

Business Intelligence and Analytics Maturity in Public Healthcare Digital Transformation

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ABSTRACT

Public hospitals have been facing dramatic challenges and changes in recent years, particularly due to the pandemic. They have quickly adopted various information technologies to improve healthcare efficiencies and to make timely informed decisions. Nevertheless, it still lacks strategic planning and guidance in making transformational changes at public hospitals, for instance, the powerful Business Intelligence and Analytics (BI&A) systems or tools based on the largely available e-health data. This study aims to identify the key BI&A maturity factors, which can then be referred for both short-term improvements and long-term planning along the digital transformation roadmap. An in-depth case study is carried out with semi-structured interviews with the key stakeholders, including: technical staff, power users, leaders, and end users. The outcomes are to identify key maturity factors for general guidance to improve BI&A capabilities in public healthcare.

Keywords: Digital transformation, business intelligence and analytics, IT maturity, e-healthcare, public hospitals.

INTRODUCTION

Public sectors have adopted various information systems (IS) to improve their performance, including public hospitals. The COVID pandemic highlighted the need to accelerate this adoption for public healthcare to make quicker decisions and respond more effectively (Reale, 2021). Business Intelligence and Analytics (BI&A) has thus become more crucial, given the significant scale and influence of data-related challenges faced by modern organizations (Chen et al., 2012). The healthcare sector is expected to prioritize this need and to witness a significant resurgence in the adoption of BI systems post pandemic (Sechi et al., 2020; Basile et al., 2023). The adoption of BI&A has a transformation potential for healthcare institutions (Hanson, 2011) but has not been equally adopted across the sectors and geographic regions, particularly public hospitals and healthcare providers. This is partially due to the lack of a systematic model and approach in assessing the status quo and guiding those transformations specifically for public healthcare. The present research thus aims to identify BI&A maturity factors in public hospitals, which will help assess their IS capabilities and guide their practice in digital transformations. An in-depth case study is carried out at a Canadian regional hospital through semi-structured interviews with key stakeholder groups. The next section presents a literature review regarding BI&A and its maturity in the healthcare sector, followed by the methodology and preliminary results of the case study. The paper concludes with expected outcomes and contributions.

LITERATURE REVIEW

Business Intelligence and Analytics

The terms “Business intelligence” and “Business analytics” (BI&A) became popular in organizations and IT communities in the late 1990s (Chen et al., 2012). Due to unpredictable changes and an increasingly complex environment (Pawar & Sharda, 1997), organizations collected internal and external data to make informed decisions (Pawar & Sharda, 1997; Siegel, 2000). BI&A has been seen as a concept and a methodology (Dresner, 1989; Power, 2007), a system comprised of both technical and organizational elements (Watson et al., 2004), a process and software (Davenport, 2006; Golfarelli et al., 2004), a platform (Kasabian, 2007; Rajterič, 2010), an enterprise architecture (Gangadharan & Swami, 2004), a capability of the organization (Wells, 2008; Popović et al., 2012; Rajterič, 2010), computerized methods and processes (Popović et al., 2012), a systematic thinking process (Power et al., 2018), a broad category of technologies, applications, processes and systems (Chen et al., 2012; Wixom & Watson, 2010), of turning data into information and then into knowledge (Azvine et al., 2006; Lönnqvist & Pirttimäki, 2006), which is used to improve the decision-making process (Elbashir et al., 2008). In this research, BI&A is seen as a capability of the organization to manage turning data into information and knowledge to improve decision making.

BI&A Maturity

The BI&A maturity is based on the relationship between the solution, application, and the temporal view of critical success factors (Hawking & Sellitto, 2010). It is the state or level of organization’s capability in managing data, information and knowledge for decision making. Factors that were critical previously may not have the same relevance after a company has improved its BI&A capabilities (Hawking & Sellitto, 2010). Some organizations leverage their BI&A capabilities better than others, allowing them to respond to more complex questions and analysis regarding the environment. Over a hundred of maturity models (MM) have been developed within the IS field (Becker et al., 2009), including the Gartner Maturity Model for Data and Analytics (Gartner, 2017). BI&A maturity models include technology and data (Chen et al., 2012; Geiger, 2009) as

an essential part, but organizational processes and workforce capabilities (Ariyachandra & Frolick, 2008; Brooks et al., 2015; Williams & Williams, 2004; Yeoh & Koronios, 2010) must also be considered when sizing the maturity levels. However, most MM are generic and focus on technical aspects (Brooks et al., 2015). Furthermore, there has been a lack of investigation on how the BI&A capability matures and the obstacles that impede or restrict this advancement (Mikalef et al., 2020).

BI&A Maturity in Healthcare Sector

Digital transformation, systems integration and BI&A have been leveraged in the healthcare sector to aid in providing quality care for patients (Basile et al., 2023; Brooks et al., 2015; Tremblay et al., 2012). Data is being used to support decision making by predicting clinical conditions (Sousa et al., 2019) and also to better informed decisions made by practitioners (Goienetxea Uriarte et al., 2017). Basile et al. (2023) have identified three groups of studies that focus on BI in the healthcare sector: (1) applying data to refine prognoses and diagnoses, (2) improving data management and communication, and (3) improving the management of the process through data. Particularly, (3) focused on research regarding the use of machine learning to improve dynamic decision making (Meyer et al., 2014), deep neural network (R.M. et al., 2020), blockchain technology for safe storage and sharing of medical data (Chen et al., 2021), data-mining framework on cervical screening processes (Lee et al., 2021), and predictive analysis on length of stay (Shahid Ansari et al., 2021) and no-show patients (Simsek et al., 2020).

In the healthcare sector, MMs have been used to address a wide variety of complexities and the high demand for hospital IS implementations (Carvalho et al., 2019). Specifically, Gastaldi et al. (2018) developed a BI-MM specific for the healthcare sector and applied it in the ISMETT private hospital. Carvalho et al. (2019) presented important research regarding the building of a hospital IS-MM, in a Portuguese context. However, future research is needed to overcome limitations and identify cultural characteristics through cross-country studies (Carvalho et al., 2019).

Despite the value of analytics methods and implementation in the healthcare sector, existing studies have not focused on factors regarding BI&A capabilities that lead to specific levels of maturity focusing primarily on public hospitals, which are unique and primary institutions within the healthcare sector. Therefore, the research question of this study is “What are the key factors assessing BI&A maturity in the digital transformation of public hospitals?” Conducting a real-world case study would allow for reaching out the stakeholders involved in digital transformations, identifying their needs and issues, assessing the IS maturity states/levels (current vs. desire), and then making strategic decisions for planning/implementing with BI&A projects.

METHODOLOGY

Case and Setting

This research conducts an in-depth case study of a public hospital in Canada. The regional hospital is located in Northwestern Ontario which has been facing challenges regarding unique demographics, complex care demand, dynamic operational, equipment needs and more. During the COVID pandemic, the Public Health Unit and the hospital worked together to implement various information technologies in order to provide more responsive and higher quality care for patients. The hospital has identified its short- and long-term service demand to develop IS strategies, particularly digital transformation, systems integration and business analytics. As a regional hospital, it has initiated e-health records management across the public healthcare providers, such as hospitals, family/specialty clinics and pharmacies. However, the largely available medical data has not been fully utilized through the significant transformational potential of BI&A. There is a lack of knowledge about the current state of the institution in terms of digital transformation, as well as a guidance of the directions and focuses that the institution to plan and implement in next phases. The present study thus aims to identify the key factors regarding BI&A maturity at the hospital, to establish a basis to assess the status quo, and to provide a roadmap for long-term digital transformations. This is in line with the Gartner’s approach (2020) for IT maturity management.

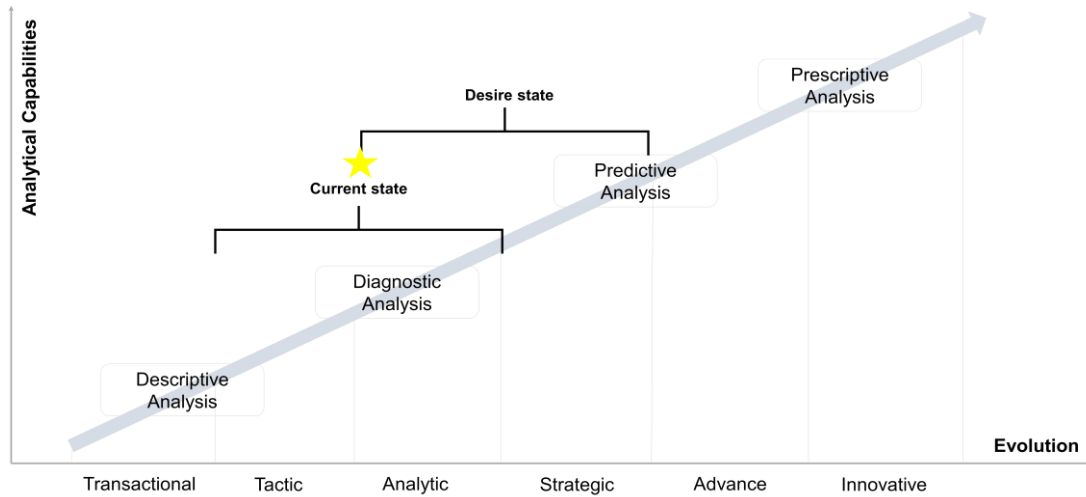
Data Collection and Analysis

The case study is carried out through semi-structured interviews with key stakeholders. Taking into account the different roles and potential impacts, four stakeholder groups are identified for the interviews, including: (1) technical staff, who are in charge of developing, implementing and maintaining BI&A tools (e.g., system administrators, database administrators); (2) power users, who are in charge of quality insurance and applications of BI&A tools (e.g., data scientists, analysts, researchers); (3) leaders, who are department heads and managers using high-level information and reports for strategic decision making (e.g., executives, directors); and, (4) end users, who are using BI&A tools for their daily work (e.g., physicians, specialists, nurses, lab technicians). Total 16 interviews are planned, four from each stakeholder group. Each interview takes about one hour and is conducted online via Webex, while the interviewees are provided with an introduction about the study context and approach in advance. The interviews are recorded with automatic transcripts, while the transcripts are reviewed by the researcher and interviewees afterwards for corrections and confirmations.

The interview transcripts are then coded by two research assistants with the NVivo software. Firstly, the coding is referring to the categories (i.e., maturity factors) based on the Gartner Maturity Model (Gartner, 2017) and the literature, which includes: alignment and governance, analytical decision-making culture/data-driven culture, individual impact, information quality, leverage (usage), organizational impact, quality of the system, systems and data integration, and user satisfaction. If no category fits the transcripts, then new categories may emerge. The categories are then further grouped and linked based on their effects in the strategic decision making for digital transformation.

PRELIMINARY RESULTS

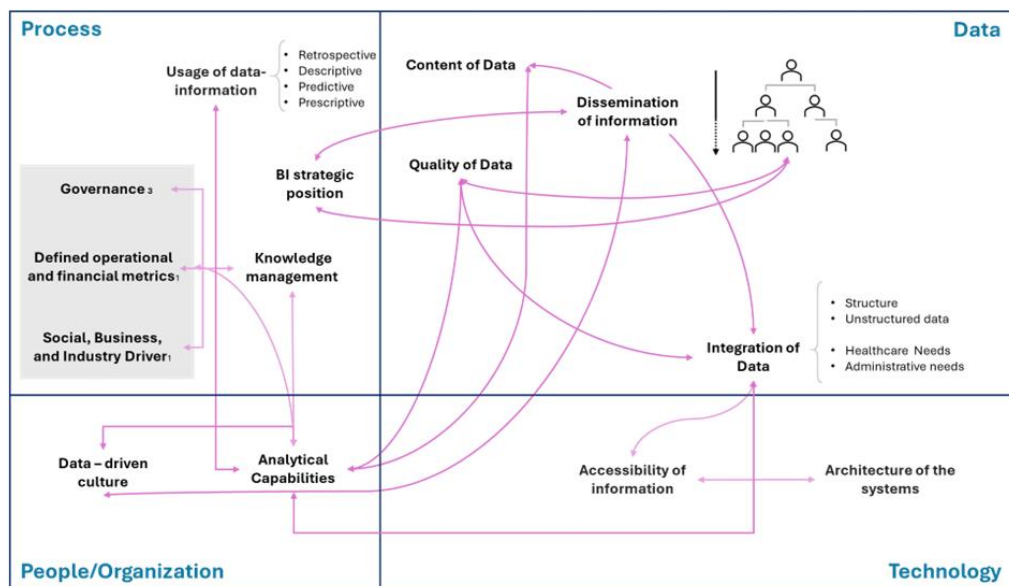
All the interviews have been completed and recorded up to date. The transcripts have been partially reviewed and coded. Preliminary results show the identification of constraints, challenges, and opportunities to leverage BI&A within the decision-making process. Overall, the hospital has analytical capabilities ranging from tactical to analytical levels (see Figure 1). The stakeholders indicate their willingness to move from descriptive analysis to predictive analysis at a strategic level. This may involve more stakeholders, predict patient occupancy, estimate future demand, and target population needs.



Source: Adapted from the Gartner Maturity Model for Data and Analytics (Gartner, 2017, 2020).

Figure 1: BI&A maturity levels and states of the public hospital.

More specifically, the key factors are identified under the four categories (see Figure 2): data, people/organization, process, and technology. The relationships among the factors (both within and between the four categories) are also analyzed and highlighted. This helps further inform the hospital about their BI&A maturity status quo with actionable targets, and thus they can make better decision in strategic planning of the projects and activities in digital transformation.



Source: This study.

Figure 2: Key BI&A maturity factors in the public hospital's digital transformation.

CONCLUSION

Expected Outcomes and Potential Contributions

The expected outcomes are the identification of key factors in assessing BI&A maturity at the regional hospital. This will help the hospital to develop strategic planning and general guidance to improve their BI&A capabilities. The findings will provide insights into the strategies and actions for promoting and implementing digital transformations in public healthcare. In particular, the identified set of factors are specific to public healthcare and can be used to develop the BI&A maturity model for both research and practice in this field.

Research Limitations and Future Work

The research has conducted a single case study, which is unique and representative as a regional hospital during their early digital transformation stages. More case studies may enrich the research by either expanding to other hospitals in the different transformation stages, or enhancing with a longitudinal study following the roadmap of digital transformation at the same hospital. This will gain more insights of the dynamics and evolutions of BI&A maturity factors at different levels and stages. Also, the identified list of key BI&A maturity factors can be further developed as an instrument for public healthcare digital transformation, which can be validated and used by public hospitals for their strategic decision making and planning.

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