Understanding the hidden value of business intelligence and analytics (BI&A)

Research-in-Progress

Nadine Côrte-Real  
ISEGI – Universidade Nova de Lisboa  
nreal@isegi.unl.pt

Tiago Oliveira  
ISEGI – Universidade Nova de Lisboa  
toliveira@isegi.unl.pt

Pedro Ruivo  
ISEGI – Universidade Nova de Lisboa  
pruivo@isegi.unl.pt

Abstract

Although some studies have examined specific business intelligence & analytics (BI&A) technologies and how they might contribute to create value and improve firm performance, to our knowledge there is no clearly articulated and theoretically grounded model in the literature that holistically explains BI&A technologies. Only limited research has examined the path to value through the impact of knowledge-based dynamics capabilities on the hidden competitive value. Grounded on strategic management theories (dynamic capabilities and knowledge-based view), we present a theoretical model for understanding how and why BI&A applications can create competitive value and improve firm performance through specific knowledge-based dynamic capabilities. Based on this model a number of propositions are postulated. This research contributes to the IT Value literature. We also expect that the continuing progress on research will produce insights for practitioners and researchers regarding the drivers that lead to BI&A value concerning organizational level.

Keywords

Business intelligence and analytics (BI&A), IT Value, Knowledge-based view, Dynamic Capabilities, Competitive advantage

Introduction

In recent years, business intelligence and analytics (BI&A) has emerged as an area of decision support systems (DSS) research and drawn growing interest from academics and researchers (Chen et al. 2012; Kowalczyk et al. 2013). In the era of Big Data, continued economic uncertainty and major industry-changing dynamics, BI&A can help to sustain organizational performance through improvement on business decision making (Chen et al. 2012; Davenport 2006; Kisker et al. 2013). Several surveys, including Gartner, Forrester, and IDC, report that most firms are interested in investing in BI&A. According to Gartner’s (2013) executive program survey, BI&A has become the first of the top 10 technological priorities for CIOs and it is present in almost every industry. IDC (2012) reported that BI&A systems promise to deliver considerable gains by transforming organizational decision-making processes. In the next few years investments in these technologies are expected to exceed $50 billion. For academics BI&A is a dynamic, attractive, and very important field of research (Chen et al. 2012; Winter et al. 2013). Some literature analysis studies demonstrate the need to better understand the current state of BI&A related research (Chen et al. 2012; Jourdan et al. 2008; Kowalczyk et al. 2013). Specifically, Chen (2012) mentions the top four topics in the BI&A literature are: competitive advantage, big data, data warehousing and decision support.
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The top topic of BI&A literature is competitive advantage, which is rooted in the logic of value creation and distribution (Piccoli and Ives 2005). The most important research questions in the field of information technology (IT), in general, involve measuring business value (Melville et al. 2004). With IT investments today being scrutinized to a degree never seen before, they must start to deliver real value, and if they fail, they risk losing funding (Gessner and Volonino 2005). Demonstrating “big data” value achieved through BI&A is the key to guarantee continuous success in organizations and optimize their utilization (Gantz and Reinsel 2011; Kowalczyk et al. 2013). Nevertheless, BI&A value can depreciate over time due to market dynamics and/or the intelligence disseminating throughout the organization in such a way that it no longer provides a competitive advantage (Slater and Narver 2000). Thus, BI&A has sometimes failed to support organizations’ decision making and failed to enhance business value. Whether and how organizations achieve business benefits from their BI&A investments remains unclear (Elbashir et al. 2013). Many organizations struggle to measure BI&A value and continuously improve it regarding organization needs (İşik et al. 2013). BI&A thus needs to be examined beyond post-adoption stages (Chen et al. 2012; Chiang et al. 2012; Elbashir et al. 2013; Malladi 2013).

This article’s contribution to the literature is threefold. First, we analyze the holistic value of BI&A, studying a set of technologies defined by Chen (2012). Second, we refine the path from dynamic capabilities toward performance by adding an intermediate construct able to capture the competitive value created through BI&A in business processes. Last, to our knowledge this is the first study to develop a theoretical model that attempts to measure BI&A value using strategic theories such as knowledge-based view (KBV) and dynamic capabilities (DC). In doing so, we contribute to the IT Value literature by examining through an original lens this recent class of technologies. Our work focuses on explaining how organizations can achieve competitive value in one particular set of technological innovations, BI&A technologies.

The remainder of the paper is organized as follows. In the next Section, based on the literature review we provide a definition of BI&A, an overview of firm level value literature, and present the theories that support our research model. Then, we present the proposed research model. Finally, future steps are described.

Theoretical Background

BI&A is a fairly new term and not an easy concept to define. The earliest business intelligence (BI) definition was introduced by (Luhn 1958) in the IBM Journal. It defines BI as a set of concepts and methods that improve decision making by using fact-based, computerized support systems. Almost 30 years later, during the 1980s, the first scientific definition appeared, specifying BI as “a management philosophy and tool that helps organizations to manage and refine business information for the purpose of making effective decisions” (Ghoshal and Kim 1986). Later, in the 1990s, BI became a popular term for the business and IT communities. In the late 2000s business analytics (BA) was introduced to represent the value of the key data analysis element in BI (Davenport 2006). Today’s definition of BI&A embraces all of the positive attributes of BI and BA. Hence, BI&A can be defined as “the techniques, technologies, systems, practices, methodologies, and applications that analyze critical business data to help an enterprise better understand its business and market and make timely business decisions” (Chen et al. 2012). BI&A has the potential to mine and analyze vast quantities of data, enable firms to enhance the existing organizational applications, and provide business-centric practices and methodologies that provide competitive advantage (Chen et al. 2012; Davenport 2006).

In the last two decades the dimension of value has been widely studied among different innovation technologies using the resource-based view (RBV) (Barua et al. 1995; Bharadwaj 2000; Mata et al. 1995; Melville et al. 2004; Ruivo et al. 2013; Soh and Markus 1995; Zhu and Kraemer 2005). We argue that BI&A needs to be measured through theories that capture its unique characteristics. Since RBV treats knowledge as a generic resource and does not distinguish knowledge-based capabilities (Alavi and Leidner 2001), we consider that KBV fits the type of capabilities offered by BI&A. Also, we intend to study value offered by BI&A in turbulent environments. KBV is used to explore firms’ potential for establishing competitive advantage in the dynamic market context, but only DC theory is able to solve the problem of
sustaining competitive advantage in turbulent environments (Grant 1996; Volberda 1996). Because DC theory constitutes the second foundation that underlies knowledge-based thinking (Pettigrew et al. 2001), we combine these two theories. Both theories seek to explain competitive advantage and firm performance.

**Knowledge-based View theory**

Organizational knowledge, such as operational routines, skills, or know-how, is a key source of competitive advantage in a more dynamic and rapidly changing environment (Lee 2001). This knowledge is created through interactions among different combinations of tacit and explicit knowledge (Nonaka 1995). Many perspectives are used to define knowledge. In this study we see knowledge as a resource controlled by the firm to conceive and implement strategies that improve its efficiency and effectiveness (Alavi and Leidner 2001).

KBV considers knowledge as the most strategically important of a firm’s resources, created by individuals in the production of goods and services to face dynamic competition (Grant 1996). KBV argues that the firm’s primary function is to leverage knowledge into productive outcomes (Kogut and Zander 1996; Nonaka 1994), and describes firm resources and capabilities as knowledge assets (Leonard-Barton 1992). It contains the idea that the primary role of the firm, in the essence of organizational capability, is to integrate knowledge (Grant 1996). Because knowledge-based resources are usually difficult to imitate and socially complex, heterogeneous knowledge bases and capabilities among firms are the major determinants of sustained competitive advantage and superior corporate performance (Alavi and Leidner 2001; Grant 1996).

Information systems can have an important role in the knowledge-based view of the firm since they can be used to synthesize, enhance, and expedite large-scale intra- and inter-firm knowledge management (KM)(Alavi and Leidner 2001). As an integrant part of knowledge management systems (KMS), BI&A supports organizational processes of knowledge creation, transfer, and application of knowledge in organizations (Alavi and Leidner 2001; Gold et al. 2001). The challenge is to integrate knowledge among groups in which BI&A plays a major role. Organizations are facing new challenges related to analyzing and leveraging big data. As an enabler of knowledge management, BI&A can play a key role in dealing with huge volumes and different forms of knowledge, both structured and unstructured (Chen et al. 2012; Tallon 2013). For many firms BI&A technologies are critical to ongoing operations of the company and also represent a significant investment.

**Dynamic capabilities theory**

The concept of DC arose from a key shortcoming of the resource-based view of the firm. Several definitions of DC are available, but essentially DC can be defined as ‘the ability to integrate, build, and reconfigure internal and external competencies to address rapidly-changing environments’ (Teece et al. 1997).

In the past decade the DC perspective has emerged as one of the most influential theoretical lenses for the study of strategic management (Schilke 2014). Consequently, DC and their impact on firm strategy, creation of value, and competitive advantage have attracted the interest of academics (Helfat et al. 2009; Protogerou et al. 2012). The attention regarding DC stems from their potential influence on competitive advantage, the key outcome variable in dynamic capabilities theory (Teece et al. 1997). DC constitutes a theoretical framework that suggests how an organization can achieve sustained competitive advantage, especially a business enterprise in a turbulent environment (Teece et al. 1997). The key role of DC is to enable organizations to change the way they do things in order to respond to changes in dynamic business environments (Helfat et al. 2009).

Several reasons justify the use of DC theory to measure BI&A value. First, many studies have applied this framework to understand the innovation value of BA (Shanks and Bekmamedova 2013; Tamm et al. 2013; Trkman 2010), giving us confidence that DC can be suitable for understanding BI&A value. Second, DC theory aims to explain the successful adaptation to change. BI&A can help an organization predict changes in product demand or detect an increase in a competitor’s new product market share and respond quickly by introducing a competing product (İşik et al. 2013). Also, BI&A focuses on understanding,
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interpreting, strategizing, and taking action to further organizational interests (Chen et al. 2012). It can be used in real-time to capture opportunities in an efficient and timely manner in rapidly changing business environments (Anderson-Lehman et al. 2004). Consequently, firms that use BI&A can have a profound influence on performance at operational, tactical, and strategic levels (Popovič et al. 2009). It is paramount to apply BI&A technologies to enhance their strategic decision making (Lau et al. 2012). Hence, we argue that dynamic capabilities provide a means to understand how and why BI&A technologies may lead to continuous improvement to assure valuable impacts toward improved firm performance.

Research Model

While KBV is concerned with the appropriation value and achievement of competitive advantages through knowledge assets, DC theory helps to explain how this value is acquired and maintained over time (Amit 2001). Grounded on KBV and DC theories, we designed our research model to explain how knowledge, as the most strategic asset of a firm, can be empowered through BI&A in order to create dynamic capabilities (P1a, P1b, P2a, P2b). BI&A technologies can offer dynamic capabilities (i.e., capabilities that allow continuous improvement and adaptation of the firm to change) to the firm based on effective knowledge management. The organization possessing these dynamic capabilities is able to achieve competitive value (P3a), depending on the environmental context in which is inserted (P3b). Finally we argue that by achieving competitive value we can improve firm performance (P4).

Our research model (Figure 1) comprises seven constructs: management of endogenous knowledge, management of exogenous knowledge, BI&A applications, dynamic capabilities, environmental turbulence, competitive value, and firm performance. Three control variables were also included in the model.

Knowledge management and dynamic capabilities link

Knowledge management is a dimension supported by KBV (Carlucci et al. 2004; Lee and Yang 2000). According to DC theory, to integrate knowledge in a continuous way in rapidly evolving environments, the firm must possess dynamic capabilities to integrate, learn, and reconfigure it (Wu 2006). Thus, exploration and exploitation of knowledge and competencies are antecedent dimensions of successful dynamic capabilities and consequent delivery of business excellence and competitive advantage (Easterby...
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Smith and Prieto 2008; He and Wong 2004; Sambamurthy and Subramani 2005). Several empirical studies have analyzed the link of KM to DC (Cepeda and Vera 2007; Gold et al. 2001; Sher and Lee 2004). Specifically, Sher and Lee (2004) divide the sources knowledge management into endogenous and exogenous. We therefore posit:

**Proposition 1a:** Management of endogenous knowledge is positively related with organizational dynamic capabilities.

**Proposition 2a:** Management of exogenous knowledge is positively related with organizational dynamic capabilities.

BI&A applications can moderate the impact of knowledge management on dynamic capabilities. BI&A is closely related with knowledge management (Chen et al. 2012) and is considered a subset of KM that promotes learning, decision making, and understanding (Herschel and Jones 2005). As we seek to offer a holistic perspective of BI&A applications, we adapted a moderator IT applications (Sher and Lee 2004) and rearranged it with several types of BI&A technology. Based on Chen et al. (2012), we classified the BI&A applications construct into five critical technical areas: big data analytics, text analytics, web analytics, network analytics, and mobile analytics. Accordingly, BI&A technologies can add value primarily at the beginning of the information value chain and help knowledge to flow around the firm in order to achieve business excellence (Popović et al. 2012). It is especially data integration and the use of analytical tools that provide valuable decision-making knowledge to minimize operating costs, segment customers, and forecast market trends (Chau and Xu 2012; Trkman et al. 2010). Also, BI&A can be used in real-time, capturing opportunities in an efficient and timely manner in rapidly changing business environments (Anderson-Lehman et al. 2004). For example, an ERP (Enterprise Resource Planning) system typically promulgates standard processes that capture data from across the firm, whereas BI&A technologies enable managers to realize the value of data (Elbashir et al. 2013). Hence, organizations can benefit from the knowledge created through BI&A technologies and maintain dynamic capabilities. We therefore propose:

**Proposition 1b:** BI&A applications moderate the effect of management of endogenous knowledge and dynamic capabilities in order the effect will be stronger among firms with more BI&A applications.

**Proposition 2b:** BI&A applications moderate the effect of management of exogenous knowledge and dynamic capabilities in order the effect will be stronger among firms with more BI&A applications.

**Dynamic capabilities and competitive value link**

Traditionally, the literature has assumed a universally positive effect of dynamic capabilities on competitive advantage (Schilke 2014). Most scholars consider the role of dynamic capabilities in firm performance (Eisenhardt and Martin 2000; Teece et al. 1997; Zott 2003). But the way dynamic capabilities precisely affect business performance still remains unclear. Protogerou et al. (2012) consider that dynamic capabilities do not directly affect the output of the firm in which they reside, but indirectly contribute through an impact on operational capabilities. Thus, operational capabilities are the output of dynamic capabilities deployment, and the value of dynamic capabilities lies in the configuration of the operational capabilities they create (Protogerou et al. 2012). Through operational capabilities organizations can create competitive value by enhancing their business processes (Sher and Lee 2004). BI&A can provide unique capabilities that use data to bring value to business processes (Elbashir et al. 2013; Shanks and Bekmamedova 2013; Shanks and Sharma 2011; Sharma et al. 2010). Thus, we posit:

**Proposition 3a:** Dynamic capabilities are positively related with the competitive value created through BI&A.

Nevertheless, BI&A may be particularly useful and valuable to firms operating in turbulent environments (Schilke 2014). Environmental turbulence is defined in terms of the frequency and amplitude of change in
the environment and general conditions of uncertainty (Duncan 1972). In this sense, different environments imply different valuations of dynamic capabilities (Eisenhardt and Martin 2000). A marked increase in environmental turbulence due to greater uncertainty in international financial markets, volatile consumer demand, and rapid product obsolescence has led firms to consider their ability to respond to change (Tallon and Pinsonneault 2011). As turbulent environments increase causal ambiguity, and competitors’ ability to imitate a firm’s capabilities decreases, dynamic capabilities may help firms to achieve competitive advantage (Eisenhardt and Martin 2000; Helfat et al. 2009; Protogerou et al. 2012; Song et al. 2005). Hence, environmental dynamism plays a key role in the link between dynamic capabilities and competitive advantage (Pavlou and El Sawy 2011; Schilke 2014). Since we argue that the first stage of competitive advantage constitutes the competitive value achieved through business processes, we therefore posit:

**Proposition 3b:** Environmental turbulence moderates the effect of dynamic capabilities and competitive value such that the effect will be stronger among firms in higher volatile environments.

**Competitive value and firm performance link**

We argue that competitive value is the perceptual stage of competitive advantage that results from an organization’s ability to effectively manage its business processes. Business processes constitute a first source of competitive advantage because they are the way that the competitive potential of a firm’s resources and capabilities is realized (Ray et al. 2004). Competitive value can be realized in five business processes: supplier relations (inbound logistics), production and operations, product and service enhancement, sales and marketing support, and customer relations (outbound logistics) (Tallon and Kraemer 2007). Since BI&A technologies are especially tailored to business processes (Elbashir et al. 2013), we believe the most efficient way to measure the competitive value offered by them resides in their impact on business processes. BI&A optimizes strategic processes related to coordination with suppliers in real-time matching of supply and demand or even personalization of offerings to customers (Davenport 2006).

Accordingly, BI&A starts to offer competitive value through its impact on business processes, and consequently can increase firm performance. This idea is consistent with the literature of IT value. The link between IT business value and the effect of IT on firm performance has often been contested (Brynjolfsson 1993; Carr 2003; Scheepers and Scheepers 2008). Due to this complexity these authors believe that research should go deeper, and they call for more process-level research on IT business value (Barua et al. 1995; Ray et al. 2004; Tallon et al. 2000; Tallon 2007). IT applications tend to be process-specific and profits may not be reflected in their aggregate performance (Ray et al. 2004; Trkman 2010). Based on these arguments, the process-oriented perspective offers a better identification of various ways of IT use to provide business value. The value of IT should therefore be measured from a process perspective, in which the prime effects are expected to be realized (Elbashir et al. 2013; Melville et al. 2004; Tallon 2007; Trkman 2010). Specifically, in a qualitative study Shanks (2011), argues that dynamic capabilities, enabled by BI&A technologies, lead to value-creating processes and ultimately to improved firm performance. Based on these arguments, we posit:

**Proposition 4:** The competitive value created through BI&A is positively related to firm performance.

**Controls**

Earlier studies suggest that three ancillary factors can influence BI&A competitive value and firm performance. Firm size is used as a proxy for the resource base of the organization that may influence BI&A competitive value and performance (Elbashir et al. 2013; Zhu and Kraemer 2002). With larger firms more resources can be allocated to enhance their business processes. Time since adoption of BI&A was included to measure the knowledge and experience that organizations obtain from working with BI&A over time (Elbashir et al. 2013). BI&A-related infrastructure sophistication assesses the differences in both generic and specialized IT systems that may affect BI&A competitive value and impact on performance.
The construct is modeled as a second-order construct with two dimensions: generic IT and specialized (BI&A) infrastructure (formative first order and formative second order) (Elbashir et al. 2013).

**Next steps**

As the next steps for this research, we will develop an online questionnaire. Five BI&A research academics and five professional experts will validate the content of the questionnaire. To assess construct reliability a pilot test with 30 companies and feedback will be incorporated (these companies will not be included in the main survey). For data collection we intend to invite professionals from several companies around Europe. The companies will be selected based on lists provided by Dun & Bradstreet, a leading global source of commercial information and insights on businesses. The goal is to achieve at least 300 valid responses. Due to the complexity of the research model and the fact that it has not been tested in the past, the data analysis will be supported by Partial Least Squares (PLS) (Henseler et al. 2009).

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