# Developing a Big Data-Enabled Transformation Model in Healthcare: A Practice Based View

*Research-in-Progress*

**Yichuan Wang**
Raymond J. Harbert college of
business, Auburn University
405 W. Magnolia Ave., Auburn AL
36849, USA
yzw0037@auburn.edu

**LeeAnn Kung**
Raymond J. Harbert college of
business, Auburn University
405 W. Magnolia Ave., Auburn AL
36849, USA
hzt0007@auburn.edu

**William Yu Chuang Wang**
AUT University, Business Information
Systems
Auckland, New Zealand
william.wang@aut.ac.nz

**Casey G. Cegielski**
Raymond J. Harbert college of
business, Auburn University
405 W. Magnolia Ave., Auburn AL
36849, USA
cegieca@auburn.edu

## Abstract

*Healthcare organizations are looking for opportunities to create new business model and value that can be implemented through information technology (IT) enabled transformation. Big data, an overwhelming phenomenon which has been addressed through various new and old data management technologies, hold the key to healthcare transformation. To address this, we developed a big-data-enabled transformation model based on practice-based view showing that the relationships among big data capability, big-data-enabled transformation practice, benefit dimensions, and firm performance. We tested this model by analyzing secondary data regarding big data in the healthcare context. Our results not only conceptually defined four big data capabilities but also found two significant path-to-performance chains. The contributions of this study are twofold. For management research, we establish a big-data-enabled transformation model to explain how big data leads to firm performance. For practitioners, we identify potential patterns that will help understanding big data's potentials and capabilities.*

**Keywords:** IT-enabled transformation, big data capability, practice-based view, content analysis

## Introduction

Big data is an overwhelming phenomenon that has aroused enormous discussion in the field of information systems (IS). A big data technology solution which involves with various technologies in terms of data capture, transformation, and consumption is ideal for all kinds of data repository in their inherent business object formats and processing an immense volume, variety and velocity (3Vs) of data across a wide range of enterprise platforms (Wang et al. 2015). The use of big data has the potential to facilitate information integration and analytical capabilities, and to provide proactive business insights to meet future market needs and trends in healthcare organizations (Raghupathi and Raghupathi 2014; Schroeck et al. 2012). It thus is expected to meet the IT-related challenges, such as the lack of integration in healthcare systems and poor healthcare information management (Bodenheimer 2005; Grantmakers In Health 2012; Herrick et al. 2010; The Kaiser Family Foundation 2012) to help transform IT value to business value in the U.S. healthcare.

However, most current big data studies in healthcare merely concentrates on a technological understanding of big data (e.g., Chawla and Davis 2013; Srinivasan and Arunasalam 2013) rather than identifying the strategic and business value of its implementation. While these pioneering big data studies have addressed the perspectives of big data's technological development and functionalities, research on big data's strategic and business aspects along with the discussion on how to adopt it successfully is urgently needed. To address this gap, the main goal of this paper is to offer a comprehensive view of big data through creating a big-data-enabled transformation model in healthcare. The big-data-enabled transformation is stemmed from the concept of IT-enabled transformation that refers to the sequential changes of first the operational improvement and internal integration through IT functionalities, and followed by transforming IT capabilities into competitive advantage and financial performance through a set of business redesign (Dehning et al. 2003; Lucas et al. 2013; Markus and Benjamin 1997; Venkatraman 1994). Such a model aims to emphasize how big data capabilities generate the potential benefits through improving a series of organizational practices, thereby increasing firm performance.

In order to develop this model, we searched for theories which offer a theoretical understanding of how to leverage IT for firm performance. Resource-based theory (RBT) (e.g., Bharadwaj 2000; Mata et al. 1995; Wang et al. 2013), knowledge-based view (KBV) (e.g., Kearns and Sabherwal 2007), and dynamic capability view (e.g., Pavlou and El Sawy 2006) have been widely applied to the information system (IS) field. Although these theories provide excellent anchors to explain how organizations obtain sustained competitive advantage through their specific organizational resources, knowledge, and capabilities, strategic management scholars have critiqued the appropriateness of these theories for their weakness in elucidating heterogeneous firm performance and the lack of a comprehensive framework (Bromiley and Rau 2014). Addressing these concerns, Bromiley and Rau (2014) propose the practice-based view (PBV) emphasizing the importance of measuring actual firm performance, and also offer an expanded conceptual framework, in which a causal path of explanatory variables (the enablers of practices), practices, intermediate outcomes, and performance is elaborated. Therefore, we use PBV as the foundation to develop big-data-enabled transformation model in a systematic fashion that ties IT capabilities, organizational practices, benefit dimensions, and firm performance together and apply it to the big data in the healthcare context. The remainder of this paper is structured as follows: the next section presents our conceptual model. This is followed by presenting our research method, current findings of the content analysis, and future directions.

## Theoretical Foundation

Our theoretical foundation comprises two perspectives: practice based view (PBV) and strategic values of IT capabilities. The aim of PBV is to explain the effects of macro-level firm behaviors or characteristics on firm outcomes (Bromiley and Rau 2014). Through the lens of PBV, the impacts of healthcare IT on clinical practices and the effects of different practices on firm performance could be seen more clearly (Bjørn et al. 2009; Boulus and Bjørn 2008; Jensen and Aanestad 2007; Oborn et al. 2011). Although previous PBV research has stressed that the use of practice itself is important for firm performance (Igira 2008; Giannopoulou et al. 2014; Bloom et al. 2012; Bloom et al 2013; Tallman and Chacar 2011), a comprehensive theoretical framework is still lacking. Bromiley and Rau (2014) present an expanded PBV framework with strategic perspectives, illustrating that different performances are manifested in firms' execution of various practices that are facilitated by explanatory factors. Their model consists of four

elements: explanatory variables, practices, intermediate outcomes, and performance, and suggests that there are strong relationships among them. The explanatory variables can be viewed as enablers of the practice. Practice is "a defined activity or a set of activities that a variety of firms might execute" (Bromiley and Rau 2014). A practice can be treated as the combination of the subject, the action, the tools and the context (Russo-Spena and Mele 2012) or a set of activities, routines and material arrangements (Schatzki et al. 2001; Schatzki 2005). Practices in the organization are related to firm performance and might operate through intermediary constructs (Bromiley and Rau 2014).

However, Bromiley and Rau (2014) do not specify explanatory variables. On one hand, it allows for idiosyncratic interpretation; on the other hand, it leaves the applicability debatable. In the context of healthcare industry, we content that IT is one of the key drivers of organizational performance (Banker et al. 2006; Mithas et al. 2011; Tanriverdi 2005). Thus we propose that IT capabilities be the explanatory variables of our IT-enabled transformation model. Following PBV, the conceptual path is illustrated in Figure 1: from IT capabilities to IT-enabled transformation practices, to benefits dimension, and then to final outcome, firm performance. We describe each construct next.



**Figure 1. IT-Enabled Transformation Model Based on Practice-Based View**
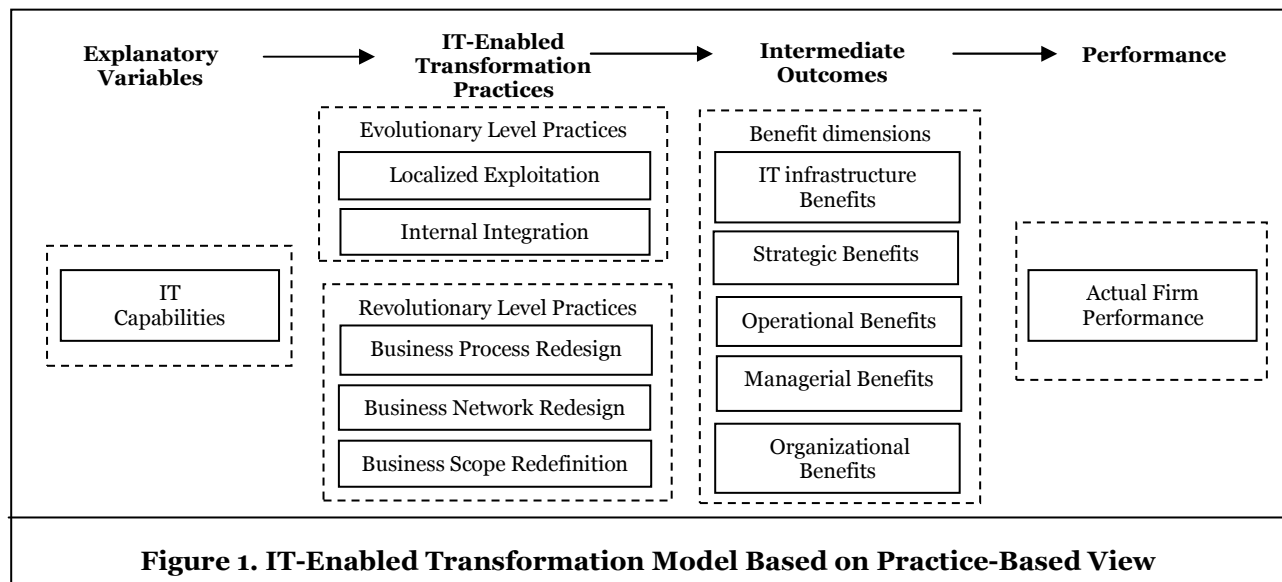
## IT Capability

IT capability has been identified as a key factor that not only drives organizational changes but also enhance organizational performance (Kim et al. 2011; Lu and Ramamurthy 2011). IT capability is defined as "the firms' ability to acquire, deploy, and leverage its IT resources to shape and support its business strategies and value chain activates" (Bharadwaj et al. 2002, p. 4). IS researchers contend that IT capabilities can be facilitated by IS/IT resources and have the potential to create business value, support managers, and enhance the range and reach of business opportunities (Doherty and Terry 2009; Karimi et al. 2007; Weill and Vitale 2002; Zhu 2004). Specifically, Pavlou and El Sawy (2006; 2010) have emphasized that paying greater attention to the leveraging dimension of IT capability, such as IT-leveraging capability can help understand the influence of specific information systems on the certain context.

## IT-Enabled Transformation Practices

Being in professionally oriented care settings, healthcare industry is more institutionally complex than other industries (Scott et al. 2000). To understand IT-enabled transformation practices in healthcare, we conducted a literature search on the social science citation index (SSCI) database that is provided by Thomas Reuters seeking healthcare-related articles in IS field published from January 1, 2005 to January 1, 2014. Based on our literature review, we conceptualize IT-enabled transformation practice following Venkatraman's (1994) view. IT-enabled transformation practice is defined as a set of organizational change activities that are executed through IT/IS supports. We treat Venkatraman's (1994) hierarchy of

five levels of IT-enabled business transformation as the IT transformation practices that consists of localized exploitation, internal integration, business process redesign, business network redesign, and business scope redefinition. Localized exploitation practice refers to "a practice to leverage IT functionality to redesign business operations" (Venkatraman 1994, p. 82). Internal integration practice refers to "a practice to leverage IT capability to create a seamless organizational process - reflecting both technical interconnectivity and organizational interdependence" (Venkatraman 1994, p. 82). These two formed the evolutionary transformation level practices. Business process redesign practice is regarded as "redesigning the key processes to derive organizational capabilities for competing in the future as opposed to simply rectifying current weaknesses" (Venkatraman 1994, p. 82). Business network redesign practice is defined as "articulating the strategic logic to leverage related participants in the business network to provide products and services in the marketplace" (Venkatraman 1994, p. 82). Business scope redefinition practice refers to "a practice that allows organization to redefine the corporate scope that is enabled and facilitated by IT functionality" (Venkatraman 1994, p. 82).

### Intermediate Outcomes and Performance

We use Shang and Seddon's (2002) potential benefits of enterprise systems as our intermediate outcomes, and link them to actual firm performance. These potential benefits can be classified into five categories: organizational benefits, managerial benefits, strategic benefits, IT infrastructure benefits, and operational benefits. Previous studies have widely applied these benefits to healthcare IT (e.g., Monem et al. 2013), enterprise systems such as enterprise resource planning (ERP) (e.g., HassabElnaby et al. 2012; Tsai et al. 2013) and customer relationship management (CRM) systems (e.g., Alshawi et al. 2011), and specific IT infrastructure (e.g., Huang and Hu 2004; Mueller et al. 2010). Finally, based on the logic of PBV, the intermediate benefits should be connected to the firm performance.

## Research Method

### Research objective and approach

Big data technology is one of the examples of IT-enabled transformation that have been introduced in recent years. In this regard, the attention on how big data can transform its values to create business values needs to be paid. Through analyzing big data cases in health care we expect to understand whether big data as a unique, distinctive IT resource can generate big-data-specific IT capabilities, and such capabilities lead to improve organizational healthcare related practices, thereby increase healthcare organizational benefits and performance. By coding the statement from case materials it will help us understand the big data capabilities and benefits, and construct a big data-enabled transformation model in health care.

We employ content analysis as the research approach to analyze our cases. Content analysis is a method for extracting various themes and topics from text, and it can be understood as, "an empirically grounded method, exploratory in process, and predictive or inferential in intent" (Krippendorff 2004, p. xvii). Strategic management scholars frequently rely on content analysis to collect difficult to obtain data in a wide range of research streams (Short and Palmer 2008, p. 727). One of the main ideas behind content analysis is that large bodies of text are grouped into a relatively small number of categories based on some criteria so that the large bodies of text can be managed and understood. Specifically, this study followed inductive content analysis, because the knowledge about big data implementation in healthcare is fragmented (Raghupathi and Raghupathi 2014).

### Data collection

Our research approach is to analyze big data cases that were drawn from multiple sources such as practical journals, print publications, case collections, and companies', vendors', consultants' or analysts' reports. The following case selection criteria were applied: (1) the case presents an actual implementation of big data, (2) it clearly describes the software they introduce and benefits obtaining from big data. We were able to collect 26 big data cases specifically related to the healthcare industry. Of these sources, we classified 15 sources (58%) as material released by vendors or companies, 2 sources (8%) as originating from journal databases, and 9 sources (34%) as print publications, including healthcare institute reports

and case collections. Categorizing by region, 16 cases were collected from Northern America, 8 cases from Europe, and 2 cases from Asia-Pacific region. The cases are listed as Appendix A.

### *Research process*

In order to ensure a better understanding of big data capabilities and benefits and build a big data-enabled transformation model in the healthcare context, we look for path-to-performance chains among each construct of IT-enabled transformation model for deeper understanding of how big data capabilities affect healthcare organization performance. The theme chosen is "causal chain", specifically; a capability (cause) for a practice then brings some intermediate outcome and then outcome (firm performance). To find the causal chains, two industry experts who both have over 15 years working experience with a multinational technology and consulting corporation headquartered in the United States, and specialized in big data were enlisted as our expert panel. This panel manually highlighted the textual contents that relate to causal chain while reading through all 26 big data cases for a couple of times. Each case was first analyzed by one of experts, who coded the path-to-performance chains. In order to increase the interrater reliability, the second expert then analyzed each case. Agreement between two experts warrantees acceptance of the chain. A total of 87 initial chains were obtained by this panel and recorded in a Microsoft Excel spreadsheet.

Next, these causal chains from the expert panel were subject to further discussions by an academic panel that composed of all the authors. Coding results were compared with the expert panel coding. If there was agreement on the coding, the chain was accepted and counted for the final tally. Once conflict occurred, two teams reassessed each case and arrived at a consensus as much as possible. If there was still discrepancy, a third author evaluated the cases and coding then casted votes.

## Current Findings

Overall, the two coding teams agreed on 84% of the classifications. Ensuring interrater reliability led to the elimination of 4 chains after much discussion and debate. Our approach resulted in finding 4 big data capabilities and a total of 83 path-to-performance chains (see small sample of chains from coding sheet in Table 1). We summarized the findings in a big data-enabled transformation, as shown in Appendix B. Among the four big data capabilities we found that analytical capability is the primary capability (coded as part of 37 chains), followed by decision support capability (22), traceability (14), and predictive capability (10). This result shows that current big data solutions mainly provide healthcare organizations the abilities to analyze the vast amount and various types of data and use analyzed information for decision making.

For big data-enabled transformation practice, results show that big data capabilities mainly support evidence-based medicine practice (22). It is followed by diversity of electric health records use practice (16), clinical data integration practice (15), multidisciplinary sharing practice (11), network collaboration practice (9), network knowledge creation practice (6), and personalized care practice (4). The results indicate that a transformation in health care through big data is still in the level of evolutionary transformation (coded as part of 53 chains) that leads to limited effect on managerial and strategic benefits.

The third element of big data-enabled transformation model, benefit dimension indicates that through IT-enabled practice healthcare organization can primarily enhance their IT infrastructure benefits (43) that followed by operational benefits (23), organizational benefits (7), managerial benefits (6), and strategic benefits (4). The outcome of this IT transformation model is the actual firm performance. Finally, our analysis reveals that the adoption of big data will generate profitability (59) and increase return on investment (24).

In addition, the results of path-to-performance chains show that the link among analytical capability, evidence-based medicine practice, IT infrastructure benefits, and profitability is particular significant (19 links). This aspect means that big data with analytical capability can improve the quality of evidence-based medicine, which in turn, facilitate IT infrastructure benefits (e.g., reduce IT cost) and increase firms' profitability.

| | Table 1. A Small Sample of Path-to-Performance Chains from Coding Sheet | | | |
|---|---|---|---|---|
| | Statement | Industry expert panel | Academic panel | Consensus Coding |
| A | The powerful analysis solution… enables the research institute to expand the reach in multidisciplinary, geographically broad studies that extract important insights from large amounts of healthcare data. This insight paved the way for doctor awareness programs designed to reduce excessive use of antibiotics. This business analytics platform is more affordable and the return on investment is often achieved after only a few months. | Analytical capability→ Multidisciplinary practice→ Operational benefits→ROI | Analytical capability→ Multidisciplinary practice→ Operational benefits→ROI | Analytical capability→ Multidisciplinary practice→ Operational benefits→ROI |
| B | With the help of analytics software, we built a framework that is able to determine optimal actions based on what has been observed so far, the beliefs about the current situation based on those observations. Ultimately, this solution provides a potential 42 percent improvement in patient outcomes, and a 58 percent savings in the cost per unit of outcome change. | Analytical capability → Evidence-based medicine practice → IT infrastructure benefits→ Profitability | Decision support capability→ Evidence-based medicine practice → Operational benefits→ Profitability | Analytical capability → Evidence-based medicine practice → Operational benefits→ Profitability |

## Discussion of Big Data Capabilities in Healthcare

### *Traceability*

Traceability is the ability to track the output data from all of the IT components throughout healthcare service units. Healthcare-related data such as activity and cost data, clinical data, pharmaceutical R&D data, patient behavior and sentiment data commonly can be collected in real time or near real time from payers, healthcare services, pharmaceutical companies, consumers and stakeholders outside healthcare (Groves et al. 2013). The primary goal of traceability is to make data consistent, visible and easily accessible to analyze. Traceability in healthcare enables monitoring the relation between patients' needs and potential solutions through tracking each dataset provided by each healthcare service or device. For example, Radio Frequency Identification (RFID) has become more dominate in place of bar code labels in U.S. hospitals. Big data traceability can track information such as an unique identifier for the location of the event and time stamp for each healthcare service in real time that are generated by RFID equipment. This information is immediately deposited in the various databases (e.g., NoSQL and Hadoop distributed file system) for future appropriate analysis at the right time. Hospitals can then take actions to improve medical supplies utilization rates and reduce the patient flow delay time.

### *Analytical capability*

Analytical capability refers to analytical techniques in a big data architecture that have the ability to process data with an immense volume (from terabytes to exabytes), variety (from text to graph) and velocity (from batch to streaming ) via unique data storage, management, analysis, and visualization technologies (Chen et al. 2012; Zikopoulos et al. 2012). The differences in analytical capability between big data architecture and traditional IT architecture are that the former has a unique ability to analyze semi-structured or unstructured data (e.g., image, audio, and video), to parallel process large data volumes, and to parse data in real time or near real time.

### *Decision support capability*

Decision support capability emphasizes the ability to produce reports about daily healthcare service to aid managers' decisions and actions. In general, this capability yields sharable information and knowledge

such as historical reports, executive summaries, drill-down queries, statistics analyses, and time series comparisons. Such information can be created after analyzing to obtain a comprehensive view for implementing evidence-based medicine, to detect advanced warnings for disease surveillance, and to develop personalized patient care. Some information is deployed in real time (e.g., medical devices' dashboard metrics) while others (e.g., daily reports) are presented in summary forms. The reports generated by analytics engines of big data are distinct from transitional IT architectures, showing that it is conducive to assess past and current operation environment across all organizational levels. In other words, big data reports are created with a systemic and comprehensive perspective and evaluated the results in the proper contexts that afford managers to recognize feasible opportunities for improvement.

### *Predictive capability*

Predictive capability is the ability to use statistical or data-mining methods on both structured and unstructured data to determine future outcomes (Hurwitz et al. 2013, p. 289). Predictive capability is a focus on the prediction of future trends and insights. This capability of big data means that the predictive analysis can conduct cross-references between current and historical data and generate context-aware recommendations that enable managers to make predictions about future events and trends. Predictive capabilities in healthcare assess current healthcare service situation to help managers disentangle the complex structure of clinical cost, identify best clinical practices, and gain a broad understanding of future healthcare trends with the knowledge of patient's lifestyle, habits, disease management and surveillance (Groves et al. 2013).

## Limitations and Future Research

Healthcare usually lags behind other industries in IT adoption. This is one of the main reasons that cases are hard to find. Although efforts had been made to find cases from different sources, the majority of the cases found are from vendors. A potential bias surfaced as vendors usually only publicizes their "success" stories. In addition, the performance measures used by both academia and industries are financial related such as profitability and ROI. Due to the uniqueness of healthcare field, scholars have posited that the measurement of healthcare organization performance should be different from the ones used for commerce. For current study, limited by the cases we found, profitability and ROI are used.

The next step of our research is to underline the development of specific healthcare practice (e.g., Evidence-based medicine practice) by leveraging big data capabilities. In addition, we present some future directions: (1) develop a scale of big data capabilities and their practices in healthcare for validating the proposed model; (2) empirically examine the two path-to-performance chains in health care found in our analysis; (3) apply IT-enabled transformation model to other contexts; (4) explore other IT-related explanatory factors, such as human IT constructs for IT-enabled transformation model; (5) explore other performance measures such as quality or satisfaction.

## Conclusion

We have developed a generic IT-enabled transformation model based on PBV showing the relationships among IT capability, IT-enabled transformation practice, benefit dimensions, and firm performance. We also tested this model by analyzing secondary data regarding big data in the idiosyncrasies of the healthcare context. Through analyzing these big data best practice cases, we sought to better understand how healthcare organizations can leverage big data as a means to transform IT to business value. In the current stage of this study, we not only conceptually defined four big data capabilities but also found two significant path-to-performance chains. Through analyzing big data cases to test this model, the potential contributions of this study are twofold. For management research, we establish a big data-enabled transformation model to explain how big data leads to firm performance. For practitioners, we identify potential patterns that will help understand big data's potentials and capabilities.

# References

Alshawi, S., Missi, F., and Irani, Z. 2011. "Organisational, Technical and Data Quality Factors in CRM Adoption - SMEs Perspective," *Industrial Marketing Management* (40:3), pp. 376-383.

Banker, R. D., Bardhan, I. R., Chang, H., and Lin, S. 2006. "Plant Information Systems, Manufacturing Capabilities and Plant Performance," *MIS Quarterly* (30:2), pp. 315-337.

Bharadwaj, A. S. 2000. "A Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation," *MIS Quarterly* (24:1), pp. 169-196.

Bharadwaj, A., Sambamurthy, V., and Zmud, R. 2002. "Firmwide IT Capability: An Empirical Examination of the Construct and its Links to Performance," Working paper, Department of Decision and Information Analysis, Emory University, Atlanta, GA.

Bjørn, P., Burgoyne, S., Crompton, V., Macdonald, T., Pickering, B., and Munro, S. 2009. "Boundary Factors and Contextual Contingencies: Configuring Electronic Templates for Healthcare Professionals," *European Journal of Information System*s (18:5), pp. 428-441.

Bloom, N., Eifert, B., Mahajan, A., McKenzie, D., and Roberts, J. 2013. "Does Management Matter? Evidence from India," *Quarterly Journal of Economics* (128:1), pp. 1-51.

Bodenheimer, T. 2005. "High and Rising Health Care Costs. Part 1: Seeking an Explanation," *Annals of Internal Medicine* (142:10), pp. 847-854.

Boulus, N., and Bjørn, P. 2008. "A Cross-Case Analysis of Technology-in-Use Practices: EPR-Adaptation in Canada and Norway," International Journal of Medical Informatics (79:6) pp. e97–e108.

Bromiley, P., and Rau, D. 2014. "Towards a Practice-Based View of Strategy," *Strategic Management Journal*, doi: 10.1002/smj.2238.

Chawla, N. V., & Davis, D. A. 2013. "Bringing big data to personalized healthcare: a patient-centered framework". *Journal of general internal medicine*, (*28*:3), pp. 660-665.

Chen, H., Chiang, R. H. L., and Storey, V. C. 2012. "Business Intelligence and Analytics: From Big Data to Big Impact," *MIS Quarterly* (36:4), pp. 1165-1188.

Dehning, B., Richardson, V., and Zmud, R. 2003. "The Value Relevance of Announcements of Transformational Information Technology Investments," *MIS Quarterly* (27:4), pp. 637-656.

Doherty, N. F., and Terry, M. 2009. "The Role of IS Capability in Delivering Sustainable Improvements to Competitive Positioning," Journal of Strategic Information Systems (18:2), pp. 100-116.

Giannopoulou, E., Gryszkiewicz, L., and Barlatier, P. J. 2014. "Creativity for Service Innovation: A Practice-Based Perspective," *Managing Service Quality* (24:1), pp. 23-44.

Grantmakers In Health. 2012. Transforming Health Care Delivery: Why It Matters and What It Will Take, Washington, DC: Grantmakers In Health.

Groves, P., Kayyali, B., Knott, D., Kuiken, S. V. 2013. The "Big Data" Revolution in Healthcare: Accelerating Value and Innovation, McKinsey & Company.

HassabElnaby, H. R., Hwang, W., Vonderembse, M. A. 2012. "The Impact of ERP Implementation on Organizational Capabilities and Firm Performance," *Benchmarking: An International Journal*, (19:4/5), pp.618-633.

Herrick, D. M., Gorman, L., Goodman, J. C. 2010. Health Information Technology: Benefits and Problems, Dallas, Texas: National Center for Policy Analysis.

Huang, D. and Hu, Q. 2004. "Integrating Web Services with Competitive Strategies: A Balanced Scorecard Approach," *Communications of the AIS* (13:6), pp.57-80.

Hurwitz, J., Nugent, A., Hapler, F. and Kaufman, M. 2013. Big Data for Dummies, Hoboken, New Jersey: John Wiley & Sons.

Igira, F. T. 2008. "The situatedness of work practices and organizational culture: implications for information systems innovation uptake". *Journal of Information Technology*, (*23*:2), pp. 79-88.

Jensen, T., and Aanestad, M. 2007. Hospitality and Hostility in Hospitals: A Case Study of an EPR Adoption among Surgeons. *European Journal of Information Systems* (16:6), pp. 672-680.

Karimi, J., Somers, T.M., Bhattacherjee, A. 2007. "The Role of Information Systems Resources in ERP Capability Building and Business Process Outcomes," *Journal of Management Information Systems* (24:2), pp. 221-260.

Kearns, G., and Sabherwal, R. 2007. "Strategic Alignment Between Business and Information Technology: A Knowledge-Based View of Behaviors, Outcome, and Consequences," *Journal of Management Information Systems* (23:3), pp. 129-162.

Kim, G., Shin, B., Kim, K.K., and Lee, H.G. 2011. "IT Capabilities, Process-Oriented Dynamic Capabilities, and Firm Financial Performance," *Journal of the Association for Information Systems* (12:7), pp. 487-517.

Krippendorff, K. (2004). Content Analysis: An Introduction to Its Methodology (2nd ed.), London: Sage Publications.

Lu, Y., and Ramamurthy, K. 2011. "Understanding the Link between Information Capability and Organizational Agility: An Empirical Examination," *MIS Quarterly* (35:4), pp. 931-954.

Lucas, H.C.Jr., Agarwal, R., Clemons, E.K., El Sawy, O.A., and Weber, B. 2013. "Impactful Research on Transformational Information Technology: An Opportunity to Inform New Audiences," *MIS Quarterly* (37:2), pp. 371-382.

Markus, M. L., and Benjamin, R. I. 1997. "The Magic Bullet Theory in IT-Enabled Transformation," *Sloan Management Review* (38:2), pp. 55-68.

Mata, F. J., Fuerst, W. L., and Barney, J. B. 1995. "Information Technology and Sustained Competitive Advantage: A Resource-Based Analysis," *MIS Quarterly* (19:4), pp. 487-505.

Mithas, S., Ramasubbu, N., and Sambamurthy, V. 2011. "How Information Management Capability Influences Firm Performance," *MIS Quarterly* (35:1), pp. 237-256.

Monem, H., Afrasiabli, M., Rezvan, P., and Dehkordi, S. A. 2013. "The Impact of User Quality and Information Quality on the IS Success in Healthcare Context," *Journal of Basic and Applied Scientific Research* (3:10), pp. 40-51.

Mueller, B., Viering, G., Legner, C., and Riempp, G. 2010. "Understanding the Economic Potential of Service-Oriented Architecture," *Journal of Management Information Systems* (26:4), pp. 145-180.

Oborn, E., Barrett, M., and Davidson, E. 2011. "Unity in Diversity: Electronic Patient Record Use in Multidisciplinary Practice," *Information Systems Research* (22:3), pp. 547-564.

Pavlou, P. A., and El Sawy, O. A. 2006. "From IT Leveraging Competence to Competitive Advantage in Turbulent Environments: The Case of New Product Development," *Information Systems Research* (17:3), pp. 198-227.

Pavlou, P. A., and El Sawy, O. A. 2010. "The "Third Hand": IT-Enabled Competitive Advantage in Turbulence through Improvisational Capabilities," *Information Systems Research* (21:3), pp. 443-471.

Raghupathi, W. and Raghupathi, V. 2014. Big data analytics in healthcare: promise and potential. *Health Information Science and Systems*, (2:1), 3.

Russo-Spena, T., and Mele, C. 2012. ""Five Co-s" in Innovating: A Practice-Based View," *Journal of Service Management* (23:4), pp. 527-553.

Schatzki, T. R. 2001. Introduction: Practice Theory, in Schatzki, T. R., Knorr Cetina, K. and von Savigny, E. (eds), *The Practice Turn in Contemporary Theory*, London: Routledge.

Schatzki, T. R. 2005. "Peripheral Vision: The Sites of Organizations," *Organization Studies* (26:3), pp. 465-484.

Schroeck, M., Shockley, R., Smart, J., Romero-Morales, D., Tufano, P. 2012. Analytics: The Real-World Use of Big Data: How Innovative Enterprises Extract Value from Uncertain Data, New York: IBM Global Service.

Scott, W. R., Ruef, M., Mendel, P., and Caronna, C. 2000. *Institutional Change and Healthcare organizations: From Professional Dominance to Managed Care*, Chicago: University of Chicago Press.

Shang, S., and Seddon, P. B. 2012. "Assessing and Managing the Benefits of Enterprise Systems: The Business Manager's Perspective*," Information Systems Journal* (12:4), pp. 271-299.

Short, J. C., and Palmer, T. B. 2008. "The Application of Diction to Content Analysis Research in Strategic Management," *Organizational Research Method* (11:4), pp. 727-752

Srinivasan, U., and Arunasalam, B. 2013. Leveraging big data analytics to reduce healthcare costs. *IT Professional* (15:6), pp. 21-28.

Tallman, S. and Chacar, A. S. 2011. "Knowledge Accumulation and Dissemination in MNEs: A Practice-Based Framework," *Journal of Management Studies* (48:2), pp. 278–304.

Tanriverdi, H. 2005. "Information Technology Relatedness, Knowledge Management Capability, and Performance of Multibusiness Firms," *MIS Quarterly* (23:2), pp. 311-334.

The Kaiser Family Foundation. 2012. Health Care Costs: A Primer, Key Information on Health Care Costs and Their Impact, The Henry J. Kaiser Family Foundation.

Tsia, W. H., Chen, H. C., Chang, J. C., Leu, J. D., Chen, D. C., and Purbokusumo, Y. 2013. "Performance of the internal audit department under ERP systems: empirical evidence from Taiwanese," *Enterprise Information Systems*, (ahead-of-print), pp. 1-18.

Venkatraman, N. 1994. "IT-Enabled Business Transformation: From Automation to Business Scope Redefinition," *Sloan Management Review* (35:2), pp. 73-87.

Wang, Y., Kung, L., Byrd, T.A. 2013. "Leveraging Event-Driven IT Architecture Capability for Competitive Advantage in Healthcare Industry: A Mediated Model," In *Proceedings of 34th International Conference on Information Systems (ICIS)*, Milan, Italy.

Wang, Y., Kung, L., Ting, C.C. & Byrd, T.A. 2015. "Beyond a Technical Perspective: Understanding Big Data Capabilities in Health Care," In *Proceedings of 48th Annual Hawaii International Conference on System Sciences*, Kauai, Hawaii.

Weill, P., Vitale, M. 2002. "What IT Infrastructure Capabilities Are Needed to Implement E-Business Models," *MIS Quarterly Executive* (1:1), pp. 17-34.

Zhu, K. 2004. "The Complementarity of Information Technology Infrastructure and E-Commerce Capability: A Resource-Based Assessment of Their Business Value," *Journal of Management Information Systems* (21:1), pp. 167-202.

Zikopoulos, P.C., Eaton, C. deRoos, D., Deutsch, T., and Lapis, G. 2012. Understanding Big Data: Analytics: Analytics for Enterprise Class Hadoop and Streaming Data. McGraw Hill.

**Appendix A.  The List of Big Data Cases**

- Material released by vendors or companies: Wissenschaftliches Institut der AOK (WIdO); Brigham and Women's Hospital; The Norwegian Knowledge Centre for the Health Services (NOKC); Memorial Healthcare System; University of Ontario Institute of Technology; Centerstone Research Institute; Premier healthcare alliance; Bangkok Hospital; Rizzoli Orthopaedic Institute; Universitätsklinikum Erlangen; Fondazione IRCCS Istituto Nazionale dei Tumori (INT); Fraunhofer FOKUS; Leeds Teaching Hospitals; Beth Israel Deaconess Medical Center; Kaiser Permanente.
- Journal databases: Anonymous private health institution in Australia; University Hospitals Case Medical Center.
- Print publications: Texas Health Harris Methodist Hospital; United Healthcare; Mount Sinai Medical Center; Nevada Department of Health and Human Services; Newton Medical Center; Sharp Community Medical Group; Thundermist Health Center; Nice University Hospital; New York State Department of Health.

**Appendix B.  The Results of Big Data-Enabled Transformation Model**