The Effects of Operational and Cognitive Compatibilities on the Big Data Analytics Usage: Firm Distinctive Value Creation

Emergent Research Forum Paper

Maryam Ghasemaghaei
McMaster University
ghasemm@mcmaster.ca

Abstract

Using big data analytics is generally considered to improve firms’ distinctive value creation. However, we argue here that the role of firm operational and cognitive compatibilities needs to be better understood in order to explore how organizations can create distinctive value from the use of big data analytics. This research-in-progress study draws on the theory of resource-based view (RBV) and information technology (IT) compatibility literature to develop a theoretical model explaining how big data analytics usage influences firm distinctive value creation, and whether firm operational and cognitive compatibilities impact the use of big data analytics.

Keywords

Operational compatibilities, cognitive compatibilities, big data analytics, value creation

Introduction

Big data analytics is being increasingly leveraged by many firms to deal with the massive amounts of data they collect (Fernández et al. 2014). Big data analytics refers to the process of using advanced technologies to analyze big data in order to discover useful information (e.g., hidden patterns) to enhance firm value creation through improving decision makings (Waller and Fawcett 2013). Although there is some evidence that using big data analytical tools can improve a firm’s value creation, a recent industry survey indicates that most companies have still not started to use these tools to deal with the massive amount of data they collect from various resources (Deloitte 2013). Many firms seem to still be in the stage of learning about the value of big data analytics in analyzing large amount of data, and the necessary information technology (IT) infrastructure they need to handle big data they collect from internal and external resources (Chen et al. 2015). Thus, the underlying mechanisms that lead to organizations’ big data analytics usage deserve close investigation. Previous research has found that the incompatibility of new technology with existing values and operations greatly inhibits adopting the use of new technologies (Teo and Pian 2003). Tornatzky and Klein (1982) reported that cognitive compatibility and operational compatibility are the most critical factors impact new technology adoption within firms. In the context of this study, cognitive compatibility refers to the compatibility with firms’ shared values about using a new technology (here big data analytics), while operational compatibility refers to the compatibility with what firms have in terms of their technology infrastructure. Thus, the first objective of this study is to investigate the impact of operational and cognitive compatibilities on the use of big data analytics.

Recent studies found that many firms that invested in big data analytics could not take full advantage of using these tools. A recent report indicates that only 25% of firms reported that big data analytics has “significantly” helped them to gain competitive advantage (Deloitte 2013). Research indicates that the main challenge that organizations face while using big data analytics is understanding the required conditions to create distinctive value through the use of such tools (Pentaho 2015). Hence, the second objective of this study is to explore what makes some investments in big data analytics more fruitful than others. Although there is a growing number of conceptual studies regarding the particular applications of big data analytics use in firm’s different functional areas (e.g., marketing and customer relationship
management) (Chen et al. 2015), a more holistic view of big data analytics use has not been advanced. The above outlined gaps in the literature limit the current understanding of the usage of big data analytics within firms, and its impact on firm distinctive value creation. Our study draws on the resource-based view (RBV) of the firm (Barney 1991) and IT compatibility literature to address the following research questions: (1) How does organizational big data analytics usage influence firm distinctive value creation? and (2) Do operational and cognitive compatibilities impact the big data analytics usage? Both of the above endevors are novel aspects not previously considered in the IS literature.

Theoretical Background

Compatibility

Rogers (1983) defined compatibility as “the degree to which the innovation is perceived as consistent with the existing values, past experiences, and needs of the potential adopter” [p. 223]. Tornatzky and Klein (1982) argue that two types of compatibility exist: cognitive compatibility which refers to compatibility with firms’ shared values, and operational compatibility which refers to compatibility with firm current practice. In the context of this study, the compatibility between firm existing IT and big data analytics (i.e., operational compatibility) could lead to the use of such tools. For example, as the volume of data grows significantly, existing firm data warehouse capacity has become strained. This leads to deteriorating access to data for making firm decisions. Therefore, in this case, there is incompatibility between using big data analytics and the available firm IT infrastructure. To solve this problem and increase the compatibility between the firm IT infrastructure and the analytical tools, some firms have started to use Hadoop which supports the storage and processing of extremely large amount of data in a distributed computing environment (Pentaho 2015). In addition, the use of big data analytics should be consistent with the existing firm values (i.e., cognitive compatibility). For example, firms that have a climate that is supportive of using new technologies may use big data analytics more than those that do not have such supportive climate.

Resource-Based View

The Resource-Based View (RBV) argues that firm resources create value which eventually lead to gain competitive advantage (Melville et al. 2004). Resources that are firm specific, valuable, and difficult to imitate enable firms to create distinctive value (Teece et al. 1997). Resources are “stocks of available factors that are owned or controlled by the firm” (Amit & Schoemaker, 2012, p. 35). In an IT context, RBV provides a framework for analyzing whether and how IT, as a resource, could be associated with providing firm value (Melville et al. 2004). According to Teece et al. (1997), firm distinctive abilities (e.g., value creation) are developed when combinations of firm resources are applied together in unique ways, and through specific organizational routines. In this study, RBV can help us understand how the linkage between the use of big data analytics and firm distinctive value creation could be strengthened by other key firm related elements including tools sophistication, bigness of data, and analytical training support.

Research Model and Hypotheses

To answer the research questions identified for this study, we propose the model shown in Figure 1 below.

![Figure 1. Research Model](image-url)
Distinctive value creation refers to the uniqueness, rareness, and inimitability of firm resources. According to RBV, core firm capabilities (here big data analytics use) lead to firm distinctive value creation which has the potential to produce competitive advantage (Long and Vickers-Koch 1995). Chen et al. (2015) argue that the use of big data analytics, an important firm information processing capability, generates firm value creation through impacting both firm productivity and business growth. Thus, we hypothesize that

**H1:** Big data analytics use is positively associated with firm distinctive value creation.

According to Fui-Hoon et al. (2001) while appropriate training can enhance the possibility of successfully use a new system, not having the proper training could decrease the value that can be generated through the use of that system. Furthermore, according to RBV, firm distinctive value creation is developed when combinations of firm resources are applied together. Thus, we hypothesize that

**H2:** Analytical training support positively moderates the impact of big data analytics use on firm distinctive value generation.

Tools Sophistication refers to the maturity and complexity of the tools (Raymond and Paré 1992) which captures the level of technological expertise within the firm (Chwelos et al. 2001). The depth of analysis could vary in firms, based on how sophisticated the analytical tools are (Davenport 2013). In general, analytical tools have three main categories: descriptive (i.e., understanding what happened in the past), predictive (i.e., understanding what will happen in the future), and prescriptive (i.e., used to simulate outcomes of possible actions) (Ghasemaghaei et al. 2016). Firms that use more sophisticated analytical tools may have higher ability to create distinctive value through the use of big data analytics compared to those that use less sophisticated tools. Thus, we hypothesize that

**H3:** Tools sophistication positively moderates the impact of big data analytics use on firm distinctive value generation.

Bigness of data refers to the extent of the presence of a set of characteristics often referred to as three Vs: volume, velocity, and variety (Rusitschka et al. 2014). Volume is defined as the amount of data, which is considerably increasing. Velocity refers to the speed that the data is stored and analyzed. Variety refers to the number of types of data. Firms are now dealing with different types of data including structured data (e.g., dates, numbers), unstructured data (e.g., social media data, videos), and semi-structured data (e.g., XML documents), from within and outside the organization (Abbasi et al. 2016). Accessing and analyzing the data that is high in volume, variety, and velocity help firms to better discover unforeseen patterns and to develop sharper insights about customers, businesses, markets and environments (Fernández et al. 2014). Thus, we hypothesize that

**H4:** Bigness of data positively moderates the impact of big data analytics use on firm distinctive value generation.

Operational compatibility refers to the degree to which the innovation (here big data analytics) is perceived as consistent with firm current practice (firm existing IT) (Tornatzky and Klein 1982). In the context of this study, the scale, nature, and scope of big data analytics applications provide interesting insights into the design and architecture of firm IT infrastructure. Particularly, the firm IT infrastructure should be able to manage network communication services, data management services and architectures, and application portfolio and services (Lu and Ramamurthy 2011) while capturing data that is high in volume, velocity, and variety. Companies are increasingly turning to NoSQL, Hadoop, and other tools to tackle information issues not addressable with relational database and data warehouse technologies (Pentaho 2015). From this perspective, we argue that if firms view big data analytics as compatible with their existing organizational practices, they will be more likely to use and apply these tools in their decision makings. Thus, we hypothesize that

**H5:** Operational compatibility is positively associated with big data analytics use.

Cognitive compatibility refers to the degree to which the innovation (here big data analytics) is perceived as consistent with firms’ shared values (Tornatzky and Klein 1982). In the context of this study, firms that strive to continually seeks new ways to increase its effectiveness of IT use, continues to experiment with new IT as necessary, and fosters a climate that is supportive of trying out new ways of using IT (Lu and Ramamurthy 2011) may view the adoption of big data analytics as compatible with existing firms’ shared values. Thus, we hypothesize that

**H6:** Cognitive compatibility is positively associated with big data analytics use.
Methodology

Research Methodology

The proposed study will involve a cross-sectional survey of CIOs, each representing a different organization, who will be recruited through a market research firm. In the research model, four of the constructs (i.e., cognitive compatibility, big data analytics use, distinctive value creation, and analytical training support) are reflective constructs, and two of them (i.e., bigness of data, and operational compatibility) are formative constructs. To measure tools sophistication, a dummy variable will be used that represents the use of descriptive analytical tools, predictive analytical tools, prescriptive analytical tools, and their combinations in organizations. For each construct, construct validity and reliability (i.e., convergent and discriminant validity) will be calculated (Werts et al. 1974). The research main questions will be answered through validating the research model of Figure 1 through structural equation modeling techniques using Partial Least Squares (PLS) as it is more suited for exploratory research (as the proposed study) (Gefen et al. 2000). Following Roldán & Sánchez-Franco (2012), the minimum sample size required to detect a medium effect size at a power of .80 and alpha of .05 would be 97 cases. To account for potential outliers, 140 participants will be recruited in total.

Conclusion

This research promises to make significant contributions to both theory and practice. It will leverage RBV and IT compatibility literature to examine how big data analytics usage influences firm distinctive value creation, and whether firm operational and cognitive compatibilities impact the use of big data analytics. Using this unique integrative view, this study advances our understanding of the value of big data analytics. This knowledge can be used for developing theories to better understand the circumstances under which IT resources can increase firm distinctive value creation which eventually lead to gain competitive advantage. The results of this study will also have important implications for managers engaged in using big data analytics to gain competitive advantage. Although there has been a great amount of discussion regarding the potential promise of big data analytics, many organizations are still reluctant to make such investments because of the uncertainty of the payoff (Chen et al. 2015). In addition, a recent report indicates that only few firms invested in big data analytics have significantly improved their firm’s outcomes (Deloitte 2013). The results of this study help managers to understand how to increase firm distinctive value creation through the use of big data analytics.

REFERENCES


