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Examining the Role of Business Analytics in Healthcare Value Chain

Research in Progress

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Abstract

This research explores how healthcare organizations are leveraging business analytics (BA) capabilities and techniques to improve quality of care and reduce cost. Given the increased interest and investment in BA, it is important to have a good understanding of what analytics capabilities healthcare organizations use to enhance value. Using Burns et al. (2002) healthcare value chain framework as a basis, we will identify the various analytics techniques/capabilities and subsequently classify them into three generally accepted classification of analytics: descriptive, predictive and prescriptive. Based on extensive search of the literature, complimented by a follow-up case study of a large regional hospital, analytics applications will be mapped onto the value chain framework in the contest of healthcare. The study will contribute to practice and academia by clearly illustrating how healthcare organizations currently utilizes or should be using analytic capabilities and techniques in order to enable them close the quality gaps.

Keywords: healthcare, business analytics, capabilities, value chain, quality improvement

Introduction

Concerns about the quality of care and economic sustainability of healthcare providers have existed for years all over the world (Dinev, T., Albano, V., Xu, H., & D’Atri, A., 2016). Government agencies and businesses who are involved in providing health coverage for workers and citizens have long called for cost control (Dinev et al. 2016). In the United States, a published report from the Business Roundtable, which represents CEOs of major companies has concluded that the US healthcare system has become a liability that hinders companies’ as well as healthcare organizations’ competitiveness in a global economy (Alonso-Zaldivar 2009). As an additional twist, the report found that higher U.S. spending fails to deliver a healthier work force, thus creating the largest “value gap” between cost and benefits among healthcare systems.

The healthcare sector has drawn attention of many healthcare providing organizations to seek better ways to re-engineering their current “modus operandi” or methods of operation. As a result, emphasis on the adoption and use of BA tools and techniques has since been increasingly enforced by many healthcare organizations as one of the most efficient ways to streamline healthcare processes and operations in order to achieve better quality of care delivery and overall performance (Agarwal, Gao, DesRoches, & Jha, 2010; Chen, Chiang, & Storey, 2012). However, while there have been several studies on the adoption and impact of BA on organizational performance, only a few studies in the Information Systems discipline have investigated BA impacts on quality of care in the healthcare sector (Sharma et al., 2014; Wang, Kung, & Byrd, 2016).

Business analytics has been defined as “the study of data to discover potential trends, analyze the effects of certain decisions or events, or to evaluate the performance of a given tool or scenario, with the goal of
improving outcomes through greater knowledge” (Reiner 2013, p. 826). While analytics have permeated all aspects of business to date, healthcare analytics represent an area of extremely high and untapped potential Wang et al (2016). The McKinsley Global Institute (MGI) estimates that big data analysis (i.e., analysis of large datasets) could save the U.S. healthcare system 300 billion dollars annually, with two thirds of that saving in the form of decreasing expenditures by 8 % (Gartner 2012; Reiner 2013).

A systemic review of the extant literature reveals that several studies have proposed models, typologies and domains to study the impact of BA on organizations (Chen et al. 2012; Holsapple et al. 2014; Wixom et al. 2013). Other studies have focused on the supply chain analytics capabilities (Chae et al. 2014) of organization from a resource-based view (Barney 1991) and dynamic capabilities perspectives (Eisenhardt & Martin 2000) (Chae & Olson 2013). While these studies have generally shown that relationship exist between BA adoption and organizational performance (operations, financial, etc.), there is – to the best of our knowledge – no study that has yet systematically investigated or shown how BA is being utilized in a large healthcare organization to improve quality of care and financial performance, which are the two key business objectives of every healthcare organization.

Thus, the healthcare industry currently lags behind significantly in taking full advantage of current and emerging state-of-the art BA tools and methods (Ferranti, Langman, Tanaka, McCall, & Ahmad, 2010; Fihn et al., 2014). Many healthcare organizations are struggling today with the implementation of BA techniques and technologies even though they invest in numerous analytics systems and applications with the hope of achieving major transformation in their daily care processes and performance (Murdoch & Detsky, 2013; Shah & Pathak, 2014). Moreover, evidence from a survey also shows that 60% of healthcare organizations surveyed fail to develop a clear, integrated enterprise strategy and vision for analytics deployment across a broad range of functions (Deloitte Center for health Solutions, 2015). One of the reasons for this immaturity of BA implementation in healthcare organizations is basically as a result of lack of understanding of the economic potential of BA (Groves, Kayyali, Knott, & Kuiken, 2013; Murdoch & Detsky, 2013).

Evidenced by the above gaps in the literature, we conclude that the current stream of research on BA has focused mainly on addressing BA implementation issues pertinent to most industries. However, research on BA implementation in healthcare is significantly lacking and as such, healthcare organizations are currently in their early stages in taking full advantage of BA techniques to address issues related to strategic choices and resource configurations (Xu, Frankwick, & Ramirez, 2016), as well as issues related to comprehensively understanding the managerial, economic, and strategic impact of BA (Raghupathi & Raghupathi, 2014; Ward et al., 2014). We further argue, therefore, that without reasonable guidelines backed by theory, not only is it difficult to help healthcare practitioners focus priorities and efforts on deriving value from the adoption of BA, but they also cannot find sufficient evidence of how BA investment can pay off (Murdoch & Detsky, 2013; Shah & Pathak, 2014).

Given this gap, and still limited understanding of the business value of BA implementation in healthcare organizations, this research is being conducted to address the following key research question:

**How can BA techniques, methods and technologies be effectively applied to improve quality of care and financial performance in healthcare organizations?**

More specifically, we answer the above higher level research question by breaking it down into the following sub-questions:

1. **What BA techniques and tools are healthcare organizations currently implementing within the different domains of their value chain network?**

2. **How are the various analytic capabilities being applied in the different areas of the value chain in healthcare organizations?**

3. **What are some of the organizational challenges facing successful implementation of BA techniques and technologies in a healthcare organization?**

4. **How are these challenges currently being addressed within the healthcare industry?**

In addressing these research questions, we will use a combination of content analysis and case study that will be conducted in a large healthcare organization through interviews and surveys. Thus, we will begin with extensive review of both academic and practitioner literature to uncover documented cases of BA
applications in different healthcare organizations. Thereafter, each application will be analyzed separately from two distinct standpoints: its categorical BA classification and its primary placement within the context of the value chain framework proposed by Burns, DeGraaff, Danzon, Kimberly, Kissick, & Pauly (2002). This will then be used to develop the mapping of analytic techniques and capabilities as they are applied in specific areas of the value chain framework of healthcare organizations. Based on the findings, our future research will focus on developing a process model for how effective application of analytics can add value to healthcare organizations.

The study will contribute significantly in several ways. From an academic standpoint, we anticipate to come up with a guideline for healthcare organizations that are currently employing BA systems or are planning to implement one in the future. Thus, by providing examples from various use of BA in other similar healthcare organizations, we can show what works and what does not work in terms of BA use. We also hope that this will better inform policy makers in making the right investment decisions with regards to training and system selection. This should also inform policy makers in large healthcare organizations that are currently utilizing BA techniques and technologies.

We also anticipate that this study will help inform BA system designers. Thus, by highlighting the issues that users face when using existing systems, designers can address these shortcomings in their future designs. Furthermore, we intend to show the importance of quality and influence on organizational outcomes and spur better quality systems as well as better management of data within those systems.

The use of value chain framework is a novel contribution to the existing literature on BA in that it allows future researchers to study and evaluate BA systems not only from traditional standpoints (e.g., their contribution to inter and intra-organizational integration, user-friendliness or effectiveness) but from an alternate viewpoint of exactly where and how a BA system fits within the overall value creation in healthcare organizations.

For practitioners, this research helps, first by cataloging existing applications of BA. This potentially allows management in healthcare organizations to understand and evaluate BA systems in their organization by going beyond the usual cost-benefit analysis and asking the higher-level question. Thus, developing such a framework that maps BA applications to the value chain of healthcare organizations is both the point of departure and the primary contribution of this paper.

The study also intends to provide justification for healthcare organizations to adopt and utilize BA techniques and technologies to facilitate and improve their work. By providing evidence of the impact of BA use on other organizational outcomes, we hope to show that BA can provide benefits and show how its capabilities can be leveraged.

**Background of Study**

Until recently, accessibility and sharing of information between various departments within healthcare organizations has been very challenging as a result of lack of integrated systems to serve as central repository for all the organizational data (Sutter, E, Oelke, N.D., Aldair, C.E., & Armitage, G.D., 2009). Traditionally, data and information used to be created, owned and stored in silos by various departments with the goal of trying to be in compliance with organizational and federal regulatory requirements put in place to ensure that patients data and information are well protected and secured (Suresh 2016). Due to the nature of complexity in data management, healthcare organizations face potential ethical, legal, and regulatory challenges with data governance (Phillips-Wren et al., 2015). However, research has shown that adopting suitable policies, standards, and compliance requirements to restrict users’ permission, will lead to improved access and sharing which, in turn, results in better efficiencies and improved care (Wang, Y., Kung, L., & Byrd, T.A., 2016). Thus, integrated health systems are widely considered to provide superior performance in terms of quality and safety as a result of effective communication and standard protocols (Gillies, Chenok, Shortell, Pawlson, & Wimbush, 2006).

Recognizing the importance of the information access and sharing in healthcare and the slow rate of IT adoption in this sector (Angst and Agarwal 2006), governments, policy makers, advocacy groups, and individuals have invested extensive efforts to promote more rapid digitization and sharing of medical data (Anderson & Agarwal, 2009). In the United States, the recently adopted stimulus package dedicates $50
billion over 5 years to spur the adoption of electronic health record (EHR) and electronic medical record (EMR). In November 2005, the U.S. Senate unanimously passed the Wired for Health Care Quality Act (S. 1418), a bill to enhance the adoption of a nationwide health information technology (HIT) and to improve the quality and reduce cost of health care (Dinev et al. 2016).

Such reforms and changes in the US healthcare delivery processes, have led to renewed interest in data-driven methods for delivering quality of care (Suresh, 2016) and performance (Simpao et al. 2014). Over the years, there has been progressive increase in the adoption and implementation of healthcare information technology (HIT), resulting in the generation of huge variety of patient data that comes from medical records (e.g. EHRs, biomedical data, etc.) as well as external data sources, such as insurance claims/billings, R&D laboratories, and social media data (Ward, Marsolo, & Froehle, 2014). Such proliferation of large-scale data has caught the attention and interest of many healthcare organizations towards making huge investments in BA techniques and applications to facilitate the extraction of valuable insights, making timely decisions, minimizing patient risk, and reducing clinical costs (Chen, Chiang, & Storey, 2012; Raghupathi & Raghupathi, 2014).

Business analytics, as is broadly defined, encompasses the use of various sophisticated analysis methods, such as statistical models and data mining algorithms for exploring data, quantifying and explaining relationships between measurements, and predicting new relationships (Shmueli et al., 2016). According to studies by Gartner (2012, 2014), BA is now one of the top priority of chief information officers and primary area of technology investment in most healthcare organizations. BA is not entirely a new concept or technique to the healthcare industry as most healthcare organizations began adopting and implementing this technique dating back to the early 1960s (Goldschmidt, 2005). Today, many companies including healthcare organizations have been implementing business analytic tools and techniques in order to enable them analyze and process their constantly growing data (Suresh 2016). Owing in large part to such a heightened attention, BA has now become an important inclusion to increase value chain capabilities of many business organizations of which the healthcare industry is one major key beneficiary (Gartner 2012; Chen 2012).

As an example, a major healthcare organization with 11 hospitals and 108 locations serving nearly 700,000 people in a large city in the US is currently deriving huge value from the implementation of BA techniques (HealthCatalyst 2016). As a Pioneer Accountable Care Organization (ACO), this healthcare organization needed to deliver superior clinical outcomes, improve the patient experiences, and enhance the affordability and sustainability of its services. Analyzing data in search of valuable clinical and business insights is an important part of the organization’s long-range strategy for achieving these goals. For several years, leaders of this healthcare organization had prioritized analytics as a key component of their strategic plan, but had yet to find an effective and comprehensive analytics system for using data to consistently deliver greater value to patients and stakeholders (Health Catalyst 2016). Hence, it is evident, from research standpoint, that the various analytics techniques and capabilities that are currently being applied in the value chain activities of healthcare organizations are currently underexplored.

**Theoretical Foundation**

The healthcare value chain framework was introduced in the healthcare industry during the early 1990s as a result of several major developments such as vertical integration, horizontal integration, managed care pressures, changes in federal reimbursement policies, the evolution of e-commerce, and the passage of the Health Insurance Portability and Accountability Act (HIPAA) in 1996 (Burns et al., 2002). This study aims to get a granular insight into which specific analytics techniques and capabilities are applied within each of the different segments of the healthcare value chain presented in Figure 1 below.

The study draws on the concepts of Burns et al. (2002) value chain framework which was proposed to basically explain how healthcare organizations are creating value through their primary and secondary activities. In the healthcare context, however, a more modified form of Porter’s (1985) original value chain has proved useful in understanding how various activities tailored toward quality of care delivery fit together (Sastry 2014). Burns et al. (2002) developed a more conventional value chain framework specifically for healthcare organizations (Figure 1). In the context of healthcare, the value chain framework redefined a reversed order in such a way that the support activities, which comprise of hospital
support services; hospital diagnostic and therapeutic services; information services; and hospital administration, collectively form the foundation activities whiles the primary activities, which include admission; care; discharge; marketing and sales; and service constitute the front-end activities. Healthcare organizations depend on this configuration of value-chain mapping to figure out how to improve quality (or lower costs) of care by delivering or connecting patients to the services in order to fully benefit from the entire chain of activities needed for better care (Sastry 2014).

![Value Chain Framework of Hospital](Adapted from Burn et al. 2002)

**Analytics Capabilities of Organizations**

Analytics capabilities can generically be classified into three different categories. These are descriptive analytics, predictive analytics and prescriptive analytics (Davenport 2013; Bedeley, Ghoshal, Iyer & Bhadury, 2016). Following is a brief discussion on these different analytics capabilities:

- **Descriptive Analytics**: Descriptive analytics is the type of statistics that provide descriptive analysis of what is evident from the data. Based on this type of analysis it is possible to find out current trends, statistics of available data. This type of analytics tries to answer the question of what has happened.

- **Predictive Analytics**: Predictive analytics is type of analytics where future of a process, product or activity can be predicted based on the result of the descriptive analytics. This type of analytics tries to answer the question of what could happen.

- **Prescriptive Analytics**: Prescriptive analytics is the most active type of analytics where the optimum output can be prescribed based on results of descriptive and predictive analytics. This type of analytics tries to answer the question of what should happen.
Proposed Methodology

The above research questions will be addressed mainly through the use of both content analysis that will involve extensive review of academic and practitioner’s literature and a case study which will be conducted through interviews with BI directors, Top level management, IT employees, physicians, nurses and other business unit employees who utilize some kind of analytics tools or technique. The content analysis complemented by interview data will provide a more granular insight in answering the research questions. First, a review of analytics applications, technologies and tools used for different levels of analytics tasks from a value chain perspective will be conducted. The purpose of literature review is not to exhaust all possible applications of analytics but rather focus on prominent exemplars of the usage of analytics in different value chain activities and processes. Review of academic and practice literature to accomplish similar purposes is common in IS literature (Zafar and Clark 2009; Zhao & Zhu 2012; Phillips-Wren et al. 2015). For the literature search, keywords to be used will include ‘analytics’, “HIT”, “EHR”, “EMR”, ‘value chain’, and combinations of different levels of analytics (descriptive, predictive and prescriptive) with different value chain activities. The data source includes academic journals, practitioners’ journals, academic and practitioners’ conference publications, publications from research organizations, white papers, periodicals, etc.

Following the content analysis study will be a case study in which we will use the methodology outlined by Yin (2009). At the moment, permission to conduct the case study has been granted by a large regional healthcare organization located in the Southeastern part of the US with currently about 536 licensed beds. The hospital prides itself as one of the largest and most comprehensive medical centers with a primary objective of always providing compassionate and quality of care for its patients. We chose to use this healthcare organization as our case subject because not only is it currently growing and expanding its operations but also because management have expressed great interest in investing huge sum of dollars to elevate organization’s analytics techniques and capabilities to the world class level. This healthcare organization expressed great interest in our research project because management wants to know how their current state of analytics capabilities and applications compare with other leading healthcare organizations and also to help them make inform decision on which specific analytics techniques and applications they should invest in the more. In this regards, top management of the healthcare organization has unanimously agreed to provide all the necessary support with regards to data collection and other necessary logistics we need to ensure that our research project is successfully executed. Currently, application for Institution Research Board (IRB) exemption has been approved and we are in the process of developing interview protocol or questionnaires to be answered by Business Intelligent/Analytics (BI&A) directors, Top Level Management, IT employees within the healthcare organization as well as external affiliate organizations or individuals such as partner hospital organizations, IT consultants for the hospital, etc. We will use these respondents as unit of analysis to examine what combinations of analytic techniques and capabilities the healthcare organizations is currently using to create value (i.e. increase quality and reduce cost) and what techniques or capabilities they wish they had in order to make their work easier.

We will take an interpretive approach to this study in order to arrive at a richer and granular understanding of phenomenon under study (Klein & Myers, 1999). We will use the theoretical framework discussed earlier to help guide the research design and also gain appropriate insights from the rich primary data to be collected through interviews and surveys (Walsham, 2006). Case studies provide a deeper understanding in the healthcare context. For instance, Oborn et al. (2011) performed a single case study on an English cancer center and their EPR usage. Goh et al. (2011) also ran a single case study of a hospital exploring HIT influences on works routines. Kealy and Stapleton (2011) used multiple cases to study telemedicine projects in conflict areas.

Expected Results, Contribution, and Future Research

This ongoing research is being conducted to explore how healthcare organizations are harnessing BA capabilities and techniques to improve quality of healthcare whiles reducing cost of care at the same time. The study will employ a combination of two research approaches namely: content analysis and case study to address research questions. Different analytics capabilities and tools will be presented in a tabular...
format where the rows will represent BA techniques and capabilities as belonging to either primary or supporting activities of the value chain whiles the three column heading of the table will identify analytics capabilities as either being descriptive, predictive, and/or prescriptive.

For practitioners, this research will help to not only be able to catalog BA systems according to different value chain activities but also allow managers in various healthcare organizations to carefully evaluate how different BA systems in different value chain activities can impact and create overall value in their organizations. In future, the framework will be evaluated empirically to identify actual usage of analytics in healthcare organization’s value chain. This should begin with studies that focus on delineating the specific organizational cultural and analytic infrastructural and capabilities variables that are germane to the different parts of the value chain. For example, it is quite conceivable that infrastructural/capability variables such as “Skills” will be different for “Marketing and sales” than for another aspect of the value chain such as “Technological development”; and exploration of the same for each part of the value chain will substantially enhance the research on the key success factors for BA in terms of contribution to the value chain of an organization.

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