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An integrated big data analytics-enabled transformation model: Application to health care

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A B S T R A C T

A big data analytics-enabled transformation model based on practice-based view is developed, which reveals the causal relationships among big data analytics capabilities, IT-enabled transformation practices, benefit dimensions, and business values. This model was then tested in healthcare setting. By analyzing big data implementation cases, we sought to understand how big data analytics capabilities transform organizational practices, thereby generating potential benefits. In addition to conceptually defining four big data analytics capabilities, the model offers a strategic view of big data analytics. Three significant path-to-value chains were identified for healthcare organizations by applying the model, which provides practical insights for managers.

1. Introduction

The arrival of the "*Age of Big Data*" presents, to many industries and the firms that populate them, heretofore unprecedented opportunities and novel complexities. A number of benefits from adopting big data analytics into business practices have been recognized by researchers and technology consultants (or vendors). Big data analytics is acknowledged to have the potential to fill the growing need of healthcare managers to manage the surge in clinical data that support evidence-based medical practice [1] and improve quality and efficiency of healthcare delivery [2]. Proponents of the application of big data in the United States claim that when properly applied, data analytics in the healthcare industry helps cut costs by $300 million annually and helps improve the management of lifestyle-induced diseases, streamline administrative complexities, and improve interfaces between customers and providers [3]. However, in fact, exponentially increasing volumes of data in various formats from different sources challenge a healthcare organization's traditional data management capabilities. Much of their rich electronic healthcare record data set is "perceived as a by-product of healthcare delivery, rather than a central asset source for competitive advantages" ([2]; p. 1351). To fully realize the benefits brought forth by big data analytics, a need exists to shift the focus from technology tools to examine and present the managerial, economic, and strategic impacts of big data analytics and explore the effective path of how big data analytics can be leveraged to deliver business value for healthcare organizations [4,5].

Research on big data analytics has primarily focused the role of big data analytics capability and examined its direct effect on firm performance (e.g., [6,7]). However, eminent scholars criticized that IT resource and capability alone may not unequivocally facilitate firm performance [8,9]. In the same vein, studies of the IT productivity paradox have suggested that IT could not directly yield significant productivity gains in healthcare settings [10]. Practice-based view (PBV) has been proposed to bridge this missing link and to help researchers and practitioners in understanding how the critical elements of practice interact with IT tools [11,12]. In the specific context of healthcare, scholars have adopted this view to provide in-depth insights to healthcare practitioners on how IT tools can be used in improving clinical practices [13,14]. Thus, we argue that adopting PBV will build a more complete picture of how big data analytics can be effectively leveraged to deliver business value. However, to date, there has been little attention given to improving our understanding of the impact big data analytics on organizational activities and business processes [12]. We seek to fill this gap by developing a conceptual model of big data analytics-enabled transformation (BDET) based on the PBV proposed by Bromiley and Rau [8] and use this as a framework to examine how big data analytics capabilities facilitate IT-enabled transformation practices and thus contribute to business value for healthcare organizations.

Our contribution to the literature on big data analytics is twofold. First, drawing on the PBV, we develop a BDET model that links big data

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analytics capabilities to IT-enabled transformation practices and then to benefits and business values. As PBV offers a new perspective to complement the extant strategic views, this model provides a deeper understanding of how healthcare practices can be facilitated through the implementation of big data analytics. Second, BDET model is applied to the healthcare context. The elements, pair-wise connections, and path-to-value chains of our BDET model are extracted from the real-world cases, which show easy-to-follow scenarios and provide new insights and guidance for healthcare practitioners.

The remainder of this paper is structured as follows: Section 2 serves as our theoretical background, which leads to the development of the research model, followed by our research method, findings and discussions, contributions to research, implications for practice and recommendations. Finally, limitations and future research directions are discussed as our conclusion.

2. Theoretical background and research model

The theoretical development begins with an introduction of the BDET model that used the PBV to explain how big data analytics and its generated capabilities enable organizations to develop inimitable practices, which in turn creates their business value. We then present big data analytics architecture components from which big data analytics capabilities are generated.

2.1. A model of big data analytics-enabled transformation

We draw on PBV as a theoretical underpinning to develop our research model. PBV emerging from strategic management aims to explain the effects of macrolevel firm behaviors or characteristics within a practice [8]. Adopting a PBV focus not only enables researchers to study how the firm implements organizational practices through the proposed explanatory variables but also helps develop a deeper understanding of which practices are needed for performance in a given context [8]. The BDET model constructed for this study is presented in Fig. 1.

As shown in Fig. 1, the linear progress path of our research model follows a PBV framework developed by Bromiley and Rau [8]: from the explanatory variables to practices, then to the intermediate outcomes ("benefits" in our model), and finally to the organizational performance ("business value" in our model). Bromiley and Rau's [8] PBV framework demonstrates how different performances are manifested in firms' execution of various practices that are facilitated by explanatory factors. In this framework, the practice, "a defined activity or a set of activities that a variety of firms might execute" ([8]; p. 1249) is a central part of the PBV. Practice can be treated as the combination of the subject, action, tools, and context [15] or as a set of activities, routines, and material arrangements [16]. The use of practice itself is important for both intermediate and organization performance outcomes [17,18]. The explanatory variables can be viewed as antecedents or enablers of the practice. The explanatory variables are not specified in the Bromiley and Rau's [8] PBV model, which allows for idiosyncratic interpretation and applications.

2.1.1. Explanatory variables: big data analytics capabilities

Drawing on the PBV, the first step to construct the BDET model is to define the explanatory variable, which in this study is big data analytics capabilities generated from big data analytics resources. Big data analytics resources, that is, big data analytics architectural components can create big data analytics-specific capabilities. In previous studies, Wixom et al. [19] identified two key big data analytics capabilities—-speed to insight and pervasive use—and their underlying dimension from big data analytics resources for maximizing business value in the fashion retail industry. Recently, Gupta and George [7] emphasized that firms have to develop big data analytics-specific capabilities to attain organizational performance. Gupta & George's study has identified various resources such as data, managerial and technical skills, and data-driven culture that together build a big data analytics capability, and this capability creates the operational and strategic business value (e.g., reduced inventory and cost savings).

Big data analytics comprises an integrated array of aggregation techniques, analytics techniques, and interpretation techniques that allow users to transform data into evidence-based decisions and informed actions [20,21]. We identified three architectural components of big data analytics from its tools and functionalities, namely data aggregation, data analysis, and data interpretation, by reviewing the relevant academic literature (e.g., [4,22]) and technology tutorials (e.g., [23,24]).

The first architectural component is data aggregation, which aims to collect heterogeneous data from multiple sources and transforming various sources data into certain data formats that can be read and analyzed [22]. In this component, data will be aggregated by three key functionalities from data aggregation tools: acquisition, transformation, and storage [4].

The second architectural component, data analysis, aims to process all kinds of data and perform appropriate analyses for harvesting insights Wald et al., 2014. This is particularly important for transforming patient data into meaningful information that supports evidence-based decision-making and meaningful use practices for healthcare organizations. In simple taxonomy of analytics developed by Delen

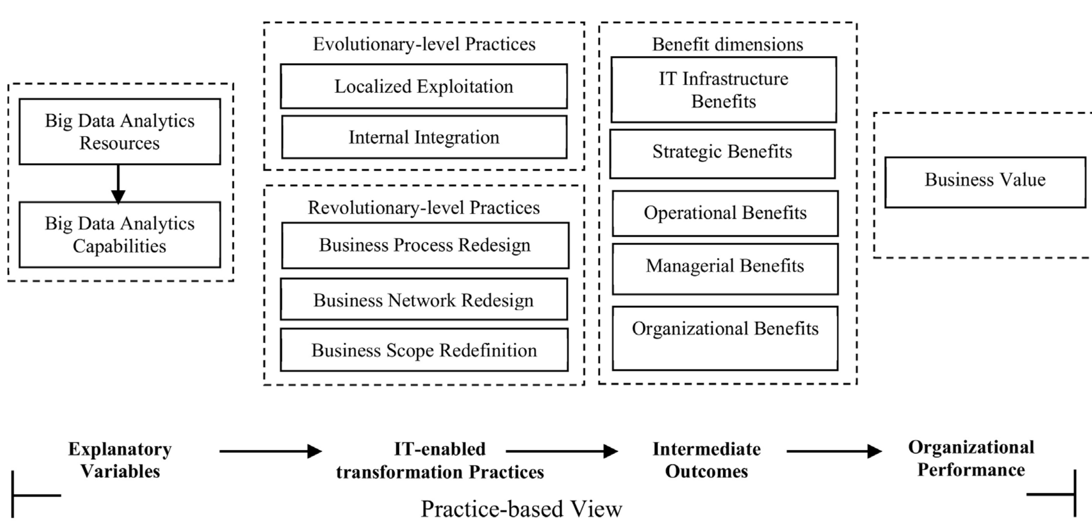

Fig. 1. Big data analytics-enabled transformation model.