



Towards an implementation framework for business intelligence in healthcare



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ABSTRACT

As healthcare organizations continue to be asked to do more with less, access to information is essential for sound evidence-based decision making. Business intelligence (BI) systems are designed to deliver decision-support information and have been repeatedly shown to provide value to organizations. Many healthcare organizations have yet to implement BI systems and no existing research provides a healthcare-specific framework to guide implementation. To address this research gap, we employ a case study in a Canadian Health Authority in order to address three questions: (1) what are the most significant adverse impacts to the organization's decision processes and outcomes attributable to a lack of decision-support capabilities? (2) what are the root causes of these impacts, and what workarounds do they necessitate? and (3) in light of the issues identified, what are the key considerations for healthcare organizations in the early stages of BI implementation? Using the concept of co-agency as a guide we identified significant decision-related adverse impacts and their root causes. We found strong management support, the right skill sets and an information-oriented culture to be key implementation considerations. Our major contribution is a framework for defining and prioritizing decision-support information needs in the context of healthcare-specific processes.

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1. Introduction and motivation

Healthcare organizations are under ever increasing pressure to do more with less and are continuously seeking ways to ensure that resources are deployed as efficiently as possible while ensuring high quality patient care (Hanson, 2011). Information is essential to meeting these goals – it has been referred to as the lifeblood of healthcare as it is essential for effective clinical and administrative decision making (Pine et al., 2012; Toussaint & Coiera, 2005). Healthcare decision making is complex and requires access to a wide array of high-quality information (Sen, Banerjee, Sinha, & Bansal, 2012). Business intelligence (BI) is defined as the use of information and specialized analytical tools to enable informed decision making in a variety of organizational contexts (Negash, 2004; Rohloff, 2011). A key characteristic of BI is that it integrates data from a wide variety of internal and external sources, thus providing an effective information platform for healthcare decision makers (Mettler & Vimarlund, 2009).

It is widely acknowledged that BI can provide benefits to healthcare organizations including improved patient care and outcomes

(Tremblay, Hevner, & Berndt, 2012), effective utilization of human resources (Crist-Grundman & Mulrooney, 2011), improved process efficiency (Flower, 2006) and cost avoidance (Pine et al., 2012; Wang, Nayda, & Dettinger, 2007). Despite these potential benefits, many healthcare organizations have not yet implemented BI systems (Hanson, 2011) and there has been very limited research on the factors that contribute to the successful implementation of BI in a healthcare-specific context. Further, numerous studies have highlighted the notion that information systems are notoriously difficult to implement in healthcare organizations. The overarching goal for our study is to identify the most critical factors that should be addressed by healthcare organizations that are in the early stages of BI system implementation, thus addressing a significant gap in existing research.

To achieve our goal we employ a case study in the Guysborough Antigonish Strait Area Health Authority (GASHA in Nova Scotia, Canada. Through this case study, we seek to answer three research questions:

1. What are most significant adverse impacts to the healthcare organization's decision processes and outcomes attributable to a lack of decision-support capabilities?
2. What are the root causes of these adverse impacts, and what are workarounds for dealing with them?

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3. In the context of questions 1 and 2, what are the most important considerations for BI system implementations in healthcare organizations?

By addressing question 1, we seek to identify some of the key decision-oriented adverse impacts attributable to the absence of decision-support capabilities within organizations like GASHA, and by extension, to highlight the benefits that accrue to healthcare organizations by implementing BI systems. Regarding question 2, we draw upon the concept of co-agency to identify the information, process and personnel-related issues that caused the impacts and identify the workarounds that are required because of these issues. Regarding question 3, we develop a framework which clearly identifies core processes and facilitates the definition and prioritization of decision-support information needs in the context of these processes.

2. Theoretical background

The ultimate goal for our study is to identify the most critical factors that should be addressed by healthcare organizations that are in the early stages of BI system implementation. In this section, we review relevant literature on Information Systems (IS) implementation considerations factors in general terms and in the specific context of healthcare. We then review BI implementation considerations.

2.1. IS implementation considerations

A significant body of research has focused on IS implementation considerations in the context of user adoption. Socio-technical and diffusion of innovation (DOI) theories are influential in this research area. The socio-technical theory states that an information system is composed of two interrelated subsystems: the technical (technology and tasks required convert system inputs into outputs) and the social (users and their characteristics and needs, as well as structure of the organization in which the system is being implemented). In order to achieve the benefits anticipated from the implementation of an IS, the socio-technical approach proposes that (a) interdependence of the subsystems must be recognized and (b) the design of the overall system must aim to jointly optimize both subsystems (Bostrom & Heinen, 1977). System designers must identify how the subsystems impact each other and must ensure the subsystems work in harmony in order to fully realize anticipated benefits (Mattia, 2011). Implicit to socio-technical theory is that effective user participation in the systems development process is essential to implementation success (Hartwick & Barki, 1994).

Numerous studies have leveraged Rogers' (1995) diffusion of innovations (DOIs) theory to explain factors that contribute to implementation success. DOI theory proposes that innovations are communicated throughout organizations through a variety of formal and informal channels over time. Individuals in the organization are viewed as having different levels of willingness to adopt the innovation. The speed of adoption is positively influenced by four factors: relative advantage, compatibility, trialability and observability and negatively by the complexity of the innovation. DOI theory has been adapted for IS research in numerous ways. For example, Moore and Benbasat (1991) expanded Rogers' five factors to eight: voluntariness of use of the system, relative advantage, task compatibility, system image, ease of use, result demonstrability, visibility, and trialability. Agarwal and Prasad (1998) argue that the specific characteristics of the innovation (e.g. relative advantage, visibility and result demonstrability) as well as the degree of voluntariness of use of the system are the key determinants of

implementation success. IS Research has consistently found that technical compatibility, technical complexity, and relative advantage are important antecedents to system adoption (Bradford & Florin, 2003).

2.2. Health information system implementation considerations

While IS implementation in many fields has achieved a certain level of success as described above, healthcare information system (HIS) implementation has proven problematic. While studies have advocated positive outcomes from HIS (McKibbin et al., 2012), there is a far more substantial body of research reporting on negative outcomes including workflow, communication, and safety issues (Ash, Berg, & Colera, 2004; Harrison, Koppel, & Bar-Lev, 2007; Kaplan & Harris-Salamone, 2009). Negative consequences occur because a HIS interacts with the people and processes that are part of the environment in which the HIS is implemented. While HISs are designed to improve specific processes (i.e. decision making), studies have shown that underlying information and process issues can impede HISs from achieving their full potential and that these issues must be managed pre-implementation (Tariq, Georgiou, & Westbrook, 2013). A systematic review on HIS diffusion identified a lack of studies on readiness (i.e. what an organization can do to assess and anticipate the impact of HIS implementation) as a key research gap (Greenhalgh, Robert, Macfarlane, Bate, & Kyriakidou, 2004). In other words the environment needs to be studied pre-implementation to identify any issues that will lead to negative unintended consequences. Understanding underlying HIS implementation issues requires a multi-dimensional approach. The concept of co-agency (Thraen, Byron, Mullin, & Weir, 2012) suggests that healthcare processes (i.e. decision making) cannot be viewed as discrete or isolated events but rather need to be studied as a set of interactions between processes, people and technology. We employ the co-agency concept in this study to identify key implementation considerations for BI in healthcare.

2.3. BI implementation considerations

Wixom and Watson (2001) developed a BI-specific implementation success model that proposes that implementation factors (strong management support, a visible business champion, sufficient resources, effective user participation, appropriate technical team skills and source system data quality) serve to positively influence implementation success from three perspectives: organizational, project and technical. They make the point that BI systems are not IT applications in the traditional sense; rather they are often an enabler of different applications. Seah, Hsieh, and Weng (2010) also highlight strong support and leadership from top management as a key success factor.

Ramamurthy, Sen, and Sinha (2008) draw on DOI theory and view BI as a major IT infrastructure innovation. They propose that implementation success is dependent upon organizational factors such as management commitment, organization size and absorptive capacity as well as characteristics of the innovation (the BI system) including relative advantage and low complexity. Isik, Jones, and Sidorova (2011) contend that successful BI implementations require specific capabilities including high quality data, appropriate user access and effective integration with other systems. Further, the specific decision environment (types of decisions, operational context) in which the BI system is implemented must be clearly defined and understood. Yeoh and Koronios (2010) describe a similar concept, "business orientation" – the alignment of BI with business goals and strategy, as an important success factor.

Popovic, Hackney, Coelho, and Jaklic (2012) identify BI maturity and identified analytical decision-making and culture as key

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