The Generative Mechanisms of Healthcare Digitalization

Research-in-Progress

Marius Mihailescu
School of Economics and Management, Lund University, Sweden
marius.mihailescu@ics.lu.se

Daniela Mihailescu
Jönköping International Business School, Jönköping University, Sweden
daniela.mihailescu@ju.se

Ulrike Schultze
Southern Methodist University, USA, and Lund University, Sweden
uschultz@smu.edu

Abstract

Digitalization is considered key to meeting the challenges that face the healthcare sector. However, the results of digitalization initiatives have often been disappointing and the literature has provided a fragmented understanding of the mixed results. While previous studies have generally focused on the advantages and the barriers of adopting healthcare IS, little attention has been paid to unearthing the causal powers that generate IT-enabled transformations. The purpose of this research is to identify the generative mechanisms of digitalization in the healthcare sector. Specifically, the research seeks to answer the following research questions: What are the generative mechanisms of digitalization in healthcare? How can they explain varying degrees of digital transformation? We draw on Archer’s morphogenetic approach, which adopts a critical realist lens, to answer these questions. As such, one of the contributions of this paper is to demonstrate the usefulness of a Critical Realist ontology for developing insights into digitalization.

Keywords: Generative mechanisms, digitalization, critical realism, morphogenetic approach.
Introduction

Information technology, particularly Electronic Patient Record (EPR) systems, whose implementation has increased significantly in the last decades (Westbrook et al. 2009), is frequently regarded as a key solution to the many challenges faced by healthcare providers and the healthcare sector in general (Berwick 2002). Indeed, the digitization of the patient record, i.e., the conversion of analog data into a digital format by applying digitizing technologies (Tilson et al. 2010), is considered by many as a silver bullet (Agarwal et al. 2010). It is expected to improve the overall quality of healthcare, including an increase in patient safety (Car et al. 2008). These outcomes are attributed to reducing redundant documentation and paperwork, increasing the efficiency of workflows (Randeree 2007), facilitating better integration across functional silos, providing real time access to patient information, reducing risks and saving time (Krog 2009).

However, many EPR implementations fail to live up to expectations (Fonkych and Taylor 2005). Some of the literature even indicates that the use of EPR systems has had detrimental effects on efficiency (Moody et al. 2004), effectiveness and patient safety (Han et al. 2005; Aron et al. 2011). Additionally, patients have not benefited from time savings (Hebert 1999). These counter-productive and counter-intuitive outcomes raise questions about the mechanisms through which IT-enabled change is effected. The mixed results of EPR implementations evident in prior research invite the development of a theoretical infrastructure that is capable of accounting for the conditions under which certain transformative forces associated with IT are triggered and with what consequences.

To develop such a conceptual scaffold, we draw on the digitalization literature and Archer’s (1995; 2011) Realist Social Theory (RST) to explain change over time. Digitalization refers to the transformation of socio-material structures based on the conversion of analog to digital information (Yoo et al. 2010a). While the digitization of content (including images, video, music) is a technical requirement of the digitalization process, the outcome of digitalization is a work practice, organizational structure and/or industry structure that leverages the liberation of content from its physical stratum to achieve digital conversion (Tilson et al, 2010). For instance, in an analog world, devices, storage media and transmission formats are specific to a service, thus limiting the reuse of the data (e.g., a paper-based medical record is limited in its application). By decoupling information from its physical storage (e.g., an electronic medical record), digitization unleashes the generative potential of recombining content with different applications and devices (e.g., using the same medical record for medical rounds and real-time analytics), thus making new ways of working, new physical work arrangements and new social structures possible.

Given the socio-material nature of digitalization, attempts to unpack this process so as to identify the generative mechanisms that produce transformations in social and material structures, a conceptual scaffold that is capable of theorizing the interaction between the technology and the social is needed. Critical realism (CR) lends itself well to such an analysis as it takes the material conditions of social life seriously (Volkoff and Strong, 2013; Mutch 2010). Through its morphogenetic approach, RST, which falls under the CR umbrella, provides the theoretical infrastructure to account for the materiality of technology (Mutch 2013). Specifically, RST enables us to examine the interplay between structure and agency over time by specifying the generative mechanisms that connect materiality, a structural property, and reflexivity, a social property.

According to Elster (2007), generative mechanisms are supposed to be the “nuts and bolts” of mid-range theory. To develop such a mid-range theory of digitalization in healthcare, we adopt Archer’s (2015) definition of generative mechanisms and defined them as the unobservable and emergent causal powers that arise from the interplay between structural proprieties and properties of agency through which observable events are produced. For example, digital materiality (an emergent property of structure) and communicative reflexivity (an emergent property of agency), may or may not trigger the organizational change associated with the conversion of analog data into digital formats.

In order to understand digitalization and explain how and why transformational outcomes are produced, our research seeks to answer the following questions: What are the generative mechanisms of digitalization in healthcare? How and why do they generate varying degrees of digital transformation in this sector? To address these research questions we draw on a longitudinal case study (Edwards et al. 2014) of a hospital that implemented an EPR system. To gain the kind of detailed insights necessary to uncover generative mechanisms, their interconnections and the contextual factors that produce
contingent outcomes (Dobson 2001), we relied on interviews, participant observation and documents produced in the field site. Causal and cross-comparative analyses were then employed to identify the generative mechanisms and explain the varying outcomes evident in the three geriatric wards under study.

This research reported here adds to our knowledge of the digitalization of healthcare by focusing on the generative mechanisms that underlie this technology-enabled change. This paper also develops methodological and theoretical rigor around the notion of generative mechanisms, which is gaining popularity in IS research (Henfridsson and Bygstad 2013). Another contribution is to the growing body of digitalization and empirical studies in the IS literature seeking to develop a socio-material understanding of how organizational transformation emerge over time (Mutch 2010). This paper also responds to the request for a more explicit consideration of reflexivity in IS research (Thompson 2004; Dobson et al. 2013). The morphogenetic approach considers the different modes of agental reflexivity and how these might be impacted by materiality (Mutch 2010).

The rest of the paper is structured as follows: prior literature on digitalization in healthcare is briefly presented in section two. Section three introduces the theoretical basis of the research and provides a brief description of RST and its morphogenetic approach, which informs the research model used to conceptualize the generative mechanisms of digitalization. The paper concludes with a description of the research design and presents some initial results.

Related Literature

Digitalization

According to Yoo et al. (2010a p. 6) digitalization represents “[t]he transformation of socio-technical structures that were previously mediated by non-digital artifacts or relationships into ones that are mediated by digitized artifacts and relationships. Digitalization goes beyond a mere technical process of encoding diverse types of analog information in digital format (i.e., “digitization”) and involves organizing new socio-technical structures with digitized artifacts as well as the changes in artifacts themselves.” This definition makes two key points: (1) that there is a distinction between digitization, a technical process, and digitalization, a socio-material process, and (2) that digitalization involves both material and social aspects.

IS research has traditionally not addressed the material aspects of technology (Orlikowski and Scott 2008). Thus, an important starting point for research into digitalization is to open up the “black box” of IT artefacts and to recognize the important role of materiality of digital technology (Orlikowski and Iacono 2001), where materiality is defined in terms of the properties that enable or constrain people’s goals and their interaction with digital technology (Leonardi 2013). Much of the digitalization literature has focused on digital innovation where scholars are primarily concerned with the characteristics, properties (Yoo et al. 2010a), design and architecture of digital technology (Yoo et al. 2010b; Yoo 2013) and less with the dynamics of organizational changes that represent digitalization. Summing up, the existing literature on digitalization provides us little insight into the generative mechanisms by which social structures are transformed to take advantage of the decoupling of content from its physical sub-stratum. Indeed, Yoo et al. (2010b) call for more research into the materiality of digitalization and the generative mechanisms underlying this form of organizational transformation.

Digitalization in Healthcare

The hospital environment is unique and complex (Braithwaite et al. 2009) and has strong hierarchical structures (Braithwaite and Westbrook 2005) with almost autonomous healthcare professionals (Jadad and Delamothe 2004). It is also characterized by highly specialized and ad-hoc work processes (Westbrook et al. 2007). Furthermore, healthcare is information intensive and the quality of its services is dependent on information being accurate, relevant, integrated and available when needed (Goh et al. 2011). Digitization of the medical record by means of an EPR promises to meet those requirements (Fichman et al. 2011): by converting analog records into digital formats, the quality of patient information is expected to increase as, for example, “unreadable” handwritten information and transcription errors are eliminated (Chao et al. 2007).
Despite the increase in digitization thanks to EPR technology, the degree of transformation (i.e., digitalization) has been low in the healthcare sector (Sherer 2010) and the anticipated improvements in performance do not always materialize (Agrawal et al. 2010). Moreover, digitalization is perceived as time-consuming (Hanseth 2007), disruptive and even life threatening (Abraham and Junglas 2011), generating unpredictable outcomes (Agrawal et al. 2010).

Even if digitalization is considered one of the most effective strategies for improving healthcare (Agarwal et al. 2010), little is understood about how and under what conditions the digitization of patient information (technical process) achieves digitalization (socio-material process) that generates transformative outcomes (socio-material structures) that leverage the decoupling of data from its physical instantiation. Most prior research focuses on the advantages and obstacles of EPR implementations, as well as factors that influence the adoption of healthcare IS (Gastaldi and Corso 2012).

**Theoretical foundation**

Given the focus on generative mechanisms in this research, a critical realism (CR) perspective is adopted. As a philosophy of science, CR promises to generate an in-depth understanding of a phenomenon and assist the researcher in describing and explaining the structures and generative mechanisms that produce observable events. In IS research, there is growing interest in the application of CR (Carlsson 2012), and particularly Archer’s (1995; 2011) morphogenetic approach (Mingers et al. 2013). However, to date there are few empirical IS-studies using Archer’s morphogenetic approach.

**Ontologically**, CR views reality in terms of three domains: the real, the actual and the empirical (Bhaskar 1978). The real domain subsumes the domains of the actual and the empirical and consists of underlying structures, mechanisms and relations; events and behavior; and experiences. The generative mechanisms residing in the real domain exist independently of the patterns of events that they are capable of producing. Relations generate behaviors in the social world. The domain of the actual consists of these events and behaviors. Hence, the actual domain is the domain in which observed events or observed patterns of events occur. The domain of the empirical consists of what we experience; hence, it is the domain of experienced events (Figure 1).

![Figure 1. Critical realist view of causation (inspired by Sayer, 2000 p. 15)](image)

**Epistemologically**, CR focuses on the relationship between mechanisms, events and our (empirical) experiences. In CR, causality plays an essential role in describing and explaining how and why the mechanisms generate events (Bhaskar 1978).
The morphogenetic approach reflects CR’s assumptions and is probably the most commonly applied in CR studies (Dobson 2011). Archer (2011) maintains that structure and agency are analytically distinct, each having relative autonomy but interacting with each other. Structure refers to “a set of internally related objects or practices” (Sayer 1992 p. 92) with emergent properties (Archer 1995). These structures are delineated by the resource distribution and the organizational and institutional positions that agents occupy as they pursue their interests. Structures shape the situations in which agents find themselves involuntarily by providing reasons or directional guidance. However, agents enjoy interpretative freedom and evaluate their situations, concerns, and projects in light of their situations. In other words, the situations in which agents find themselves do not have a direct impact upon agents, but are reflexively mediated via agents’ own concerns through the stance they take (Archer 2011).

By advancing the notion of analytical dualism, i.e., artificially disentangling the dialectical interplay between structure and agency, the morphogenetic approach helps a researcher study how structure shapes action and social interaction (i.e., agency), and how agency changes (i.e., morphogenesis) or reproduces (i.e., morphostatis) a given structure. By employing the morphogenetic approach, digitalization is conceptualized as a phenomenon that emerges from the interplay between structure and agency over time. Archer (2015) operationalizes the analytical structure-agency dualism by means of a morphogenetic cycle that consists of three phases: structural conditioning, social interaction, and structural elaboration. As an explanatory framework, the morphogenetic approach thus provides not only a conceptual tool to describe and explain social change over time but, as Mutch (2010) asserts, it also gives the opportunity to emphasize the materiality of technology (structure), and explain how this may or may not affect the different modes of agential reflexivity (agency).

The conceptual framework

Realist Social Theory provides both an explanatory framework for examining interactions between structure and agency, and a theoretical lens for developing the generative mechanisms that produce certain digitalization outcomes. Figure 2 provides a visual representation of this RST-inspired framework.

Figure 2. Research Framework
Figure 2 illustrates the elements needed to theorize causal paths. We derived three possible digitalization outcomes, i.e., low, medium, and high degrees of organizational transformation. The framework helps us identify generative mechanisms and explain how they produce various degrees of digitalization. This variation in outcomes is attributed to the interaction among generative mechanisms and their activation in certain conditions.

Over time the socio-material structure and agency emerge, intertwine and redefine one another. The explanatory format to render change, i.e., morphogenesis, consists of a sequence of three phases: Socio-cultural Conditioning (T1), Socio-material Interaction (T2-T3) and Structural Elaboration (T4) as illustrated in Figure 3. This figure reflects the focus of our study on healthcare digitalization by incorporating some of the empirical details that help explain digitalization as an emergent, morphogenetic sequence.

Structural conditioning represents the start of a morphogenetic sequence. Reflective of T1, it corresponds to conditions prior to healthcare digitalization. As a result of challenges, that thrust interrelated agents within a particular structure, relationships between socio-cultural (e.g. resources, roles, values, beliefs) and digital technology elements (e.g. IT infrastructure, content, processes and services) are activated. In this case, the available socio-cultural and technology elements and the combinations thereof are represented by an EPR system. Along with the distribution of available resources, socio-material configurations distribute vested interests in accordance with particular bargaining positions.

According to Archer (1995) the occurrence of relationships of necessary or contingent complementarities and necessary or contingent contradictions within structures produces four situational logics that motivate agents to advance or defend their life chances and to pursue different modes of interaction. These four situation logics are correction, protection, elimination and opportunities. Situational logics foster particular types of reflexivity and provide directional guidance by supplying reasons for specific modes of incorporating digital technology into healthcare operations. This represents the initiation of the healthcare digitalization and sets up the conditions that subsequently trigger (or fail to trigger) the generative mechanisms of digitalization.
Socio-material interaction: T2-T3 corresponds to the action of agency through socio-material interaction. Once the EPR is implemented, agents take a stance towards the structural conditions that confront them and act in pursuit of their interests. For instance, they might seek to maintain or change their situations. They devote resources and pursue different changes through their actions and interactions with other agents. When interrelated agents use different modes of reflexivity to deliberate on their personal and relational concerns, they take particular stances towards the integration of digital technology into healthcare operations.

The first three modes of reflexivity: communicative, autonomous and meta-reflexive indicate an active agent with a distinctive stance towards his or her situation. A fractured reflexivity produces a passive agent who lacks a stance towards his or her environment. The different modes of reflexivity have distinct consequences for the patterns of EPR integration and the socio-material configuration that are mobilized. This represents the emergence of digitalization in healthcare settings.

Structural elaboration: at T4, the socio-material interactions from the previous phases actualize the digitalization of healthcare. New socio-material configurations are characterized by particular forms of EPR integration and ways of organizing. It represents temporal stability. A specific morphogenetic change is now evident and it can be classified as developmental, interactional or creative (Donati, 2013).

Applying the morphogenetic approach as a framework for studying healthcare digitalization highlights that digitalization is a socio-material change generated over time by the interplay between (i) situational logics, which are delineated by socio-material configurations that provide directional guidance by enabling or constraining different modes of integration; and (ii) agential stances, which are delineated by self-determined configurations of concerns outlined by different modes of reflectivity motivated agents to pursue different actions and interactions. This interplay explains the emergence of digitalization as a morphogenetic process. The outcomes of one morphogenetic cycle form the start and socio-material conditioning of a subsequent cycle.

Research design

Research site

A case study of three geriatric wards in Jönköping County Hospital that was implementing an EPR serves as the empirical basis for this research. The hospital was ranked among the best in the world (Baker et al. 2008), having achieved a level of service quality that was described as “perhaps unparalleled internationally” (Kenny 2008). When Jönköping County decided to move from a paper-based patient records system to a digitalized system in 2009, we exploited this unique opportunity to study the digitalization at one of its clinics, namely the geriatric clinic. This clinic housed three wards: Geriatric A (orthopedic rehabilitating of patients with osteoporosis and fractures), Geriatric B (stroke care) and Geriatric C (dementia patients). This research setting provided us with a valuable opportunity to leverage comparison and contrast (Guba and Lincoln 1989) to identify the generative mechanisms of digitalization and explain causal conditions underlying different outcomes.

Data collection

To gain sufficiently detailed insights into the generative mechanisms that drive digitalization, we relied on interviews, observations and field-generated documents for data collection (Easton 2010). An interview guide was developed and refined through an iterative process. The first author completed 64 semi-structured interviews in two phases: 33 interviews before and 31 interviews after the EPR implementation (Table 1). The interviews lasted between 45 – 60 min and were audio-recorded. The interviews were transcribed verbatim and sent back to the respondents for member checking. In order to complement and validate data from interviews, the first author spent 80 hours in each ward (40 hours before and 40 hours after the EPR implementation) as a participant observer. He followed nurses on ward rounds, sat in on their meetings and generally observed their work practices.
Table 1. Summary of Interviewees

<table>
<thead>
<tr>
<th></th>
<th>Phase 1 before EPR implementation</th>
<th>Phase 2 one year after EPR implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Geriatric Clinical</td>
<td>Managers: 2</td>
<td>Manager: 1</td>
</tr>
<tr>
<td>Ward A</td>
<td>Managers: 1</td>
<td>Physicians: 1</td>
</tr>
<tr>
<td></td>
<td>Physicians: 3</td>
<td>Nurses: 5</td>
</tr>
<tr>
<td></td>
<td>Physiotherapist: 1</td>
<td>Physiotherapist: 1</td>
</tr>
<tr>
<td></td>
<td>Occupational therapists: 2</td>
<td>Occupational therapists: 2</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>Total: 11</td>
</tr>
<tr>
<td>Ward B</td>
<td>Managers: 1</td>
<td>Physicians: 2</td>
</tr>
<tr>
<td></td>
<td>Physicians: 2</td>
<td>Nurses: 5</td>
</tr>
<tr>
<td></td>
<td>Physiotherapists: 2</td>
<td>Physiotherapist: 2</td>
</tr>
<tr>
<td></td>
<td>Occupational therapist: 1</td>
<td>Occupational therapist: 1</td>
</tr>
<tr>
<td>Total</td>
<td>11</td>
<td>Total: 11</td>
</tr>
<tr>
<td>Ward C</td>
<td>Managers: 1</td>
<td>Physicians: 1</td>
</tr>
<tr>
<td></td>
<td>Physicians: 1</td>
<td>Nurses: 4</td>
</tr>
<tr>
<td></td>
<td>Physiotherapist: 1</td>
<td>Physiotherapist: 1</td>
</tr>
<tr>
<td></td>
<td>Occupational therapist: 1</td>
<td>Occupational therapist: 1</td>
</tr>
<tr>
<td></td>
<td>Counsellor: 1</td>
<td>Counsellor: 1</td>
</tr>
<tr>
<td>Total</td>
<td>9</td>
<td>Total: 9</td>
</tr>
<tr>
<td>Grand Total</td>
<td>33</td>
<td>31</td>
</tr>
</tbody>
</table>

**Data analysis**

As the objective of this research was to identify the generative mechanisms of digitalization and explain how and why digitization generates different organizational outcomes, the empirical material was subjected to cross-ward comparisons and causal analysis. Following Bergene (2007), the empirical data was analyzed in two phases. In the first phase, the analysis was concerned with the understanding of the context and pre-existing conditions of the digitalization phenomenon. The empirical material was converted into narratives of the digitalization on each ward.

The transition from these narratives to the identification of generative mechanisms followed a five-step process developed by Wynn and Williams (2012). We first analyzed the data to identify the structural conditions. Then, we identified and described the components of the structure. In the next step we identified the generative mechanisms according to Hedström and Swedberg’s (1998) topology, i.e., situational mechanism (macro-micro level) that helps us to explain how contexts or events form the beliefs, desires and opportunities of actors; action-formation mechanism (micro-micro level) that helps us to understand how individual actions and priorities are effected by a combination of beliefs, desires, and opportunities; and transformational mechanism (micro-macro level) that explains how actors through their actions and interaction generate outcomes at a macro-level. In the fourth step we elaborated them through retroduction, i.e., the reconstruction of the conditions necessary for a given outcome to occur. By analyzing the interplay between social and material elements we then settled on three generative mechanisms of digitalization (i.e., standardization, alignment and convergence). In the fifth and last step, we analyzed the selected generative mechanisms to find the contextual conditions that triggered them. This allowed us to explain the diversity of digitalization outcomes across the three geriatric wards.
Initial results

Although the analysis is still in progress and we have not yet completed our analysis and validated the generative mechanisms of digitalization in healthcare, we nevertheless have identified three generative mechanisms that partially explain the differences in digitalization outcomes across the three wards. These are standardization, alignment, and convergence.

Standardization mechanism, that is, a process by which work practices are reproduced as a mandatory replacement of paper-based devices afford a digitization of patient records. Activated, this mechanism should take away the need to record patient-related data on paper. However, the nurses at ward A, for example, continued to rely on paper to take notes during the ward round.

Alignment mechanisms, that is, a process by which more personalised services are provided as a revision of work practice afford a visualised communication of patient-related information. For example, at ward B the ward round takes place at the physician’s office. The patient visualizes his or her medical data on a screen. Furthermore, the EPR replaced the daily meeting between the nurses. By contrast, the nurses at ward A found that patient hand-offs were more effectively made face-to-face and spoken communication rather than via computer-mediated texts.

Convergence mechanism, that is, a process by which more services (e.g., care documentation, referral questions, health administration, resource planning) are supported as an increased interconnection of EPR’s modules afford a shared information and communication platform. For example, physicians at ward C started to check the status of patient orders to ensure that patients received the care ordered.

Additionally, it was interesting to note that many of the anticipated benefits of EPR did not materialize in any of the three wards. For instance, the system did not replace the daily meeting between the nurses. They found that patient hand-offs were more efficiently made face-to-face and spoken communication rather than via computer-mediated texts. Furthermore, the nurses continued to rely on paper to take notes during the ward round.

Conclusion

This research-in-progress seeks to identify the generative mechanisms of digitalization and the conditions under which they are triggered to help explain the differences in the outcomes of digitizing medical records in the healthcare sector.

The generative mechanisms we identify in this paper are subject to limitations. Specifically, given our strategy of identifying mechanisms by means of comparison and contrast, they are likely to make a difference in digitalization (i.e., they explain varying degrees of organizational transformation), but are unlikely to provide a complete explanation of the digitalization process. As such they are merely candidate explanations (Sayer 2000) that need to be validated according to criteria for evaluating case study research within critical realism (Healy and Perry 2000). We do not assert that the proposed generative mechanisms completely explain the outcomes observed. As such, further research has to be conducted in order to refine or falsify them in other study contexts.

While our candidate mechanisms are somewhat tentative, this research nevertheless makes a number of contributions. IS research would benefit from insightful knowledge about the generative mechanisms of digitalization as they are useful in understanding and explaining how digitalization emerges. Additionally, this research finds evidence for the usefulness of critical realism for developing substantive contributions in the IS field. Specifically, Archer’s morphogenetic approach helps explain the relationship between the materiality of digital technology and social organization over time, and their intended and unintended outcomes. For example, the models suggested in this study include technology (i.e., has a material aspect) and help to interpret and contextualize digitalization, and to provide descriptions and explanations that take into account that which contributes to the occurrence of digitalization and the conditions under which it occurring over time. Finally, understanding the conditions and the outcomes of an attempt to introduce new technology may also assist IS developer in developing better solution and design of EPR systems.
References


Archer, M. S. 2015. “How agency is transformed in the course of social transformation: don’t forget the double morphogenesis”, in Generative mechanisms transforming the social order, M.S. Archer (ed.), Switzerland: Springer International publishing.


The Generative Mechanisms of Healthcare Digitalization


