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EXPLAINING BIG DATA IMPACT ON HEALTHCARE ORGANIZATIONS: A TECHNOLOGY AFFORDANCE APPROACH

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Abstract. Big Data as pervasive, disruptive, and innovation-driven technology are now a hot topic in academic and business fields. In particular, the healthcare industry is one of those most exposed to the organizational changes produced by the Big Data and Born Digital Data phenomena. Healthcare organizations have to adapt their organizations to manage an ever increasing amount of data affecting their ability to deliver high quality services that must be both effective and efficient. We advance that the Technology Affordance theory can be used to explain how information technology is involved in organizational changes. The paper highlights the importance of an Affordance-Based Theory used to explain this particular issue.

Keywords: Big Data; Affordance; Organizational Change; Healthcare.

1 Introduction

The amount of data produced by current computer based information systems is growing exponentially in any business industry. Organizations use various analytical techniques to study structured and unstructured forms of data. These data analytics can aid new products and processes discovery, new organizational forms and layouts, better productivity and new policies configurations (Tallon P.P., 2013). New opportunities for value creation have effectively emerged. Data can be seen as drivers of innovation when organizations are capable to exploit them to take decisions, improve processes and solve problems (Micheal K., Miller K.W., 2013). At the same time organizations face new challenges with respect to how much data to save and store, to data security and to customer privacy protection. For these reasons, Big Data are seen as a disruptive technology.

That's particularly true in healthcare. Healthcare manages vast amount of digital contents: electronic health records, insurance records, pharmacy prescriptions, patient

feedback and responses. These data are generated by numerous patient points of care, sophisticated medical instruments and web-based health communities. That's what means Big Data in healthcare: a single data matrix might have hundreds of thousands of patients with many records, heterogeneous in formats, and collected over a long period of time. Furthermore, these data have to be managed daily by hospitals and private clinics (Chen et al. 2012). Big Data are radically changing the entire health community creating discontinuities affecting healthcare organizations. Managing data is increasingly becoming a core competence in daily routine, requiring an appropriate organization and a technological structure to be present to guarantee right decision making and value creation.

This study proposes to shed light on these challenges and issues through the affordances lens. Affordances are seen as actions potential for behaviors associated with achieving a specific goal and arising from the relation between information system and a goal oriented actor or organizations. We will clarify how the use and the adoption of an Affordances-Based Theory would benefit the resource looking into this particular issue.

This paper is organized as follows. Section 2, 3 and 4 present an overview of the background literature on *Big Data*, *Organizational Change* and *Affordances* respectively. Section 5 presents the importance of an Affordances-Based Theory to study how the adoption of a particular technology affects and impacts individuals and organizations. Section 6 explains how Affordances can be linked to Big Data as a fresh look to analyze their impact on organizations. Section 7 concludes and presents the possible future works as well as the implications of what stated in the previous sections.

2 Big Data

The "Big Data" problem is not just about size. It also refers to the speed, the volume and the computational and analytical capacity required to manage data and derive insight (Hemerly J., 2013). The term Big Data has increasingly been cited in scientific publications during the last 7 years, indicating the growing interest in the phenomenon from scientific and entrepreneurs' communities. The enormous amount of data produced every day reflects the magnitude and the impact of data-related problems to be solved in present-day business organizations such as database and information lifecycle management, storage, analytical capabilities (Chen et al. 2012; Pospiech M. and Felden C., 2012).

Pospiech M. and Felden C. (2012) categorize previous existing literature on Big Data dividing papers and articles in two categories: (1) those that refers to a technical/data utilization perspective and (2) those that have a functional/data provisioning perspective. Their review shows that the Big Data topic and researches are technical driven, and focused on performance aspects. Technical data provisioning, methods like data mining and deep analytics are deeply discussed. On the opposite, investigations about Big Data in an overall perspective, such as functional data provisioning and utilization are missing.

Chen et al. (2012), strongly suggesting to push the research to advance key technologies in analytics, identify different research frameworks in Business Intelligence & Analytics, such as big data analytics, text analytics, web analytics, network analytics and mobile analytics.

The Internet and the pervasive computerization of business activities enable most customer data today to be natively digital, i.e. *born digital*. Big Data slightly differ from Born Digital Data for inherent characteristics: the first concept concerns the vast amount of data available today that stretch the limits of traditional database architectures, while the second term refers to data captured or born in digital form, not digitized through scanning or manually input. With a proactive Big Data and Born Digital Data approach, firms can better exploit opportunities for extracting business value from customers' data (Piccoli G. and Watson R., 2008).

Unfortunately, current Big Data research is focused on analytics studies, and hardware and software management aspects. Dimensions of value creation and business opportunities are disregarded. Information systems literature too mainly explores the phenomenon through the logic of its adoption, and does not take into account the interplay between technology and organizational changes, and the fact that the Big Data usage profile and effective value are properties that arise from the interactions between social actors and the technology artefact.

Affordance-Based Theories are particularly suited to provide a proper understanding of the uses and the consequences of the IT artefact, considering this mutual interaction between social actors and the technological element itself (Majchrzak A., Markus M.L. 2012).

2.1 Big Data and HealthCare

According to Chen et al. (2012), the health community is facing a tsunami of health- and healthcare-related content generated from daily care activities and patients feedbacks. Extracting knowledge from health Big Data, identifying and developing new decision models, understanding the Big Data management impact on individuals and organization can generate meaningful impacts on healthcare quality and long term care and empowerment of patients and physicians.

Healthcare sector has vastly increased supply of information: pharmaceutical companies has been aggregating research and development data into medical databases, payors and providers have digitized patient records, governments and public stakeholders have opened clinical trials data and information on patient covered under public insurance programs (Kayyali B., Knott D. and Van Kuiken S. 2013).

In healthcare, where data are personal and sensitive, managing Big Data impacts also security and privacy manners that make the operations of sharing, aggregating, sorting and analysing particularly challenging (Ahier, 2012).

Recent literature (Ahier, 2012; Kayyali B., Knott D. and Van Kuiken S. 2013) shows several example of Big Data adoption in hospitals and clinics worldwide. Significant clinical knowledge, such as predicting medical treatments effectiveness, and deeper understanding of patient disease patterns can be gained from electronic healthcare records; data deriving from health social media, e.g. claims and comments,

are able to lead to healthcare decision support and making, set the basis for patient-centered therapy and social, environmental and economical knowledge.

Although Big Data adoption in the healthcare system is already been studied from a medical and clinical point of view, references on how healthcare organizations have to be prepared on the adoption, and the consequences of it, in terms of organizational impact, change and readiness, and the management of Big Data are missing.

3 IT and Organizational Change

The widespread application of information technology is transforming the way in which the information is collected, exchanged, and stored, requiring a high level of coordination within units and organization.

The role that IT plays in organizations is radically changing over time. If IT was primarily used to automate existing operations and to increase the speed of communications, nowadays IT is mainly seen as an enabler for organizational changes that can lead to productivity gains (Zammuto et al., 2007). IT has taken over many coordination and control responsibilities from hierarchy, allowing people to organize around the work itself and what could be done with information. Leonardi's (2007) study demonstrates how the information generated by state-of-the-art IT can lead the change in the social structure of an organization. By exploring the informal advice networks that constitute an organization's social structure, Leonardi (2007) understands how the informational capabilities of an IT implementation – the potential a technology has for creating, modifying, transmitting and storing information – can lead to organizational change. Studying the introduction of an information technology into an organization and recognizing that the adoption of a new technology is always followed by organizational accommodations and changes, Volkoff et al. (2007) propose a technology-mediated organizational change theory that contemplates both the focus on the technology and the influence of the social interaction. With the imbrication metaphor, Leonardi (2011) explains how the interaction with technology leads to organizational changes, either adjusting work routines or introducing new form of information system. As digital technology is becoming pervasive new organizational forms associated with the adoption of this technology have to be studied (Yoo et al. 2012).

4 Affordances

The concept of Affordances has a long history, starting from the first studies in ecological psychology to the adoption of the theme in the information system field. According to Greeno (1994), Gibson's concept of affordance (1986) can be explained as the interaction involving an agent with some other system. The conditions that enable that interaction include properties of the agent along with some properties of the other system. Affordance is a property of whatever the person interacts with and it has to be a property that interacts with a property of an agent in such a way that an activity can be supported. Affordances are preconditions for activity, but do not imply that that specific activity will occur (Greeno, 1994). Gibson originally placed the

concept of affordance in the ecological psychology field, where the theme was also developed with other contributions.

Considering the complex relationships between technologies and the social, and the interactional circumstances in which they exist and are meaningful, Hutchby (2001) argues that affordances are functional and relational aspects. They frame, but do not determine, the possibilities for action in relation to an object. Switching to the concept of affordance in terms of the sociology of technology, technology can be understood as artefact. This artefact may be shaped by and/or shaping of the practices humans use in interaction with, around and through them. Hutchby (2001) develops Gibson's concept of affordance declaring that affordances are functional and relational, in the terms that are enabling factors in a given actor's attempt to engage in some activity and that are different for one actor than for another. In an artefact, affordances do not necessarily derive from natural feature of the artefact's materiality, but can be designed into the artefact; affordances set limits on what it is possible to do with, around, or via the artefact (Hutchby, 2001).

Zammuto et al. (2007) use affordances to explain the relation between IT and organization and identify affordances for organizing as a concept that emerge from the intersection of IT system and organization system. Five possible affordances are listed (Visualizing Entire Work Process, Real-Time/Flexible Product and Service Creation, Virtual Collaboration, Mass Collaboration, Simulation/Synthetic Representation) as potentials/capabilities made possible by the combination of technical and organizational features. Zammuto et al.'s (2007) research is relevant for us as they were the first to coin the term *affordance for organization* as a bridging concept that emerges from the intersection of IT system and organization systems, highlighting the intertwining of IT and organizational features.

Majchrzak and Markus (2012) set a light on what they named *technology affordance* as "action potential, that is, to what an individual or organization with a particular purpose can do with a technology or information system". Their study is relevant because emphasizes the importance of a technology affordance theory to study how people and organizations use information systems and how the use of information system affect individuals, organizations, and their performance.

According to Volkoff and Strong (2013), the concept of affordance helps specify mechanisms and enables to build theories of the effects of introducing new systems into organizations. They define affordance as the potential for behaviors associated with achieving an immediate concrete outcome and arising from the relation between an object (e.g. an IT artefact) and a goal oriented actor or actors. Strong et al. (2013) distinguish between affordances as potential for action and actualization as actions taken by individuals to realize those potentials. They define actualization process the process by which the affordance, the potential for behavior, is realized in an organization and elevate the concept of affordance to organizational affordance, indicating the potential actions to be actualized by a group of individuals in order to achieve organizational level immediate concrete outcomes in support of organizational level goals. Volkoff and Strong's (2013) study is particularly relevant since argue how affordances arise in the real domain from the relation between the assemblages of organizations and of IT artefacts, how affordances are actualized over time by organizational actors,

and how these actualizations lead effects observable in empirical domain. Strong et al. contribution to the affordances literature is particularly significant because authors define an Affordance-Actualization mid-range theory for a particular IT adoption in a specific field sector, explaining IT-associated organizational change.

Hence, this study advances that Affordances-Based Theories are a correct method to study organizational changes that organizations are experiencing due to the disruptive introduction of technology and information systems. We assume moreover that anticipatory models can be created on the base of Affordances-Based Theories.

5 Importance of the Affordance to study IT-Associated Organizational Change

One framework that is used to study how people and organizations interact with technology and to explain the increasingly symbiotic relationship between IT and organizations is the one of affordances (Zammuto et al. 2007, Majchrak and Markus, 2012). In this context affordances can be seen as a framework that help to study the technology adoption, the technology use, the impact on organizations and the consequences that derive from. Affordance-Based Theory overcomes the gap set by psychological, social psychological and sociological theories taking into consideration the possibility that individuals, using technology can create new practices and obtain new outcomes that could not occur without the use of technology (Majchrak and Markus, 2012). Beating the assumption in which technology was seen as something fixed and immutable, affordances need to be perceived and triggered by the actor to achieve the immediate concrete outcome, producing changes in the organizational routine that may affect future actions (a phenomenon called “imbrication”), such as IT and organizational changes (Volkoff & Strong, 2013). With the same point of view, affordances also are well accommodated in the context of Business Intelligence, technology that affords dramatic changes in decision making process and performance (Chen et al. 2012).

Affordance-Based Theory surmounts limitations of the theories that focus only on social behavior, but as a sociotechnical theory does not derive from either a technological or social imperative, but both technological and organizational aspects emerge together and are taken into account with the same consideration. Affordance-Based Theory does not make simplistic and deterministic assumptions and does not incorporate constructivist logics, but, as based on critical realism, better explains in the context itself the phenomenon of the interplay, as a product of the human interaction with the artefact.

Thus, Affordance-Based Theories can be use to better explain how information technology is implicated in organizational change (Volkoff and Strong, 2013).

6 Importance of Affordance to study Big Data Impact on Organization

As a pervasive digital technology, Big Data incorporate digital capabilities that deeply into the very core of the products, services, and operations of many organizations radically change the nature of them. Big Data provide an environment of technology affordances able to create innovations characterized by generativity, the capacity to produce unprompted change in organizational functioning (Yoo et al., 2012).

The application of an Affordance perspective on the Big Data facilitates the comprehension of the interplay of the social actor, as people or organizational intents, and the technology. Through the Affordance lens, the impact of Big Data on organization can be studied as a phenomenon not yet considered by the current research literature.

7 Conclusion and Future Work

Information technology has been identified as a key element for effecting needed changes in healthcare organizations. To achieve desired outcomes, such as better quality care, higher efficiency/productivity, reduced costs, and greater patients, providers and staff satisfaction, healthcare organizations have to be able to manage IT-associated changes, due to the massive production of data. In this specific context, affordances can be used to explain organizational change process associated with the accommodation and management of Big Data, improving the record of reaching the desired goals mentioned above.

Because Affordance-Based Theories are quite new and not fully developed, more studies and researches can be carried on. Some gaps have been identified in developing, for example, valuable grand theories, general theories applied to all organizations and all IT artefacts, and further mid-range theories, theories applied in specific contexts and selected organizations focusing only on particular technologies.

Affordance-Based Theories can be used to develop empirical studies based on the interaction between actors and IT in organizational changes, since interaction mechanisms are not yet clear.

Methodologies can be also developed that are able to anticipate tendencies and to better understand and manage organizational changes for practitioners and managers.

In short, understanding the human interaction with the IT object through an Affordance-Based Theory can be meaningful to highlight how this interplay is shown and the healthcare field is a critical context where this relationship is particularly consistent. To conclude, we first summarized the key contributions from the literature, and highlighted why affordance are the turnkey to effectively study the interplay between information technology and organizations.

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