), and EHR supporters and doubters. For rounds one and two, six physicians participated, each from a different clinic location. Data from the first two rounds provided coverage across the variety of sites in terms of the implementation process and the initial reactions of providers to the EHR. For round three, we expanded our data collection to include four additional physicians and their staff, from four additional clinic locations. These sites, where individuals had begun to use the system in unexpected ways, were added in the

course of “theoretical sampling” (Glaser and Strauss, 1967) to ensure that the full spectrum of possibilities with respect to the emerging core categories (e.g., actualization) had been explored. Interviewees were given a small stipend for participating in round three. With few exceptions, the same individuals were interviewed in each round. Our findings are from these 110 interviews (30 in round one (R1), 30 in R2, and 50 in R3).

Data Analysis and Theory Building

We conducted data analysis in accordance with grounded theory methods. Specifically, we coded interview transcripts as we continued to collect data. We used the NVivo software package to support our coding and analysis process. The research team met weekly to review emerging codes and to ensure that we were coding consistently. Early interviews were coded by two coders. After consistency was established, each interview was coded by one researcher, usually one that was present at the interview, because presence at the interview provided better understanding of what the interviewee was conveying. When the data revealed interesting themes, we wrote memos about those themes.

During open coding, we coded each interview using codes the data suggested to identify broad themes, e.g., standardization of processes and roles, accountability effects. When few new open codes emerged (saturation was reached), we began axial coding to reveal dimensions of concepts and relationships among concepts for the major interesting themes that emerged during open coding. As axial coding progressed in each data collection round, we initiated selective coding to identify theoretical patterns through a process of constant comparison of similarly coded passages across interviews and through relating these data-driven patterns to existing literature.

We did not go into the field with pre-existing theoretical concepts. As we coded and noticed that different sites and different providers used the EHR features in different ways, but that use of particular features did not necessarily provide similar outcomes, we turned to the literature on IT-enabled change. In particular, we compared our findings to Markus and Silver's (2008) award winning paper and to DeSanctis and Poole's (1994) classic paper. The concept of affordances seemed to fit our observations, but the concept of affordances has only been proposed, not actually used, in the IT-enabled change literature. Our data, especially as findings emerged from our axial and selective coding, provided the basis for our articulation of an affordance-actualization process theory, as presented in the next sections.

Model of IT Affordances and their Actualizations

The general model of affordances and their actualizations that emerged from our data and our analysis of the affordances literature is shown in Figure 1. The left side of Figure 1, which presents affordances, is discussed in this section. The right side, which presents the process of actualizing affordances, is presented in the next section.

Guidelines for Specifying Affordances in an IS context

From the definition of an affordance as the potential for action arising from the relation between objects in the environment and an animal – or, in the IS context, between an IT artifact and its users, potential or actual – two guidelines emerge to help us with applying the concept of affordances to studies of IT effects.

> ***Guideline 1****: Affordances are related to, but must be carefully distinguished from, features of the IT artifact.*

When writing and thinking about affordances, it is easy to mistakenly conceive of them as properties of objects (Chemero, 2003), but they are distinct. The features of an

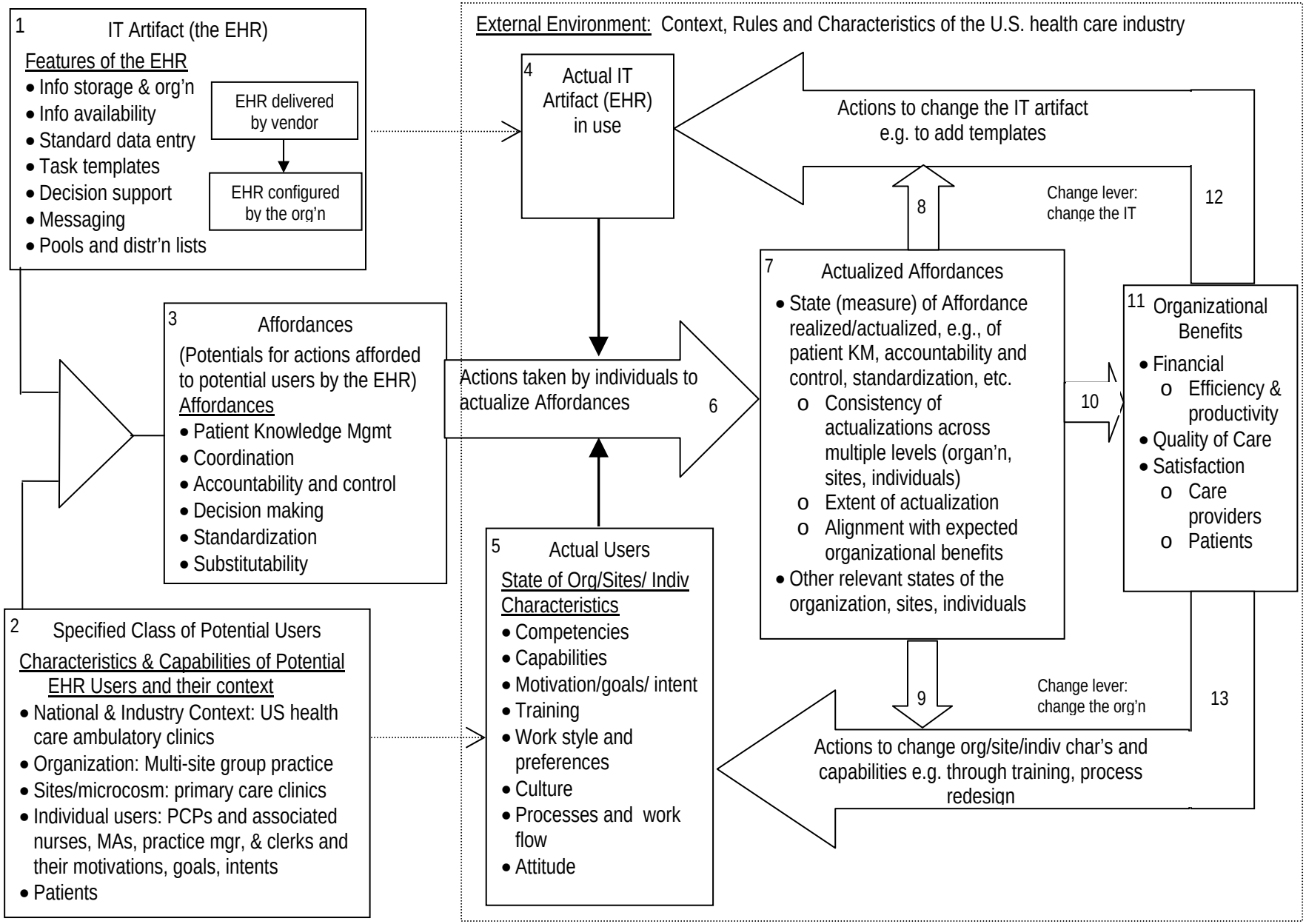

Figure 1: Affordances and their Actualization

IT artifact (Figure 1, Box 1) are its technical components, including the storage and organization of information, task templates, decision support features, and messaging functionality. These features, when viewed in relation to potential users (Box 2), give rise to affordances (Box 3), but are not affordances themselves. Furthermore, an IT artifact such as an EHR may evolve even before users have access to it, e.g., the artifact as delivered by the vendor and the artifact as configured by the organization (Box 1); as the features change, so too may the associated affordances.

> ***Guideline 2:*** *Affordances are related to, but must be carefully distinguished from, characteristics and capabilities of potential and actual users and the user context.*

While affordances are related to the users and their intentions (in an environment where no user exists who could actualize them, the affordances cannot be said to exist), they are clearly distinct from those users (Markus and Silver, 2008). This perspective differs from user-centric views of technology, such as those informed by Giddens' (1984) structuration theory, where technology itself has no structure except when it is being used (Rose et al., 2005). For affordance theory, we must not only distinguish the IT from the users and their organization, but also distinguish affordances from both of these. Affordance theory does not demand the presence of actual users, merely potential users, which we might think of as the class of users for which the IT was designed and/or purchased. The distinction between potential and actual users is not often made in the IS literature but, as we shall see, is helpful in understanding the challenges of benefit realization.

Traditional affordance literature discusses affordances in relation to individual "animals", but IT users are generally not independent entities, and work in an organization. An EHR is designed to be used in a HC organization, which is the third of

four levels often used to characterize the HC context (Berwick, 2002). At the lowest level is the experience of patients, those for whom HC is being delivered. At the highest level is the external environment, i.e., the national and industrial HC context, which may include organizations such as insurance companies, whose rules and practices may also affect EHR implementations. Our study does not explicitly study the patient experience, nor the external environment, but does acknowledge their relevance and influences.

We focus at the second level, the microsystem of care delivery, i.e., the care delivery processes at a particular site. In our study, these are the clinical sites where physicians, their staff and managers work. Above the microsystem or site is the HC organization, with its culture and common practices, which is also important in our study. Our affordances lens revealed another important level, that of the individual providers and non-clinical staff that form the microsystem of care delivery. While decisions about acquiring and using an EHR are made at the organizational and microsystem levels, it is individuals who are taking actions using the EHR, i.e., who choose how to actualize an affordance and whose actions affect benefit realization.

We must also remember that the user-system relationship is not the only source of affordances. Consider accountability, one of the affordances revealed in our data and discussed in the next section. The EHR provides the HC organization with the potential for greater accountability, but it is not the only source of accountability. Clearly the clinics we observed had various forms of accountability before the EHR was installed.

Using these guidelines, we present the affordances revealed in our data.

Table 1. Clinic – EHR Affordances

Affordance	Affordance Definition and Example from our Data	Supporting EHR Features	Supporting Org. Capabilities
Patient knowledge management	Ready access to well organized and complete data about every patient, with easy means of performing updates. "If I'm at a different site, seeing somebody else's patient, on a weekend, whatever, everything's there" (Physician, Clinic B)	Patient information stored and available real-time anywhere	Ability to add and update patient data by HC providers at any location Treat patient data as an overall clinic resource
Coordination	Prompt communication among HC providers and staff, including external facilities and entities. "If one of my patients sees a specialist this morning, I can read the note this afternoon" (Physician, Clinic G)	Messaging features Patient information stored and available real-time anywhere Features for defining pools, e.g., the nursing pool	Providers willing to use the EHR's messaging features for all patient-related communications Providers willing to use pools Timely production of physician notes for each visit.
Standardization	Adherence across the organization to a defined standard for all data, procedures, and roles. "Messages from nurses are better. It has forced them to ask standardized questions, with responses taken down in an order" (Physician, Clinic A)	Stored protocols for nurses and others on the phone with patients Forms for standard data, e.g., to record a note for a patient's physical exam Restricted access to EHR features by role	Intention and willingness of clinical sites to standardize
Accountability	Transparency of what has been done, when, and by whom, and resulting responsibility. "You make a mistake, you fix it. It's going to have your initials on it" (MA, Clinic F)	Audit trail, a record of exactly what was done, who did it, and when they did it	Willingness to use audit trail information
Substitutability	Creation of pools of workers who can act for each other. "It's in the pool, any nurse that receives that call, can pick up and find out what the patient requires." (Nurse, Clinic D, R3)	Standardization features (easier to substitute if roles are standardized) Audit trail information so can substitute into an incomplete process Messaging to pools, forwarding messages	Willingness to standardize roles, tasks, and data, to use pools and to share data
Decision making	Immediate treatment suggestions prompted by relevant relationships among parts of a patient record and relevant external knowledge. "It's giving you the pertaining tests which are needed for this diagnosis." (Physician, Clinic H, R3)	Various decision support features such as medication alerts that use patient data Easy access to online clinical references	Ability and willingness to practice evidence-based medicine through using EHR-collected data Ability and willingness to adopt decision support features

Six Clinic-EHR Affordances

Table 1 presents the six clinic-EHR affordances revealed from our data, namely *patient knowledge management*, *coordination* among providers and with various HC facilities, *standardization* of data, tasks, and roles, *accountability*, *substitutability* among providers, and *decision making* about diagnoses and treatments. Each affordance represents the possibility for a specific set of goal-oriented actions that could be taken by the clinic sites and their employees using the EHR. For each affordance, Table 1 provides a definition of the affordance and a short quote from our data. It also lists the EHR features supporting each affordance and the organizational capabilities that enable or impede it in actualizing that affordance.

To understand the process of actualization developed in this paper, we must start with a clear understanding of what an affordance is. Thus, we describe two of the six affordances in Table 1 in a little more detail, namely patient knowledge management and accountability. An expected affordance from installing an EHR in the clinic is better ***patient knowledge management***, which means enabling providers to always work with a complete and well-organized set of data about a patient whenever and wherever they want. Compare this to paper charts, which can only be in one location and thus are not always in the needed location. This affordance is distinct from the features of the EHR that support it. That is, the patient knowledge management affordance is not the same as the structure of a patient record in the EHR database or the facilities for real-time access of those records from many locations. It is a relationship between those features and the various clinical providers that enable them to provide better quality patient care.

Another expected affordance from installing an EHR in the clinic is greater ***accountability***. The accountability affordance means transparency, i.e., everyone in the clinic knows what was done, when it was done, and by whom, and thus enables responsibility for accomplishing the objectives of one's role. While the EHR has features, in particular its audit trail, that provide the information needed for transparency, the audit trail feature is distinct from the accountability affordance which is defined in relation to an individual who is accountable for their actions. The clinic-EHR accountability affordance is also distinct from various organizational capabilities and characteristics, e.g., reporting relationships, designed to facilitate accountability without the EHR. Similarly the accountability affordance is distinct from individual characteristics and capabilities. For example, those working in HC tend to be concerned about delivering high-quality care and thus individually are already very responsible for their actions.

The six affordances emerged during open coding of our data (although not yet labeled as affordances). These potentials for action were clearly apparent to those involved with the EHR. As we moved to axial coding, it became apparent that individuals had differing views of these affordances. The six affordances as presented in Table 1 capture the viewpoint of the clinic as a whole, essentially capturing the perspective of the managers purchasing the EHR. To describe an affordance in a meaningful way, we must be more specific about the class of users.

How the Accountability Affordance differs by Role

In our data, and more generally in the HC context, the various roles of medical staff provide a defined class of users. In our study, we have data from five roles: physicians,

nurses, medical assistants (MAs), non-clinical support staff (e.g., check-out secretaries), and practice managers. To demonstrate the difference between the organizational or clinic level concept of affordance and individuals' concept of affordances, we examine the accountability affordance as described by a variety of respondents in each of these roles. While the accountability affordance differs for various individuals, the primary EHR feature supporting the accountability affordance, its audit trail (see Table 1), does not change. The meaning of the accountability affordance – the potential it holds for action – is what differs across individuals. In our data, the meaning of the accountability affordance to individuals differed primarily by their role, as summarized in Table 2, and described below.

In our data, the physician's view of the accountability affordance was that it supported their professional, legal, and ethical responsibility for a patient's care, and enabled them to ensure the patient was receiving the care they ordered. In contrast, nurses interpreted the accountability affordance as enabling them to do everything a physician requested, exactly as the physician requested because it was all recorded in the EHR, and thus they could no longer be blamed for various problems. Most of the MAs did not mention accountability because it had little effect on their job of rooming patients and recording patient vitals in the EHR. They did take care to fix any typing errors because they knew the EHR recorded what they did. Like nurses, non-clinical staff knew exactly what the physician had ordered and could ensure they handled their part of placing the order. In addition, accountability meant they knew what tasks they needed to do and when they had completed their work. Finally, practice managers interpreted the accountability affordance as enabling them to do process improvement. Practice

managers were not concerned about their individual accountability, but with using the audit information to solve problems and improve the care delivery process.

Table 2. Accountability Affordance by Role

Role	Individual-level Accountability Affordance	Example from our data
Physician	I can ensure that patients receive the care I ordered.	I know that things don't get missed. … even if the patient does not stop at the desk, the order is there. (Physician, Clinic H, R3) You can follow up to see if somebody really has done something … so it's the rare occasion when somebody isn't doing their job. (Physician, Clinic C, R3)
Nurse	I can do exactly what the physician requested and cannot be blamed for any problems	Nothing is hanging. It would be a doctor's error if something was hanging, not a nurse error. (Nurse, Clinic I, R3)
Medical Assistant	I should be sure not to make mistakes in recording vitals	It's got your name there because you logged in (MA, Clinic E, R3).
Non-clinic Staff	I know what the physician wants I am better able to track my work -- what is completed and what remains	Everything that the doctors ask for, it's all right there. (Secretary, Clinic F, R3) It makes me feel better at the end of the day, than to leave piles and piles on my desk. (Secretary, Clinic A, R3)
Practice Manager	I have the information I need to manage the process and initiate process improvements.	Not so that I can point fingers. It's more for problem solving and re-education. … Look for trends in the process. …Or if there was an error, what happened? And why? (Practice Manager, Clinic J, R3)

From our data, we see how the different user roles affect how they interpret and give meaning to an affordance, and thus what potentials for action they see. While interpretations of affordances clearly differ across roles, they also (although less prominently in our data) differ across clinic sites. Similarly, we would expect differences in affordances across organizations. These user-related differences observed in our data reinforce the theoretical definition of affordances as a relational concept. Specifically, the various characteristics and capabilities of users matter; IT effects are not determined

solely by the features of the IT. Nor are benefits likely just because those selecting the software see relevant organizational level affordances.

Actualization of Affordances

Why and how users choose to actualize an affordance is key to understanding how and why IT artifacts produce organizational effects. It is only when affordances, the potentials for action, are actualized by individual users that they produce desired benefits (and unintended outcomes) for organizations. Thus, we turn to the process of actualizing affordances, the right side of Figure 1.

Actualized Affordances and their Effects on Organizational Goals

We first discuss the outcomes, i.e., the characteristics of actualized affordances (Box 7) and their connection to organizational goals (Box 11) so we can refer to them as the actualization process is discussed. In the term "actualized affordances" (Box 7), we include both changes to work processes and the direct outcomes of those processes. Actualized affordances may produce processes that function very similarly to the way they did before the EHR was installed, or they may represent major changes, such as more standardized data and processes, better decision-making, and better coordination. As a result, actualized affordances may or may not produce organizational benefits in terms of the goals of the organization.

Organizations install an EHR because managers expect to achieve organizational benefits (Box 11). The organizational outcomes of care delivery processes can be characterized into three broad categories of measures: (a) financial (i.e., lower costs, higher revenues, and efficient resource usage), (b) quality (i.e., extent to which patients receive sufficiently high quality care when they need it), and (c) satisfaction (i.e., care

providers' satisfaction with processes and the work environment, and patient satisfaction with treatment). These desired organizational outcomes overlap with, but are not the same as, Berwick's (2002) six aims for improving the U.S. HC system, namely safety, effectiveness, patient centeredness, timeliness, efficiency, and equity.

Organizational benefits do not arise directly from EHR implementation, but indirectly via individual use (Delone and McLean, 1992; Goodhue and Thompson, 1995; Soh and Markus, 1995). In our model, individuals as they perform the work activities of their role using the EHR (Arrow 6) are taking actions that lead to actualized affordances (Box 7), which in turn lead to organizational benefits (Box 11).

The Actualization Process

While pre-actualized affordances (Box 3) are often thought about at the clinic or organizational level, their actualization occurs at the individual level as users engage with the EHR in performing their work tasks (Arrow 6). As they interact with the EHR and its information, users develop an understanding of the EHR, including an understanding of the affordances, and the meaning of those affordances, both for themselves and their organization. For each user, the affordance is somewhat different, reflecting a personal understanding of the objectives to be achieved.

When actualizing affordances, users are enabled and constrained by their own capabilities and characteristics and those of their organization (Box 5), and by the features of the EHR (Box 4). As they do their work, users implicitly and explicitly assess the state of their actualizations (Box 7), and change their actions as needed in response to those assessments (Arrow 9). They may also change, or request changes to, the EHR (Arrow 8). Similarly, at the clinic or organizational level, organizational benefits may or

may not be achieved (Box 11), resulting in managerial actions to change the organization, clinic, or the users (Arrow 13) or the EHR (Arrow 12).

We organize our presentation of the actualization process using critical realism's time stratification of (1) pre-existing structural conditions, (2) the actions taken by individuals to actualize affordances, and (3) the resulting changes to the structural conditions. For each of these three general components of the actualization process, several dimensions emerged from our data, as shown in Table 3.

Table 3: The Actualization Process

Components of Actualization Processes	**Dimensions**
Pre-existing Conditions enabling and constraining actualizations	Pre-existing organizational and individual characteristics and capabilities
	Pre-existing features of the EHR
State of Actualizations	Consistency of Actualizations
	Extent of Actualizations
	Alignment of Actualizations
Revised Conditions enabling and constraining actualizations	Revised organizational and individual characteristics and capabilities • Corrective changes • Improvement changes
	Revised features of the EHR • Corrective changes • Improvement changes

Pre-existing Conditions

The actualization process takes place in an existing context of organizational and user characteristics and capabilities (Box 5) and an installed EHR (Box 4). This context represents the existing structural conditions in which users interact with the IT artifact (Volkoff et al. 2007).

Organizational and Individual Characteristics and Capabilities that Enable or Constrain Actualizations

At the individual level, *computer capabilities* are one source of variation in the ability to actualize. The history of low computer use in clinical settings means that many providers have never been required to use computers in their work. For example,

> I'm not great on the keyboard. I'm old enough that I'm post PC generation, so for me to enter documentation on the keyboard is not very practical. (Physician, Clinic G, R2)

> No problem with the computer. I use it all the time, in the office, at home. (Physician, Clinic B, R1)

Across all roles, such variation in computer experience was observed. Difficulty with basic computer use was more frequent for physicians and nurses, and less frequent for MAs who were usually younger.

> It's an age thing, because you got to remember the average age of a nurse, at [this clinic] is in his or her forties. So we haven't grown up with computers. (Nurse, Clinic F, R2)

Individuals' actualization actions may also be influenced by their *attitudes* toward the EHR. For example, physicians viewed the exam room computer as a "third person in the room", but they varied in their attitude toward this third person. Some thought it interfered with their ability to communicate with, and get information from, patients, while others thought of it as an assistant that could, on-demand, provide history in a graph, e.g., of blood sugar levels, thus, enabling better communication with patients.

The clinic sites also varied in their ability and interest in trying new things, leading some clinics to be more *proactive* in exploring what the EHR could do for them. For example, at several sites, nurses doing phone triage took actions to encode physician rules into the system (with physician approval), which empowered nurses to take more actions on the phone. At other sites, nurses did not take such actions. While our data

provided examples of some sites being more proactive both with the EHR and with other activities than other sites, the reasons for such differences were not obvious.

That individual characteristics and capabilities, such as computer expertise and attitude toward the EHR, matter should not surprise IS researchers. These constructs are often included in our models of technology acceptance and task-technology fit. What the IS literature has explored less thoroughly is what these individual and site differences mean for the process of implementation. In our model, these are the existing conditions that individuals experience as they take actions to actualize affordances. This means that the process of actualizing affordances is an individual journey, experienced differently by each person depending on their individual capabilities, characteristics, and viewpoints.

EHR Features that Enable or Constrain Actualization

EHR features may enable or constrain users' ability to actualize affordances, that is, the EHR's design may be a good or poor fit with the tasks users are trying to perform. To the extent that the EHR is a poor fit, users will need to do extra work to perform their tasks. When asked what they liked best and least about the EHR, most users had a number of positive comments and fewer negative comments, but there were definitely ways in which the EHR did not provide good support for their work tasks.

One common complaint was that any patient's chart could only be open by one person at a time.

> Two people cannot be in the same chart at the same time, so sometimes I'll have to write it on a paper and give it to the doctor, but I cannot put it in [the EHR] until the doctor is done with their section. (MA, Clinic H, R3)

This restriction constrained the ability of different offices to coordinate, e.g., someone from a primary care office could not be looking at the chart simultaneously with a specialist office, making it more difficult for users to coordinate patient care.

Another common complaint was the time it took to use the EHR because it required many steps to do things, as indicated by the following nurse, or required users to answer the same question multiple times, as indicated by the following physician.

> Just the non-user friendly, lack of uniformity or simpleness. I just wish it could be a little simpler so we could understand it and do it without having to refer to a paper … I just wish it could be a little bit easier, a little bit quicker and simpler (Nurse, Clinic A, R2)

> You go into the system, you type in bone mineral density, and then a screen will pop up and will ask you when do you want to have it done, and then it asks you why you want to have it done. Well OK, those are reasonable questions. Although I could argue that it should be one click, and then I have to actually have to order it. When I order it, it will ask me, when do you want to have it done, and why are you doing this? So I have to answer those questions twice. (Physician, Clinic D, R3)

A common complaint from all providers (physicians, nurses, and MAs) was the medical vocabulary of the EHR. This was especially frustrating to physicians because they are well trained to use exact medical terminology, which the EHR did not recognize.

> If you use certain words that you're used to, the computer isn't and it kicks out phrases. So you can't say osteoarthritis of the knee anymore, … You end up making up a diagnosis that you ordinarily have used for umpteen years that you can't use because the stupid machine won't take it. (Physician, Clinic C, R3)

Such computer system problems are not surprising to typical computer users nor to IS researchers, especially those who have studied the many user complaints about enterprise systems. HC providers, however, who are more experienced with medical devices that require FDA approval, are surprised to be asked to use systems with what they perceive as obvious flaws. Despite the problems, the EHR overall provided good support with few constraints to accomplishing the work of each of the roles in the clinic.

State of Actualizations

Actualization of an affordance is an individual level activity (Arrow 6), but for an organizational level system such as an EHR, the resulting actualization state (Box 7) is the state of resulting clinical level processes. Because the actualization process is carried

out by many users, each enacting their individual actualization journey, the state of the resulting actualizations depends on how well these individual actions contribute to the whole. In our data, three dimensions captured the resulting state of the actualizations, their consistency, extent, and alignment.

Consistency of Actualizations

Because actualization is an individual level activity, but the resulting actualized affordance is typically at the clinic or organizational level, consistency of those individual actualization actions matters. Our data indicate that actualization is more likely to achieve desired benefits if the actualizations are consistent across users. Consistency ensures that the actions of users jointly serve to actualize the affordance; inconsistent actions may interfere with each other. Consistency means that the actualizations are compatible, not necessarily the same.

Consistency with the actualizations of other users includes both users in the same role and users in different roles. Actualizations were generally consistent with others within the same role because of similarity of meaning and intent within roles, but not always. For some actualizations, user actions differed based on individual computer capability and attitude. For example, some nurses liked phone scripts because they helped ensure completeness and thus used them, while other nurses thought scripts interfered with a process in which they were expert, and thus rarely used them. The more computer capable physicians were able to use the EHR more effectively to ensure that tasks were completed. By the end of one year of use, even some of the physicians with limited computer abilities had managed to use the accountability data to ensure that orders did not fall through the cracks.

Because users in different roles are working from different meanings and intentions, their actualizations may be less consistent. In our data, actualizations across roles were occasionally inconsistent. For example, practice managers worked to standardize MA tasks so that MAs were more easily trained and could substitute for one another. Some physicians, however, asked MAs to tailor their work to the physician's particular individual style, that is, some physicians chose not to actualize MA task standardization.

Extent of Actualizations

A second dimension of the state of actualizations is the extent of those actualizations, which captures how much actualization is accomplished. Users may not actualize affordances to an extent that provides organizational benefits. Over time, the organization expected the EHR to help it improve the quality of care delivered, achieve financial benefits, and increase the satisfaction of its patients and its employees. It expected financial benefits in the first year or two (1) by eliminating the costs of paper charts, including the cost of vans to transport charts each day as patients visited different clinic sites, e.g., to see a specialist, (2) by eliminating or reducing the costs of transcribing physician notes as physicians moved from dictation to typing their notes, and (3) by increasing revenues through more timely and complete billing.

All of these immediate financial benefits depended on sufficient actualizations by individual physicians. For example, the organization could not realize the cost savings of eliminating paper charts and their transportation until physicians stopped requesting those paper charts and used the electronic records instead. Similarly, while some physicians switched at least partially to typing their notes, others continued to use dictation, resulting in continuing costs for transcribing notes.

> I have always loathed dictating. you tell me I got to get rid of that? I was very happy. (Physician, Clinic A, R2)
>
> I've cut my dictations in half so I'm not going back and reviewing and signing dictations, so that helps. (Physician, Clinic G, R2)
>
> I think most physicians including myself still do an awful lot of dictation because … I haven't established a flow as of yet. So it's still uncomfortable. (Physician, Clinic C, R2)

The second quote above was typical. Physicians switched to typing for simple, well-structured patient visits, but retained dictation for more complex visits. The extent to which they switched was influenced by their basic computer and typing expertise and by their mix of patients, i.e., the percentage of their patients with complex problems. Unfortunately, the older, more experienced physicians with fewer computing skills were also more likely to have patients with complex problems. Switching to typed notes was also influenced by their attitudes toward templates for notes and the resulting de-personalization of their notes. This differing extent of actualization across individuals directly affects whether expected organizational benefits are achieved.

While switching from dictation to typed notes provides a financial benefit by reducing transcription costs, it was also important for actualizing the patient knowledge management affordance, and thus providing better quality care. For example,

> The notes, I had a patient call in, went to specialty the day before, put a phone call to us the next day, and I could actually read that specialty note, which helped me, you know, in resolving whatever the issue was. (Nurse, Clinic J, R3)

Typed notes provide more timely patient information because they are immediately available. In contrast, dictated notes involve delays due to the transcribing process of sending dictated files to a transcription service and subsequent physician review and approval before they were made available. Furthermore, transcribed note review is often delayed because physicians are busy. In addition, as noted earlier, the management and the culture at each clinic served to encourage users to a greater extent of actualization or

to constrain them to lesser actualization. Some users became proactive and took actions to actualize beyond what anyone had planned or expected.

Alignment of Actualization

A third dimension of the state of actualizations is the alignment of actualization actions with organizational goals. Achieving benefits from the EHR not only requires consistency among user actualizations and a high extent of actualization, but also that user actualization actions are aligned with organizational goals.

For the most part, our data shows alignment between the actualization actions of individuals and the goals of the organization. In the previous section, we identified several reasons for the low extent of actualization sometimes observed, including the complexity of patient conditions and the lack of adequate computer skills. Another reason for the lack of actualization extent could be a reluctance to actualize that occurs when individual goals are not well aligned with the organizational goals. For example, several physicians preferred not to give up paper charts and continued to ask for them, but because the electronic records did not always have the complete patient history, there were also valid reasons to ask for paper records. We did not identify clear misalignment problems in our data, partially because it is difficult to distinguish the valid reasons for staying with the status quo from reluctance to change. Specifically, some users were determined to learn quickly and improve their skills, while others were still struggling with basic computer use one year after go-live. For example,

> I, within a week, was not dictating any notes any longer, which for me was a major goal for the system to not have that there. (Physician, Clinic A, R2)

User capabilities and attitudes toward using the EHR affected not only their ability to actualize affordances, but also their willingness to do so.

Revised Conditions

As Figure 1 shows, the actualization process is dynamic; it is an on-going process. As users and their managers observe and assess their actualizations (Box 7) and the resulting organizational benefits (Box 11), they may adjust the EHR (Arrows 8 and 12) or adjust the characteristics and capabilities of users and the organization (Arrows 9 and 13), resulting in revised conditions enabling or constraining actualizations. In our data, many of the feedback-based actions taken soon after implementation focused on correcting problems with using the EHR. At some point, the focus of feedback-based actions shifted from corrections to process improvement. For example with the accountability affordance, the initial focus was individual accountability, but over time it shifted to system-wide or process accountability.

The actions taken to change the features of the EHR or the characteristics and capabilities of the organization and individuals can be initiated at a variety of levels. Actions can be taken by individuals as they perform their daily tasks or request changes to the EHR. They can be taken by a particular microsystem (clinic site) as practice managers initiate additional training for some providers, or by the organization, e.g., teaching lean or process quality principles to providers or paying vendors or consultants to make changes to the EHR. Finally, actions may be taken by the industry, such as insurance companies increasing compensation to organizations that submit transactions electronically or vendors making substantial changes to the capabilities of EHRs.

Revised User and Organizational Capabilities and Characteristics

While the organization was willing and able to revise the EHR as requested by users, changing organizational elements rather than the EHR was often a more appropriate solution. For example, some problems were specific to particular individual

actualization journeys, and thus individual solutions were often appropriate. In addition, changing the organization was sometimes easier because changes could be implemented locally without assistance from others.

The most apparent method for revising user capabilities early in the implementation process was training. Training before go-live was designed to provide basic familiarity with the EHR, not proficiency. The organization's management was realistic in acknowledging that most training must happen on the job as patients are served. Thus, during the first week of go-live, physicians were assigned individual trainers and worked to a 50% schedule (each patient had a double slot). Physicians continued on a 25% reduced schedule for two more weeks with trainers coming less frequently. As a result of this training design, each physician had a trainer they knew well and could call any time. This provided the foundation for the organization's one-on-one on-demand training. Anyone could schedule personal one-on-one training. In addition, the practice manager often scheduled additional training for a group of people in the same role, and IT, which monitored usage, also sent trainers when they detected less than optimal usage patterns. As a result, as users became ready for more advanced training to help them use the EHR more efficiently and effectively, trainers were sent to user sites to train users as they worked, pointing out ways to use the EHR better.

The focus immediately after implementation was on individual accountability in using the EHR. Everyone was learning how to use the EHR and how to work so that there were no unexpected results. Problems arose including users making mistakes that resulted in the system doing something unexpected and tasks falling through the cracks

so required actions were not taken. For example, a nurse discovered that the system had unexpectedly sent in a prescription:

> And I did it. It was me. … one pharmacist, it was a local one, called me up and said, this is kind of weird. And I said yeah. It is, it's weird. … I didn't even know I was ordering those scripts. (Nurse, Clinic F, R2)

Avoiding such events might require organization-wide changes, or only local changes for a few individuals who needed more training.

Management also set up regular sessions by roles, e.g., physician sessions, practice manager sessions, or nurse sessions, to discuss such problems and to share solutions. Early on, these sessions focused on problems using the EHR. Later they focused on initiating process improvements to make better use of the EHR and improving care delivery processes. Users would try out ideas shared at these sessions at their sites, perhaps adapting them to the particular characteristics and capabilities of their site and users. In addition, process improvements were initiated by groups of providers or by practice managers, sometimes in their local microsystem, sometimes across most clinics.

Practice managers used the audit information to recognize when additional training might be needed to help someone along their individual actualization journey. They also used it to manage real-time from their office because they could see backlogs and things not getting done and could re-allocate some staff. As physicians identified problems regarding completion of items ordered for patients, they brought these problems to improvement groups for recommendations. Nurses used the audit trail of contacts with patients to develop better ways to serve patients on the phone.

One problem that became apparent after go-live was a significant increase in physician workload for all physicians. Recognizing that physicians could not, and would not, continue to work an extra hour or two each day on top of their already long days,

management convened a physician workload task force. As a result, a number of experiments were undertaken at various sites, depending on the needs and interests of each site. One such experiment was assigning an MA as a scribe to physicians having difficulty with the amount of typing. While it was ultimately decided that scribes were not a good general solution, scribes did work well for a few physicians, who continued to use them when interacting with the EHR, enabling them to actualize affordances to the same extent as more computer proficient physicians.

In our data, individual users reported assessing their actions and the results of those actions. They were seeking to understand the system, to actualize the affordances, and to change themselves and their colleagues in ways that allowed them to better actualize affordances. As the above examples highlight, practice managers and organizational management were active in responding to problems with using the EHR. Their responses were important because some problems, even ones involving only a few users, required an organizational or site level response because a good solution was beyond what an individual could do.

Revised EHR Features

As typical of any large organizational system, the EHR itself underwent a number of changes after go-live. Early in the implementation process, a number of small but important problems with the EHR were fixed as users identified them. For example, the EHR's library of medical terms was gradually improved as users requested changes.

> Something as simple as an ANA anti-nuclear antibody is not in the dictionary. (Physician, Clinic A, R2)

Users were encouraged to collect and report things they did not like about the EHR.

> We were told that if we find something about [the EHR] that we don't like, to make a list, so that's one of the things we're doing (Nurse, Clinic A, R2)

The EHR is programmable in the sense that users can develop tailored templates. Physicians were allowed to create their own templates, and some did. While templates were developed before go-live, after physicians learned the EHR, they better understood which templates were needed and how they should be designed. As a result, new templates were developed and earlier ones were modified. Some templates were for individual use, while others were for groups of physicians, depending on whether a common solution was appropriate. Physicians could develop templates themselves or they could ask IT to develop them. IT would also develop templates for any user requesting them, which was one way the organization supported individual level actualization journeys.

An example of organizational level efforts to revise EHR features occurred when it became apparent that many physicians were not able (or perhaps willing) to type notes for complex cases. The organization searched for another solution for producing typed notes without requiring physicians to type them all. As a result, they implemented software that converts voice to text, so that physicians could still dictate, but that dictation would be converted to a text note by the software rather than being sent to a medical transcription service. This was an acceptable solution for both the organization and for physicians. It enabled physicians to align their actions, and the extent of those actions, with the organizational goal of digital notes available in near real time, through various methods tailored to the capabilities of individual physicians.

As part of a physician workload task force, the organization sanctioned the encoding of individual physician rules into the EHR as templates for triage nurses to

follow for simple cases, e.g., urinary tract infections and sore throats. Nurses then worked with physicians and with IT to develop physician-approved templates.

The above examples are not intended as a complete list of revisions to the EHR, but serve to highlight a few salient changes or types of changes apparent to users. As a result, the EHR is not a constant; it is evolving as users add templates and request changes and as managers search for solutions to ease the difficulties some users were having with the EHR. The EHR was changed in ways that supported and were tailored to individual users.

> They've taken us staff's suggestions to the group that we purchased it from and said these are the five enhancements that we want. So it's very helpful. I like that relationship. So we're constantly like building on what we have. (Practice Manager, Clinic J, R3)

In summary, our data revealed seven dimensions of the actualization process, grouped into three components, that explained how and why affordances were actualized (see Table 3). The first component was the pre-existing structural conditions. The two dimensions, the pre-existing organizational and individual characteristics and capabilities and the pre-existing features of the EHR as delivered for use, were the starting conditions that constrained or enabled user actions. The second component was the state of the actualizations. Because actualization is an individual level process, the consistency, extent, and alignment of individual user actions were key for actualizing organizational level affordances. The final component is the revised structural conditions, resulting from changes to the EHR and to the organizational and individual characteristics and capabilities based on observing the actualized affordances and associated organizational benefits. These revised conditions served to continue the process of actualization and thus were important for actualizing affordances and achieving organizational benefits.

Discussion

The affordance-actualization-feedback (AAF) model shown in Figure 1 presents a specific AAF instance, one relevant for EHRs implemented in health care clinics, but also provides a template for the affordance actualization process in general. With this model, we have not only acted on the suggestions of Markus and Silver (2008) and Zammuto et al. (2007) to utilize an affordance lens based on a critical realist perspective, but also, by using "actualization" instead of the DeSanctis and Poole (1994) concept of "appropriation", we have picked up where Markus and Silver (2008) left off, and completed the task of building a model that explains the organizational effects associated with the introduction of IT. The affordance-actualization (AA) lens also addresses injunctions in the IS literature that models of IT effects in organizations should somehow address the materiality of the IT artifact, the non-deterministic process by which IT leads to organizational effects, the multi-level nature of IT-enabled change processes, and the intentionality of managers and users as agents of change (Orlikowski and Barley, 2001; Monteiro and Hanseth, 1996; Burton-Jones and Gallivan, 2007; Boudreau and Robey, 2005; Leonardi and Barley, 2008). Several observations regarding our model illustrate the advantages of employing an AA lens over the many other conceptualizations that have been employed to study IT effects in organizations.

In explicitly acknowledging both the materiality of the IT artifact and that this materiality can shape and constrain IT use (Zammuto 2007), the AA lens permits a clear separation of the material IT artifact from the organization, which allows us to look at the underlying mechanisms through which the introduction of IT affects organizations, without invoking a deterministic view. While permitting the separation of IT artifact

from the organization, it does not assign agency exclusively to either one, but rather accommodates the distributed character of agency across individuals, organizations, and technology (Suchman 2007). Because affordances arise from the relation between an IT artifact and potential or actual users, both are involved in the process of actualization. Because any relationship must, by definition, be between separable entities (Slife, 2004), the affordance concept not only captures the user-IT relation, but also acknowledges that this relation was formed from separate user characteristics and IT features. The advantage of considering the artifact as separate from the users is that only then can we properly discuss the design of an artifact, the benefits that might be realized by introducing such an artifact, or other similar topics of interest to practitioners and IS researchers.

This ontological separation distinguishes the affordance perspective from the sociomaterialist perspective (Orlikowski, 2007; Orlikowski and Scott, 2008). Sociomateriality highlights the interpenetration of people and technology (i.e., lack of separation) in the course of the daily practices of the former as they use the latter. For example, Berg (1997) shows how the micro-processes of EHR use invoke a set of characteristics and capabilities that are broadly distributed across a network of artifacts and individuals. No part of this network is in control of the outcome, which occurs instead through a process that Berg calls "drift". In contrast, the affordance lens does not focus on the description of micro-processes, but rather allows an examination of outcomes at various levels.

Part of the power of the AA lens is that it enables examination of the implementation process at different levels simultaneously, from the individual user to the

organization as a whole. The initial recognition of available affordances, generally done by managers when they select a new system, is at the organizational level. They are motivated to achieve specific organizational goals, and so express expected benefits and their measures, and thus the desired affordances, at the organizational level as well. When the system is given to users, however, and actualization begins, the process is executed by individuals. While individuals' awareness and perspective on affordances is likely informed by communications from management about what the system is expected to achieve, the meaning and value of affordances to them develops from their interaction with the system and each other, and their personal perspectives, goals, and motivations. To the extent that there is lack of consistency across how different people view the affordances and thus the actions they take to actualize them, the desired benefits may be difficult to achieve.

The impetus for changes to the system or to the organization's policies and structures comes from individual frustration at not having the tools needed to achieve individual level objectives as challenges arise, not unlike the "discrepant events" described by Majchrzak et al. (2000). Changes are also initiated by managers as they received feedback about the resulting actualizations and benefits. We believe one of the reasons our research site was successful is that managers and the IT group focused on the needs of individuals by providing individualized training, training by role, opportunities for individuals to propose or even implement system changes, and in extreme cases, personal support such as scribes. Specifically, managers realized that benefits would only be realized to the extent that individuals were able to use the system in a manner that was aligned with their personal goals as well as organizational goals.

The AA lens's accommodation of multiple levels differs from previous process models in the literature, which tended to focus on a single level. For example, Leonard-Barton's (1988) model of implementation as mutual adaptation between the technology and the organization focused largely on organizational level phenomena with only passing mention of individuals and work groups. By contrast, DeSanctis and Poole's (1994) Adaptive Structuration Theory focused on individuals and their interactions within a group. Of course, these researchers focused where they did because of the specific cases they studied. An organizational level perspective made sense for Leonard-Barton, who studied the implementation of large scale production processes or equipment, while the GDSS studies of DeSanctis and Poole automatically led to studying small groups and individuals. The EHR we studied naturally led us to develop a model that facilitated an examination of organizational and individual level affordances and actualization processes.

Focusing on affordances rather than IT features provides for a non-deterministic process model. Rather than assuming that specific IT features lead to specific effects, the concept of affordances acknowledges that different users interpret affordances and develop meanings about affordances based on their individual and role-based goals and intentions. During the actualization process, the actions these users take to actualize affordances reflect these differing goals and intentions. Thus, actualization is a forward-looking process – looking forward toward user goals (a pull approach) rather than backward toward IT features (a push approach). In this way, affordances and the actualization process are conceptually consistent. The forward looking activities during actualization are related to what the user wants to achieve, which is well aligned from a

theoretical perspective with the definition of affordances as the possibility for goal-directed action. Thus the AA model has an internal consistency and makes clear the causal relationship between affordances and outcomes. From a critical realist perspective, the affordances are the causal mechanisms from the "real" domain that generate observable outcomes in the empirical domain. By acknowledging that structural conditions exist separately from and prior to the actions users take, critical realism also enables us to build a process model of how the effects emerge over time.

Finally, if ecological psychologists are correct, an affordance perspective is also a much more natural way to view objects in the environment such as IT artifacts. Discussing affordances rather than IT features, in turn, may enable IT professionals to improve their communication with users who are less interested in features per se than in what those features will enable them to do.

With its forward-looking, goal-directed approach, the AA lens acknowledges the intentionality of users and managers as they perform their work processes with an IT artifact, providing at least part of the explanation for why different effects are observed in different organizations. By explicating the causal relationship between affordances and outcomes, the AA lens goes beyond diffusion and assimilation models of IT spread that explain why organizations or individuals choose to adopt and use an IT artifact without explaining the resulting organizational effects. Furthermore, the AA lens neither conflates the IT artifact and the user as in sociomateriality, nor does it set up a dialectic between the two, as in Actor Network Theory (ANT). Instead it acknowledges the distinction between them, then focuses the discussion on affordances, which emerge from the relation between the two, not from either one individually. Where ANT focuses on

"translation", the ongoing negotiation between actants, whether they be objects or individuals, (Walsham, 1997), the AA lens distinguishes between the IT artifact – user dialectic, which it avoids by focusing on affordances, and the user-user dialectic. While it acknowledges the importance of this latter conflict, it places it in the background, focusing instead on users and their goals, and the concept of actualization. Another related concept is enactment (Orlikowski, 2000). Like actualization, this concept implies a continuous process of change. The difference is that enactment relates to the rules and resources that constitute the structures of "technology in practice", whereas actualization focuses on what the user wants to achieve.

Process models of IT effects in organizations have provided many new insights for IT researchers. Because these models require a rich set of longitudinal data, they are typically based, as is our study, on a single IT artifact in a single organization in a particular industry. Thus, any particular study may produce results that are not generalizable. For example, Majchrzak et al. (2000) argue that previous studies examined organizational and IT structures that were not sufficiently malleable. For our study, we must examine whether our health care context affected our model negatively. We believe our choice of health care as a context helped to uncover the insights in our model. For example, health care organizations typically have at least two lines of authority, the medical and the administrative, instead of a traditional hierarchy. Physicians consider themselves to be independent operators, and make their own choices rather than following management's lead. This served to highlight the importance of individual level affordances during actualization and reinforced the concept of actualization as an individual level journey. This theoretical insight helps us provide

guidance for practitioners because it underscores the need for managers to understand the variety of affordances at the personal level, so they can assess consistency with what the organization wants, and take actions to improve alignment. Yet, even this is probably generalizable to other organizations. In traditional hierarchies implementing organizational level systems (e.g., enterprise systems in manufacturing organizations), it is likely that the various individual level journeys are critical in determining the outcome. While top-down authority can be used to drive change in such an environment, quick managerial response to individual problems with using a system, as occurred at our field site, will facilitate benefit realization.

In summary, the AA lens provides both a lens for conceptualizing the relation between an IT artifact and its users, i.e., affordances, and a lens for conceptualizing the non-deterministic process by which that IT artifact becomes embedded in an organization and produces effects, i.e., the actualization process. The affordance and actualization concepts, separately and together, have advantages over other conceptualizations in the literature of the IT artifact and the process by which IT becomes embedded in an organization. Together they provide a theoretical lens for investigating what it is about IT that matters in organizations as the technology is used and leads to both desired and unintended organizational changes.

Conclusion

This paper makes four distinct contributions. First, by embracing the calls (Markus and Silver, 2008; Zammuto et al., 2007) to adopt affordances as seen from a critical realist perspective as a means for understanding IT effects, we have developed a mid-level grounded process theory of how clinics actualize affordances arising from the

implementation of an EHR. In so doing, we have replaced the concept of appropriation with actualization, which we believe will provide the foundation for research studies that are better able to explain and predict how and why IT leads to, or fails to lead to, organizational benefits. We have also highlighted the importance of looking at the individual level journeys as the foundation for organizational outcomes. This insight alone should improve managers' ability to achieve the desired organizational benefits.

While the theory as presented relates to EHRs and HC practitioners, and was developed based on a study in a single setting, the general form provides a template for other such theories. Specifically, any IT artifact in relation to a specific class of users gives rise to a set of affordances that capture the potentials for action for that class of users. This provides both researchers and managers with a new lens for viewing an IT artifact with its potential users. The actualization process in our theory provides an alternative view of the process of achieving benefits that can help us produce better models of IT benefit actualization and better practice in industry. The three measures of actualization, their consistency, extent, and alignment, also contribute to better models. Furthermore, the actions based on feedback about actualized affordances provide a new lens for thinking both theoretically and practically about ways to continue the process of IT-enabled change and innovation about which various researchers have speculated.

In addition, while we studied only one EHR package, its features are common to most EHR systems, so that the set of six affordances revealed in our data should be generalizable to other EHRs in clinic settings. As part of our on-going research, we are conducting a second study in another set of ambulatory clinics that are using a different EHR package, so we can further assess the generalizability of our results.

Our second contribution was that in developing our model, we operationalized the theoretical definition of affordances in the literature by providing guidelines for researchers and specific examples of affordances in our study. To date, there have been calls for using an affordance lens in studies of IT effects, but even the first step of identifying specific affordances and how they are related to features of the IT artifact and to characteristics and capabilities of users in organization, has rarely been taken.

Third, in describing how we uncovered the salient affordances and the components of the actualization process, we provide an example of how empirical studies of affordances can be conducted at a time when such examples are rare. As noted above, our model in Figure 1 provides a general template for additional affordance-actualization theories. Researchers can follow our approach of using a critical realism lens and grounded theory methods to develop another mid-level theory for a different type of IT and organization. Alternatively, researchers could test our model in different contexts.

Finally, in examining the specific actions taken at our research site, we offer practitioners insights into how they may derive benefits from their EHR. In particular, we urge managers to recognize that the affordances they view as central to clinic success may not coincide with the affordances as seen by individual HC practitioners. Since affordances are specific to users, realizing the desired benefits, will require identifying any inconsistencies, and addressing them on an individual basis so that individual level affordance actualization journeys are supported. This will include, but not be limited to, individualized training, customized support, and responsiveness to concerns.

While we have presented an overall model of clinic-EHR affordances, much remains to be done. A valuable next step would be to explore the relationships between

each specific affordance, its actualization, and specific outcomes. For example, if a HC organization actualizes the patient knowledge management affordance well, will it achieve better quality patient care? There are many research questions of this general form that could and should be explored.

In general, by providing an overview of the causal mechanisms that lead from IT features, in combination with organizational and personal capabilities and characteristics, to IT effects, we have built a new process model that extends existing theory and helps practitioners identify what it is about a particular IT artifact that matters in a specific environment, and how to realize the benefits they expect.

References

Alvarez, R. (2008) "Examining Technology, Structure and Identity during an Enterprise System Implementation," *Information Systems Journal* (18) 2, pp. 203-224.

Archer, M. S. (1995) *Realist Social Theory: the Morphogenetic Approach*. Cambridge, UK: Cambridge University Press.

Ashurst, Colin, N.F. Doherty, and J. Peppard (2008) "Improving the impact of IT development projects: the benefits realization capability model", *European Journal of Information Systems* (17) 4, pp. 352-370.

Berg, M. (1997) "Of Forms, Containers, and the Electronic Medical Record: Some Tools for a Sociology of the Formal," *Science, Technology, & Human Values* 22(4), pp. 403-433.

Berwick, D. M. (2002) "A User's Manual for the IOM's 'Quality Chasm' Report," *Health Affairs*, (21) 3, pp. 80-90.

Bhaskar, R. (1978). *A Realist Theory of Science*. Sussex, UK: The Harvester Press.

Bhaskar, R. (1998). General Introduction. In M. S. Archer, R. Bhaskar, A. Collier, T. Lawson and A. Norrie (Eds.), *Critical Realism: Essential Readings* London, UK: Routledge, pp. ix-xxiv.

Boudreau, M.-C., & Robey, D. (2005) "Enacting Integrated Information Technology: A Human Agency Perspective," *Organization Science* 16(1), pp. 3-18.

Burton-Jones, A., & Gallivan, M. J. (2007) "Toward a Deeper Understanding of System Usage in Organizations: A Multilevel Perspective," *MIS Quarterly* 31(4), pp. 657-679.

Chemero, A. (2003) “An Outline of a Theory of Affordances,” *Ecological Psychology* (15) 2, pp. 181-195.

DeLone, W., and E. McLean (1992) "Information systems success: The quest for the dependent variable," *Information Systems Research* (3) 1, pp. 60-95.

DeSanctis, G., and M.S. Poole (1994) "Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory," *Organization Science* (5) 2, pp. 121-147.

Gibson, J. J. (1986) *The Ecological Approach to Visual Perception,* Hillsdale, NJ: Lawrence Erlbaum Associates, (originally published 1979).

Giddens, A. (1984) *The Constitution of Society,* Cambridge, UK: Polity Press.

Glaser, B. (1978) *Theoretical Sensitivity: Advances in the Methodology of Grounded Theory,* Mill Valley, CA: Sociology Press.

Glaser, B. G. and A. L. Strauss. (1967) *The Discovery of Grounded Theory: Strategies for Qualitative Research,* Chicago, IL: Aldine Pub. Co.

Goodhue, D.L., and R.L. Thompson (1995) "Task-Technology Fit and Individual Performance," *MIS Quarterly* (19) 2, pp. 213-236.

Heft, H. (2003) “Affordances, Dynamic Experience, and the Challenge of Reification,” *Ecological Psychology*, (15) 2, pp.149-180.

Hutchby, I. (2001) "Technologies, Texts and Affordances," *Sociology* (35)2, pp. 441-456.

Leonard-Barton, D. (1988) "Implementation as mutual adaption of technology and organization," *Research Policy* (17) 5, pp. 251-267.

Leonardi, P. M., & Barley, S. R. (2008) “Materiality and change: Challenges to building better theory about technology and organizing,” *Information and Organization* 18(3), pp. 159-176.

Locke, K. (2001) *Grounded Theory in Management Research,* Thousand Oaks, CA: Sage Publications.

Majchrzak, A., R.R. Rice, A. Malhotra, N. King (2000) “Technology Adaptation: The Case of a Computer-Supported Inter-organizational Virtual Team,” *MIS Quarterly* (24) 4, pp. 569-600.

Markus, M. L. and M. S. Silver (2008) “A Foundation for the Study of IT Effects: A New Look at DeSanctis and Poole’s Concepts of Structural Features and Spirit,” *Journal of the AIS* (9) 10/11, pp. 609-632.

Michaels, C.F. (2000) “Information, Perception, and Action: What should ecological psychologists learn from Milner and Goodale (1995)?” *Ecological Psychology* (12) 3, pp. 241-258.

Mingers, J. (2002) Real-izing Information Systems: Critical Realism as an Underpinning Philosophy for Information Systems. *Twenty-Third International Conference on Information Systems*, Barcelona, SP, pp. 295-303.

Mingers, J. (2004) "Real-izing Information Systems: Critical Realism as an Underpinning Philosophy for Information Systems," *Information and Organization* (14) 2, pp. 87-103.

Monteiro, E., & Hanseth, O. (1996) "Social Shaping of Information Infrastructure: On Being Specific about the Technology," in W. J. Orlikowski & G. Walsham & M. Jones, R. & J. I. DeGross (Eds.), *Information Technology and Changes in Organizational Work* (pp. 325-343). London: Chapman & Hall.

Norman, D. A. (1988) *The Psychology of Everyday Things*, New York, NY: Basic Books.

Norman, D. A. (1999) "Affordance, Conventions, and Design," *Interactions* (6) 3, pp. 38-43.

Orlikowski, W. J. (2000) "Using Technology and Constituting Structures: A Practice Lens for Studying Technology in Organizations," *Organization Science* 11(4), pp. 404-428.

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

Orlikowski, W.J., & Barley, S. R. (2001) "Technology and Institutions: What Can Research on Information Technology and Research on Organizations Learn from Each Other?" *MIS Quarterly* 25(2), pp. 145-165.

Orlikowski, W.J., and C.S. Iacono (2001) "Research Commentary: Desperately Seeking the "IT" in IT Research - A Call to Theorizing the IT Artifact," *Information Systems Research* (12) 2, pp. 121-134.

Orlikowski, W.J., & Scott, S.V. (2008) "Sociomateriality: Challenging the Separation of Technology, Work and Organization," *Academy of Management Annals* 2(1), pp. 433-474.

Rose, J., M. Jones, and D. Truex (2005) "Socio-Theoretic Accounts of IS: The Problem of Agency," *Scandinavian Journal of Information Systems* (17) 1, pp. 133-152.

Slife, B. D. (2004) "Taking Practice Seriously: Toward a Relational Ontology," *Journal of Theoretical and Philosophical Psychology* 24(2), pp. 157-178.

Soh, C. and M.L. Markus (1995) How IT Creates Business Value: A Process Theory Synthesis, *Sixteenth International Conference on Information Systems,* Amsterdam, NL, pp. 29-41.

Stoffregen, T. (2000) "Affordances and Events," *Ecological Psychology* (12) 1, pp.1-28.

Stoffregen, T. (2003) "Affordances as Properties of the Animal-Environment System," *Ecological Psychology* (15) 2, pp. 115-134.

Suchman, L. (2007) *Human-Machine Reconfigurations: Plans and Situated Actions* (2nd ed.), New York, NY: Cambridge University Press.

Turvey, M. (1992) "Affordances and Prospective Control," *Ecological Psychology* (4) 3, pp. 173-187.

Walsham, G. (1997) “Actor-Network Theory and IS Research: Current Status and Future Prospects,” in A. S. Lee & J. Liebenau & J. I. DeGross (Eds.), *Information Systems and Qualitative Research* (pp. 466-480). London: Chapman & Hall.

Wynn Jr., D.E. and C.K. Williams (2008) Critical Realism-Based Explanatory Case Study Research in Information Systems, *Twenty-Ninth International Conference on Information Systems*, Paris, FR.

Volkoff, O., D.M. Strong, and M.B. Elmes (2007) "Technological Embeddedness and Organizational Change," *Organization Science* (18) 5, pp. 832-848.

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

芽|Sprouts

Working Papers on Information Systems | ISSN 1535-6078

Office:
Sprouts
University of Amsterdam
Roetersstraat 11, Room E 2.74
1018 WB Amsterdam, Netherlands
Email: admin@sprouts.aisnet.org

芽|Sprouts