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Understanding the Factors Affecting Organizational Adoption of Big Data in Developing Countries

(Full Paper Submission)

Shiwei Sun
Auburn University
szs0100@auburn.edu

Casey G. Cegielski
Auburn University
cegieca@auburn.edu

Lin Jia
Auburn University
lji0011@auburn.edu

Dianne J. Hall
Auburn University
halldia@auburn.edu

ABSTRACT

We have arrived at the era of big data, which has become a driver for firms’ competitive advantage. This study explores the factors affecting organizational adoption of big data in developing countries. A conceptual model is proposed by combining the diffusion of innovation theory (DOI), the institutional theory and the technology-organization-environment (TOE) framework. Relative advantage, compatibility, and complexity are used to represent technological factors; organizational readiness for change, technology readiness, adequacy of resources, and firm size are used to represent organizational factors; competitive pressure, trading partner readiness, and regulatory environment are used to represent environmental factors. The moderation effect of market turbulence is also discussed.

KEYWORDS: Big data, Technology adoption, Technology-organization-environment, Developing countries

INTRODUCTION

Because of fierce market competition and turbulent marketing environment, firms should adopt various state-of-the-art information technologies to develop competitive advantage (Sultan, 2010; Low et al., 2011). Data is considered as the new oil and can drive firms’ growth (Rotella, 2012). However, firms need a capability to unearth the true value of overpowering data. In recent years, big data has been fashionable and critical in both business and IT fields. It is of great importance for decision-making, marketing, and research. Big data is characterized as volume, variety and velocity (3Vs) (Manyika et al., 2011).

With the advent of big data technology, larger volume data can be collected and analyzed faster than ever before. For instance, sensing copious data generated in transactions, marketers can gauge customers’ information with big data technology. However, we are at the early stage of big data adoption worldwide. Different form the developed countries, there is a lagging effect in information technology adoption in developing countries (Tigre, 2003; Dutta and Roy, 2004; Molla and Licker, 2005). Since the organizational and environmental constraints of developing countries are different from those of developed countries, the adoption of a new information technology might face more risks (Molla and Licker, 2005). Big data technology has not yet
been well accepted in developing countries. Consequently, effort is imperative to identify determinants affecting big data adoption in developing countries for a better understanding of the global diffusion.

2014 is regarded as the year for big data adoption going mainstream in the enterprise (Columbus, 2014). As a step to achieve their leapfrog development, developing countries are trying the best to make a catch-up. For instance, currently China’s desire is to promote innovation-oriented economy (Liu et al. 2011). As the era of big data has started (Boyd & Crawford, 2012), it provides the firms in developing countries with a new opportunity to build innovation capabilities and create business value. Therefore, understanding the innovation characteristics and organizational, environmental factors affecting the adoption of big data is important for both practitioners and academics.

For big data, a new technology innovation, adoption at organizational level is particular important. To the best of our knowledge, there is no research systematically explore the key factors that affect the organizational adoption of big data, especially in the context of developing countries. Rooted in the diffusion of innovation theory (Rogers, 2003) and the institutional theory (Dacin et al, 2002; Scott, 2001), this research distinguishes the determinants affecting the organizational adoption of big data and sheds some light on future empirical studies.

However, most of IS scholars’ attention mainly focuses on the introduction, function and value of big data. For example, Watson (2014) systematically explores the concepts, technologies and applications of big data. In terms of big data adoption, the conceptual model building work and empirical study are still in infancy. By our research, we will provide the conceptual model and call for empirical research on big data adoption in developing countries.

The paper proceeds as follows. The next section, a literature review is presented, in which the definition of big data and theoretical background are presented. Then the conceptual model is proposed, and the propositions are developed. Finally, implications for theory and practice, limitations and future work are discussed.

LITERATURE REVIEW

The Concept of Big Data

Derived from business intelligence and analytic (BI&A), big data has been defined in various ways. Some scholars view it as the ever-increasing information from different sources that is very “big” to process (e.g. Jiao et al. 2013; Liu 2013). Some other scholars consider it as an approach or business analytics that assist organizations analyze amount of data (e.g. Boubeta-Puig et al. 2014). For this buzzword, there has not been a well-accepted definition (Chen et al. 2013). However, most people accept that big data refers to big sets that are overpowering in size (e.g. Chen et al., 2013; Hey et al., 2013; Kwon & Sim, 2013; Salah, 2013; Tien, 2013).

As a new technology, big data can be considered as an innovation for organizations (Rogers 2003). In this research, we define big data as a new technology characterized with its advanced BI&A function. It can create business value by its unique analytical and predictive capabilities, which can deal with the data that couldn’t be processed by the traditional approach (Chen et al. 2013; Gobble 2013).

Diffusion of Innovation Theory (DOI)

There are many theories to guide IS acceptance research such as technology acceptance model (TAM) (Davis, 1989), theory of panned behavior (TPB) (Ajzen, 1991), diffusion of
innovation theory (DOI) (Rogers, 2003), institutional theory (Scott, 2001; Dacin et al, 2002), and theory of acceptance and the use of technology (UTAUT) (Venkatesh et al., 2003). We will use diffusion of innovation theory and institutional theory to develop our conceptual model because they both have a good applicability at the organizational level for analysis.

According to Rogers (2003), innovation adoption is “the process in which an innovation is communicated through certain channels over time among the members of a social systems” (Rogers, 2003, p. 5). At the firm level, innovation is closely related to internal organizational structure, external organizational characteristics, and leader attitude toward change. Thus, the innovation and organization characteristics contribute to the adoption of a new technology.

Five important innovation characteristics are relative advantage, compatibility, complexity, trialability, and observability, determining the rate of adoption (Rogers, 2003). Past literature suggests that relative advantage, compatibility, and complexity are particular important (Tornatzky & Klein, 1982).

Institutional Theory

Institutional theory highlights the institutional environment in shaping organizational actions and can be used to explain institutional change (Dacin et al., 2002; Scott, 2001). Many studies have used this theory to explain IT adoption (Chatterjee et al., 2002; Purvis et al., 2001; Teo et al., 2003). According to this theory, institutional decisions are not only driven by organizational goals but also by social factors. These factors might be pressures from political and social sources (Oliver, 1997). The pressures can push firms in the same industries homologous because they can imitate the actions of industry leaders. Based on this theory, we posit that pressures from customers, competitors, trading partners, and governments will encourage firms to adopt big data technology.

Technology-Organization-Environment (TOE) Framework

The TOE framework was proposed by Tornatzky and Fleischer (1990) as shown in Figure 1. A threefold context, technology, organization and environment, was identified to analyze adoption and implementation of innovations. The TOE framework is consistent with diffusion of innovation theory and institutional theory. Consisting of environment context, the TOE framework helps explain inter-organizational innovation diffusion more effectively (Hsu et al., 2006). A lot of research drew on this framework to analyze IT adoption factors (Lin & Lin, 2008; Pan & Jang, 2008; Teo et al., 2006; Zhu et al., 2003; Zhu et al., 2004; Zhu & Kraemer, 2005; Zhu et al., 2006).

In this research, the TOE framework serves as the overarching theory. The technology context mainly refers to innovation characteristics. Organization context mainly refers to organizational readiness. Organization context relates to environmental characteristics. The perceived benefits from technology are acquired by the support of organization resources. The adoption process is also affected by external environmental factors. Each context is discussed below.
RESEARCH MODEL

Research Conceptual Model

Based on the TOE framework, an abundance of factors have been distinguished in the developing countries adoption context. Instead of listing all of them, we choose to focus on some key factors. The research model was proposed in Figure 2 by combining the diffusion of innovation theory, the institutional theory, and the TOE Framework. The model includes ten factors that are anticipated to have a direct impact on adoption of big data technology. The market turbulence is anticipated to moderate the effects of these ten variables on the organizational adoption of big data.
Relative advantage refers to “the degree to which an innovation is perceived as better than the idea it supersedes” (Rogers, 2003, p. 15). At the organizational level, factors related to value, cost, and social status can be considered elements of relative advantage. For big data technology, relative advantage can be measured by increased business opportunities, improved customer services, enhanced competitiveness, and created extra value for customers. Relative advantage was found to be a consistently critical predictor of IT adoption (Premkumar et al., 1994).

Compatibility refers to “the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters” (Rogers, 2003, p. 15). At the organizational level, compatibility means to what extent the changes introduced by big data are compatible with existing values, information infrastructure, and practices.

Complexity refers to “the degree to which an innovation is perceived as difficult to understand and use” (Rogers, 2003, p. 16). At the organizational level, it means the complexity of big data
usage and its related applications development. Complexity of a new innovation will impede the adoption of big data.

The potential innovation factors are listed in Table 1.

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<tr>
<th>FACTORS</th>
<th>THEORY FOUNDATION</th>
<th>REFERENCE</th>
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<tbody>
<tr>
<td>Relative Advantage</td>
<td>Diffusion of Innovation theory</td>
<td>(Hsu et al., 2006; Moore &amp; Benbasat, 1991; Rogers, 2003; To &amp; Ngai, 2006; Wang et al., 2010; Zhu et al., 2006)</td>
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<tr>
<td>Compatibility</td>
<td>Diffusion of Innovation theory</td>
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<td>Complexity</td>
<td>Diffusion of Innovation theory</td>
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**Organization Characteristics**

Readiness is the organizational members’ attitudes, beliefs and intentions (Armenakis et al., 1993). Organizational readiness for change refers to “the extent to which organizational members are psychologically and behaviorally prepared to implement organizational change” (Weiner et al., 2008, p. 381). It is deemed to be an antecedent of adoption behaviors (Armenakis et al., 1993). As a multi-level construct, readiness for change can be measured at the individual, group and organizational levels. At the organizational level, it can be measured by aggregating individuals’ appraisals or individuals’ assessments of collective capabilities when the outcome is the sum of individual performance (Bandura 2000; Klein, 2000; Weiner, 2008). Many studies have examined that attitudes have a strong influence on technology adoption (e.g. Keen, 1981). It is likely the most important organizational characteristic for information technology adoption (Petter, 2013). Organizational readiness for change is especially important for developing countries because they have a pressing need for change to learn information technology from the developed countries (Straub et al., 1997).

Appropriateness, management support, and change efficacy can be used to measure organizational readiness for change holistically.

Appropriateness means that the prospective change is advantageous for the organization (Holt et al., 2007).

Management support means that top managers are willing to allocate resources and encourage the initiative adoption of the prospective change (Holt et al., 2007). The fastest rate of adoption of an innovation usually comes from authority decisions (Rogers, 2003). If the managers have stronger competence and higher IT knowledge, they can exert more influence on firms’ adoption of big data.

Change efficacy means that organization members have enough experiences and skills and can easily handle the changes brought forth by adopting of big data (Holt et al., 2007).

Technology readiness is also called technology competence. It includes technological infrastructure and IT experts (Low et al., 2011), which influence IT adoption by conversion cost and compatibility of extant information systems and network technologies. A lot of studies have examined the role of technological competence in affecting firms’ intention to adopt new information technology (Kuan & Chau, 2001; Pan & Jang, 2008; To & Ngai, 2006; Wang et al., 2010).
Currently, lots of companies in developing countries do not have sufficient internal IT expertise because it is difficult to hire enough information systems experts.

Adequacy of resources means to what extent of technology, business and human resources are adequate in a firm (Powell & Dent-Micallef, 1997; Zhu et al., 2004). IT infrastructure pertains to technology resources in an organization (Powell & Dent-Micallef, 1997). Adequacy of human resources means that employees with IT knowledge and skills are adequate to adopt big data (Powell & Dent-Micallef, 1997). Business resources include capabilities and assets of an organization. Constraints of organizational technology resources, human resources, and business resources impede the adoption of innovations (Jarvenpaa & Leidner, 1998; Rogers, 2003). Compared with developed countries, developing countries face more challenges of lacking resources. Thus, technology resources, business resources, and human resources are crucial to adoption of big data in developing countries.

Many research has found that firm size is an important factor affecting IT adoption (Dholakia & Kshetri, 2004; Hong & Zhu, 2006; Pan & Jang, 2008). It is anticipated to affect the perceived importance of big data.

The potential organizational factors are listed in Table 2.

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<th>FACTORS</th>
<th>THEORY FOUNDATION</th>
<th>REFERENCE</th>
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<tbody>
<tr>
<td>Organizational Readiness for Change</td>
<td>Diffusion of Innovation theory and Institutional theory</td>
<td>Holt et al., 2007; Molla &amp; Licker, 2005; Kuan &amp; Chau, 2001; Powell &amp; Dent-Micallef, 1997; Wang et al., 2010; Zhu &amp; Kraemer, 2005</td>
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<tr>
<td>• Management Support</td>
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<tr>
<td>• Appropriateness</td>
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<td>• Change Efficacy</td>
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<tr>
<td>Technology Readiness</td>
<td>Institutional theory and Diffusion of Innovation theory</td>
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<tr>
<td>• Technology competence</td>
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<tr>
<td>Adequacy of Resources</td>
<td>Diffusion of Innovation theory</td>
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<tr>
<td>• Technology Resources</td>
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<td>• Business Resources</td>
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<td>• Human Resources</td>
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<td>Firm Size</td>
<td>Diffusion of Innovation theory</td>
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**Environment Characteristics**

Competitive pressure, trading partner readiness and regulatory environment are included as the environmental factors.

Pressure from competitors refers to the extent of pressure from a firm’s competitors in a certain industry (To & Ngai, 2006). It is likely to influence a firm’s need to start a new process or a new product. As high-technology industries change rapidly, firms in those industries are more responsive to their competitors’ actions, especially the IT adoption of innovations.

Pressure from trading partners has been recognized as an important factor in affecting IT adoption (Lin & Lin, 2008; Pan & Jang 2008; Premkumar & Ranamurthy, 1995). An organization
might adopt a new innovation just in order to follow its partners and maintain its internal balance with them.

Government plays an important role in affecting information technology adoption. The institutional arrangements in developing countries are not well scheduled (King et al. 1994; Montealegre, 1998; Montealegre, 1999). Regulator environment means that the government may encourage firms to adopt big data technology by providing infrastructure, legal environment, and regulatory directives (Zhu & Kraemer, 2005). If the government shows a clear commitment to big data technology, it will encourage firms to adopt big data by providing policy supports. Some empirical studies have tested the positive relationship between regulatory environment and firms’ intention to adopt information technology (Kuan & Chau, 2001; Wang et al., 2004).

The potential environmental factors are listed in Table 3.

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<th>FACTORS</th>
<th>THEORY FOUNDATION</th>
<th>REFERENCE</th>
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<tbody>
<tr>
<td>Competitive Pressure</td>
<td>Institutional theory</td>
<td>Lin &amp; Lin, 2008; Pan &amp; Jang, 2008; To &amp; Ngai, 2006; Wang et al., 2010; Zhu &amp; Kraemer, 2005; Zhu et al., 2004; Zhu et al., 2005</td>
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<tr>
<td>Trading Partner Readiness</td>
<td>Institutional theory</td>
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<tr>
<td>Regulatory Environment</td>
<td>Institutional theory</td>
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**Moderation of Market Turbulence**

Market turbulence means the changes of customers’ product preferences, demand, and needs (Hult et al., 2007; Jaworski & Kohli, 1993). In comparison with developed countries, market turbulence in developing countries becomes more obvious because of the rapid change of business environments.

As our research model includes some external environment factors, the level of market turbulence may cause induced changes. Rapid market changes can cause destructive impact on the existing relationship between firms’ adoption of innovations and its antecedents (Weiss & Heide, 1993). Firms’ intention to adopt big data is possibly influenced by market turbulence when we include external environment factors in our research model.

**PROPOSITIONS**

Based on literature review and theory background, we proposed the following ten propositions.

**Propositions for Innovation Characteristics**

If firms perceive that big data can help increase business opportunities, improve customer services, enhance competitiveness, and add customers’ value, they are more likely to adopt big data technology.

*Proposition 1: Perceived relative advantage of big data will have a positive relationship with firms’ intention to adopt big data.*

If firms perceive that big data technology can be more compatible with their existing values, information infrastructure, and practices, they are more likely to adopt big data technology.
Proposition 2: Compatibility of big data will have a positive relationship with firms’ intention to adopt big data.

If firms perceive that big data technology less complex in use and further related applications development, they are more likely to adopt big data technology.

Proposition 3: Complexity of big data will have a negative relationship with firms’ intention to adopt big data.

Propositions for Organizational Characteristics

A higher organizational readiness for change could reduce residence to adopt a new innovation. Hence, organizational readiness for change positively impact intention to adopt big data.

Proposition 4: Organizational readiness for change will have a positive relationship with firms’ intention to adopt big data.

The higher technology readiness can provide a better platform for new information technology, which can make adoption easier. Accordingly, technology readiness positively affects firms’ intention to adopt big data.

Proposition 5: Firms’ technology readiness will have a positive relationship with their intention to adopt big data.

Firms with adequate resources can well prepare and facilitate an IT adoption and implementation. Thus, higher adequacy of resources leads to greater intention to adopt big data.

Proposition 6: Adequacy of resources will have a positive relationship with firms’ intention to adopt big data.

As larger firms have more resources facilitating adoption and implementation, and would bear higher risks, they tend to adopt new innovations. Thus, larger firm size leads to greater intention to adopt big data.

Proposition 7: Firm size will have a positive relationship with firms’ intention to adopt big data.

Propositions for Environmental Characteristics

In a competitive market, adopting big data technology can benefit firms a better understanding of operation efficiency and market insight. Thus, higher competitive pressure positively influences intention to adopt big data technology.

Proposition 8: Competitive will have a positive relationship with firms’ intention to adopt big data.

A firm usually shows its fitness with its trading partner by adopting a similar innovation. Therefore, higher trading partner readiness leads to greater intention to adopt big data.

Proposition 9: Trading partner readiness will have a positive relationship with firms’ intention to adopt big data.

Government can build a trustworthy institutional environment in which firms can enjoy their confidence and aspirations to adopt big data technology. Thus, higher regulatory environment contributes to greater intention to adopt big data.
Proposition 10: Regulatory environment will have a positive relationship with firms’ intention to adopt big data.

Propositions for Market Turbulence

When market turbulence on low levels, the technology-organization-environment characteristics can effectively influence the intention to adopt big data. However, when market turbulence is very high, the relationship between technology-organization-environment characteristics and intention to adopt becomes unpredictable.

Proposition 11a: Market turbulence will have a negative moderation effect for complexity.
Proposition 11b: Market turbulence will have a positive moderation effect for other listed factors.

CONCLUSIONS AND IMPLICATIONS

This research deepens our understanding of factors affecting firms’ adoption of big data in developing countries and serves as a foundation research about big data adoption.

This research explores ten factors that affect big data adoption in developing countries. Relative advantage, compatibility, complexity, organizational readiness for change, technology readiness, adequacy of resources, firm size, competitive pressure, trading partner readiness, and regulatory environment are critical to the adoption of big data in developing countries. Market turbulence is anticipated to moderate the relationship between these ten factors and firms’ intention to adopt big data.

This research enables practitioners to have a better understanding of the determinants of big data adoption. Several factors outlined deserve managerial attention. Some factors such as management support are within IT managers and senior managers’ control. To employ this research results, managers should identify critical success factors that lead to a successful adoption of big data in organizations. Managers can also discern the potential risks for initial big data adoption in terms of environment factors. For the big data services providers, this research suggests that they need to pay attention to relative advantage, compatibility, complexity of big data technology. They can also distinguish potential big data service users according to the factors we proposed. For clients who use big data services, readiness and resources are important and aid them in their quest for creating business value.

LIMITATIONS AND FUTURE WORK

There are several limitations to this study. First, the generalizability is limited, because we mainly explore the factors in the context of developing countries. There is still a lot of work ahead to explore other factors affecting adoption of big data in certain situation. Second, the goal of this study is to investigate the factors affecting firms’ intention to adopt big data conceptually. Data collected from developing countries is needed to test the validity of our conceptual model.

This research systematically explores factors affecting organizational adoption of big data in developing countries. However, future empirical research is needed to validate our proposed conceptual model. We call for future research to test all the propositions. Case study and empirical study both will extend our research on adoption of big data.
REFERENCES


