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Investigating the Determinants of Big Data Analytics (BDA) Adoption in Asian Emerging Economies

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Abstract

Big Data Analytics (BDA), being an emerging technology, is used in many echelons of business and management. Extant research lack focus on the factors that impact the organizational adoption of this technology. Organizations need to assimilate it in a full-scale and deep level to fully realize its benefits and therefore worthy of study.
Present paper, drawing upon Technology-Organization-Environment (TOE) framework, proposes and investigates the determinants that influence BDA adoption in context of the firms from two big emerging economies of Asia –China and India. Data collected from 106 organizations is tested and the results and implications contribute to understanding of the determinants affecting BDA adoption.

Keywords

Big data analytics; Innovation diffusion; Absorptive capacity

Introduction

Big data, as the name suggests, refers to large datasets that are challenging to store, share, search, visualize, and analyse and here the orders of magnitude exceed conventional data processing and the largest of data warehouses. Big Data, coming from various sources, whether an airline jet collecting ten terabytes of sensor data for every half an hour of flying time, New York Stock Exchange collecting one terabyte of structured trading data each day, or a conventional structured corporate data warehouse sized in terabytes and peta-bytes, is sized in peta-, exa-, and even in zetta-bytes. It also signals that it is not just about volume, the approaches to analysis compete with data content and structure that can neither be anticipated nor predicted. There is a need to put proper analytics and the science behind them to filter low value or low-density data and divulge high value or high-density data. Also, big Data has a broad array of interesting architecture challenges and thus, new analytical techniques are required to adopt.

Usually data volume, velocity, and variety describe big data, but the unique attribute of Big Data is the manner in which the value is revealed. In conventional business intelligence, the simple summing of a known value reveals a result, such as order sales becoming year-to-date sales. But big data requires a refining modelling process to discover any value, i.e. making a hypothesis, creating statistical, visual, or semantic models, validating, and then making a new hypothesis. And for this, it either takes a person interpreting visualizations or making interactive knowledge-based queries, or by developing 'machine learning' adaptive algorithms that can discover business meaning (Agrawal, 2013). With the growth of big data, firms in emerging economies have also started investing in solutions that interpret consumer behavior, detect fraud, and even predict the future using big data analytics (BDA).

Undoubtedly, the rise of big data in prominence has led to a titanic focus on exploring how organizations can harness information to gain a competitive advantage. However, despite big data's well documented benefits, it would be important to investigate, how organisations across the globe are putting it to use and in which way? Recently, Big Data Analytics (BDA) has emerged as a new technology to enhance overall efficiency of management through productivity, performance, and better decision-making of the organizations in real-time.

However, recent research in information management lack focus on BDA adoption which is just one part of an adoption process, and it cannot ensure wide-scale exploitation and usage of BDA. Therefore, without wide-scale adoption, the benefits of BDA cannot be fully realized. Thus, the adoption stages of assimilation are especially worthy of a focused study (Fichman, 1999, Zhu, Dong, & Kraemer, 2006a), especially in emerging economies, like China and India. The economic status and regulatory environment of such countries are different from developed countries where BDA technology already has established usage at huge level. Thus, it would be worthy to investigate how innovation assimilation gets influenced by contextual factors in such environments.

Motivated by above theoretical gaps, present paper proposes an integrative model integrating determinants that impact BDA adoption in the context of two developing countries from Asia –China and India. The model is based on diffusion of innovation (DoI) theory, institutional theory and technology, organization and environment (TOE) framework.

Background

Being a dynamic and complex process, innovation assimilation, can be better understood by the use of multi-stage models to justify the use of aggregation measure of assimilation. A three-staged change model (Lewin, 1952) including unfreezing, moving, and refreezing describes the phenomenon of a system implementing organizational innovation. Another study categorized assimilation into three primary stages (Meyer & Goes, 1988), i.e. knowledge-awareness stage, evaluation-choice stage, and adoption-implementation stage. Literature also identifies that assimilation can be viewed as a six-stage process from initiation followed by adoption, adaptation, acceptance, routinization to a complete infusion stage (Cooper & Zmud, 1990). Other studies further propose the stages like adoption, internal diffusion, and external diffusion (Premkumar, Ramamurthy, & Nilakanta, 1994) and adoption, implementation, and assimilation (Zhu et al., 2006b).

Extant studies also investigate diffusion from a multi-stage perspective, i.e. adoption, implementation, and assimilation classifying each diffusion stage into three categories, e.g. adoption consists of initiation, comprehension, earliness of adoption and adoption, implementation consists of adaptation, acceptance, and implementation, and assimilation consists of routinization, infusion and assimilation (Wu & Chuang, 2010). Determinants that can influence each adoption stage are investigated along with financial and non-financial firm performance.

The study conducted on the adoption process of e-business (Zhu, Kraemer, & Xu, 2006b) investigated the adoption from three stages perspective based on the TOE framework, i.e. initiation, adoption, and routinization. A comparative study regarding adoption between developed countries and developing countries suggests that technology readiness strongly influences adoption in developing countries while technology integration has a significant effect on the adoption in developed countries.

Existing stage-based models capture the dynamic nature of innovation assimilation and provide a clear picture of the complete assimilation process. They also describe antecedents of each stage and provide a theoretical foundation for innovation assimilation research. Present research proposes to use an aggregated measure of adoption and justifies the reason for this.

In the face of the scientific nature of stage-based models to portray innovation adoption, this research proposes the use of an aggregate measure to operationalize BDA adoption. Previous study investigated the role of aggregation in the measurement of IT-related organizational innovation and identified some circumstances when aggregated measures were favourable (Fichman, 2001). Under such circumstances, antecedents that have the same direction in all adoption stages are suitable for aggregation as the aggregation across adoption stages can be more robust and generalizable and promote stronger predictive validity (Fichman, 2001). The proposed research model has all of the predictors in the same direction across all adoption stages and therefore, to raise the generalizability and predictive validity, present paper has aggregated behaviour across the adoption lifecycle within an organization.

To identify the antecedents of innovation adoption, the TOE framework targets the influencing factors under the technology, organization, and environment categories that can impact IS-related decisions (Mishra, Konana, & Barua, 2007). For example, a study investigates the intention of discontinuing information systems (Furneaux & Wade, 2011). Another study takes up the TOE framework to investigate EDI adoption in small businesses (Kuan & Chau, 2001). One of the research studies investigates six variables drawing upon the TOE framework to successfully differentiate non-adopters from adopters of e-commerce (Hong & Zhu, 2001). A recent study explores how factors within the TOE framework influence the e-business adoption at the organizational level (Zhu et al., 2006b).

The TOE framework has substantial consistent empirical support in the literature. Thus, it provides a foundation for the analysis and consideration of suitable determinants for understanding an innovation-adoption decision. Therefore, present research draws upon this framework to understand the influence of antecedents within each sub-category.

Regarding the technological context, classic DoI (diffusion of innovation) theory (Rogers, 1995) identifies five innovation characteristics including, relative advantage, which means the degree to which an innovation is perceived as being better than the idea it supersedes, compatibility, which is defined as the degree to which an innovation is consistent with existing business processes, practices and value systems, complexity, the degree to which an innovation is difficult to use, observability, the degree to which the results of an innovation are visible to others, and trialability, the degree to which an innovation can be experimented with (Rogers & Shoemaker, 1971). Among these factors the first three are most frequently used to explain and predict innovation diffusions and therefore this study proposes to include them as technological factors in the research framework.

Organizational context describes the characteristics of an organization, which mainly include firm size, degree of centralization, formalization, complexity of its managerial structure, the quality of human resources, and amount of slack resources available (Iacovou et al., 1995). These factors could help explain why some organizations are more innovative but others are less prone to innovate. One of the studies capture that the diversified performance differences of innovation diffusion are due to the significant differences in the resources the firm possess, which include managerial knowledge, technology infrastructure, and prior experiences with IT (Mishra et al., 2007). Other studies also suggest that the value firms obtain from IT is dependent on their skills to leverage it (Bhardwaj, 2000; Mata, Fuerst, Barney, 1995). Firms that possess strong managerial capability and prior IT experiences can utilize agile technology, like BDA technology, more efficiently than their competitors. Therefore, present research includes technology resource competency, organizational size, and absorptive capacity, which are regarded as organizational resources, as antecedents.

Environmental context is the arena where a firm conducts its business -the industry, competitors, and dealing with government (Tornatzky & Fleischer, 1990). Institutional theory (Paul & Powell, 1983) proposes that institutional environment provides rule-like social expectations and norms for appropriate organizational structures, operations as well as behaviors and practices. The firm's perceptions of these pressures affect its interpretation of the environment in general and innovation intentions in particular. Thus, present study investigates factors within the institutional pressure that will impact BDA adoption processes.

Institutional pressures are classified into three categories: coercive pressure, normative pressure, and mimetic pressure. Coercive pressure, defined as the pressure originating from political influences, is exerted by the powerful firms on which the focal firm depends (Paul et al., 1983). This pressure is mainly from dominant suppliers and customers because these dominant partners hold resources which organizations need such as new business contracts or funding. Normative pressure refers to the perceived extent to which members of the dyadic relational channels have adopted the innovation and the extent to which the government and industry agencies promote the use of information technology (Paul et.al, 1983). In the proposed model, regulatory support is used as the normative pressure that will influence the adoption processes of BDA. Mimetic pressures are those that make an organization imitate others when the organizational technologies are poorly understood, goals are ambiguous, or the environment is uncertain (Paul et.al, 1983). Since BDA standard is still uncertain and investment is irreversible in developing countries, it means the market of BDA is still uncertain in such economies. Firms will follow others that have successfully implemented this technology. Meanwhile, fierce competition makes organizations imitate those enterprises that have already successfully adopted this technology. Therefore present research includes environmental uncertainty and competition intensity as the source of mimetic pressure.

Research Model and Hypotheses

In this section, a research model to explain and predict BDA adoption for firms in emerging economies is proposed. As introduced in the previous section, the TOE framework is used to identify antecedents that impact BDA adoption. In Figure 1, the research model is described.

Predictions Related to Technological Factors

In this section, influencing factors related to the technological context are introduced. Factors within this context include relative advantage, complexity and compatibility.

Relative advantage

Several studies have used relative advantage to predict innovation adoption and diffusion. For example, considering RFID (Radio Frequency Identification) technology as one of the agile technologies of last couple of decades, there are some studies on RFID adoption, one by Tsai et al. (2010) who investigated RFID adoption in the Taiwanese retail industry and found that relative advantage had a positive impact on RFID adoption. Zhu et al. (2006a) investigated determinants of post-adoption stages of innovation diffusion, using enterprise digital transformation as an example of innovation. Their results indicate relative advantage positively influences e-business usage. Ramdani

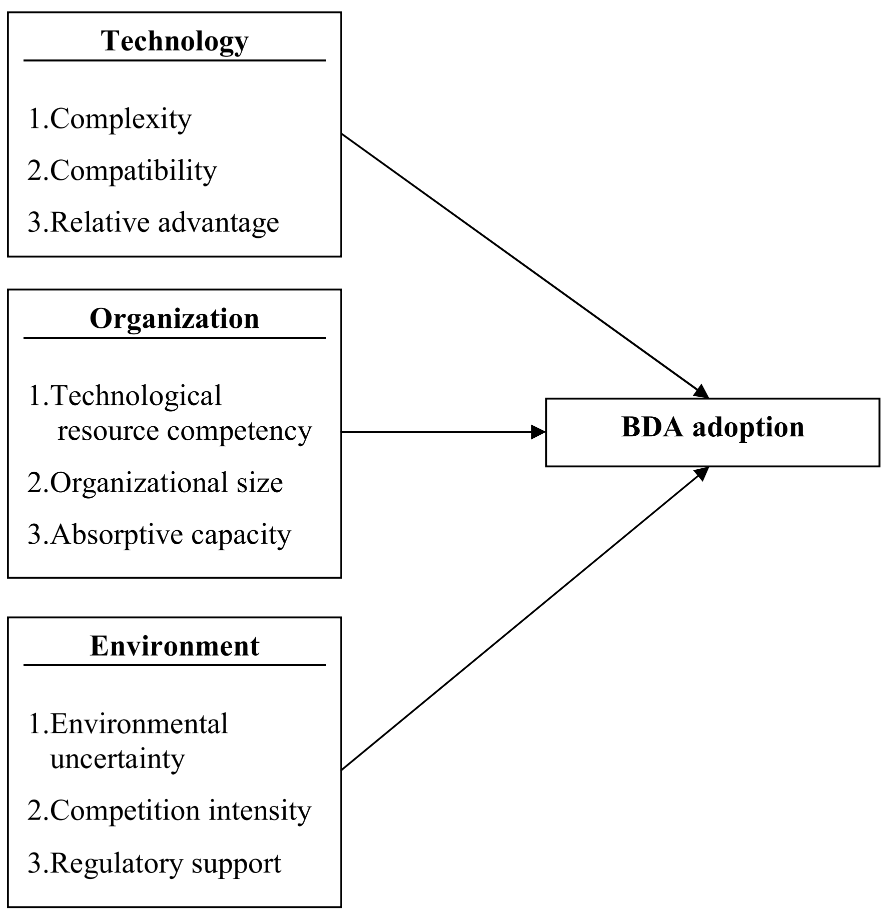

Figure-1. Research Model

and Kawalek (2009) predicted SME's adoption of enterprise systems and suggest that the greater the perceived relative advantage of enterprise systems, the more likely they will be adopted by SMEs (small and medium enterprises). Kwan and Chau (2001) investigated adoption of EDI technology and suggest that relative advantage is a key factor within the technological context that can influence EDI adoption.

Following these studies, relative advantage would be an important factor to motivate organizations to adopt BDA technology. Decision makers will evaluate whether this technology has relative advantage over conventional systems. Compared to conventional systems, BDA can help companies in several aspects, for example, in tracking, controlling, decision-making and innovating in real-time. If integrated with other backend systems, BDA can reduce the lead time, improve efficiency, and reduce labour costs. The preceding observations suggest the following hypothesis.

Hypothesis 1. Organizations that perceive the relative advantage of BDA have a high degree of adoption.

Complexity

It is defined as "the degree to which an innovation is perceived as relatively difficult to understand and use" (Rogers & Shoemaker, 1971). In the BDA context, complexity may be the immaturity of BDA technology, lack of common standards, the difficulty of integrating BDA with the existing enterprises' information systems and business processes. Thus, complexity of innovation should also be analyzed to make sure that an organization has enough financial and human capital to overcome the difficulties during implementation process.

Complexity includes two components: the challenges of customization and high costs (Tsai et al., 2010). BDA systems should be customized for a specific working environment. There is a great need to adjust the BDA backend system and existing IT systems for better co-ordination like as data transmission. The second complexity involves the high investment or maintenance costs. Costs related to BDA operations including skilled manpower and IT infrastructures are high and irreversible.
Costs are further exacerbated by the absence of uniform BDA standards. Firms that perceive high technology complexity will act more cautiously in adopting BDA and assimilate it into their enterprises. Accordingly, following hypothesis may come out.

Hypothesis 2: Organizations that perceive high complexity of BDA have a low degree of adoption.

Compatibility

It, in technological context, is the degree to which an innovation is perceived as being consistent with the needs or the existing practices of the potential adopters (Rogers, 1983). Therefore higher the compatibility greater is the likelihood of innovation adoption (Cooper & Zmud, 1990). Rather than simply substituting for existing data driven technologies within the current processes, implementing BDA technologies might often be combined with process innovations leading to better results. At the same time resistance to change may be an important issue on the implementation of BDA systems. Therefore, compatibility may be an important determinant of BDA adoption. The following hypothesis is proposed.

Hypothesis 3. Organizations that perceive high compatibility of BDA have a high degree of adoption.

Predictions Related to Organizational Factors

Besides technological context, factors in the organizational context can also influence BDA adoption processes. Present research includes Technological resource competency, organizational size as well as absorptive capacity into the organizational context and investigates their influence.

Technological resource competency

Technological resource competency or technological readiness combines IT infrastructure and IT capability (Zhu et al. 2006a, 2006b).

Regarding IT infrastructure, Grant (1991) classified IT-based resources into three categories, (1) the tangible resource comprising the physical IT infrastructure components; (2) the human IT resources comprising the technical and managerial IT skills; (3) the intangible IT-enabled resources such as knowledge assets, customer orientation, and synergy.

According to resource-based theory, tangible resources enable firms to assimilate innovations more quickly and improve products (Bharadwaj, 2000). Compared to a less developed and non-integrated IT infrastructure, a highly integrated IT infrastructure provides a platform to launch innovative IT applications faster than its competitors (Bharadwaj, 2000). Therefore, tangible resources are relevant factors that might influence BDA adoption processes.

Human resources include two components: technical IT skills and managerial skills. Since BDA adoption process would entail significant changes of the business processes and IT infrastructure, managerial capability would play an important role in coordinating activities related with process redesign (Zhu et al. 2006b). Technical IT skills become important in the analysis, design, and implementation of changed business processes.

Intangible resource includes customer orientation, knowledge assets and synergy (Bharadwaj, 2000). Previous research suggests that customer orientation has a significant role on innovation adoption.

Since BDA can shorten, for example, the lead time from requirement generation to manufacturing to customers, it can radically improve the customer services. If a company is more customer-oriented, it will consider improving customers' satisfaction through introducing innovations such as BDA technology. Thus, customer orientation might be a significant sub-factor that has significant impact on BDA adoption.

Knowledge asset refers how the knowledge, skills and experiences of the employees in an organization are embedded in its processes, policies, and information repositories (Bharadwaj 2000). Knowledge assets are also critical for the BDA adoption, because if a firm has strong repositories of knowledge and skills in their employees, it will be easier for them to assimilate new innovations.

Synergy is defined as sharing of resources and capabilities across organizational divisions (Bharadwaj 2000). The firm that can share knowledge and information across its functional units is more flexible and can react faster to address needs. Because BDA technology has the power to share information across all key divisions like as marketing, warehouse, purchasing, production or R&D divisions across a company, it provides an excellent way to share resources and information. Thus, synergy of intangible resources should also relate positively with BDA adoption, and is therefore included into present research model.

Based on the above review, physical IT infrastructure, human IT resources, and intangible resources should all have significant positive influences on BDA adoption. A firm's IT infrastructure is a major business resource and a key source for maintaining long-term competitive advantage (Bharadwaj, 2000). Therefore, technological resource competence may be an antecedent of BDA adoption process.

In a way BDA is a sweeping innovation that can radically change the strategic planning to operational processes of any organization, but doing so requires substantial IT and managerial capability. Technologies that enable more radical improvement require substantial complementary changes to organizational structures, routines, and policies (Fichman, 2004). Consequently, BDA adoption requires changes regarding organizational and process adaptations (Chatterjee et al. 2002).

However, not all firms can manage adaptation effectively because they lack managerial skills and know-how for change management (Robert et al., 2003). Thus, the effect of IT capability or IT professionals, which refers to the capability of managing organizational adaptation to accommodate BDA adoption (Zhu et al., 2006b) is important to investigate.

Organizational adaptations regarding BDA adoption include making organization changes on structures and coordination mechanisms (Chatterjee et al., 2002), and acquiring new expertise necessary to use the innovation (Fichman, 1999). Several studies explain IT failure as a frequent result of management issues such as lack of synergy between business and IT skills, knowledge on how to integrate the technology with the business strategy, how to acquire skilled technical people and train them to use the BDA systems. Such broad management failures suggest that managerial obstacles can impede BDA adoption when organizations cannot make organizational changes, redesign business processes, and acquire new expertise. Therefore, following hypothesis is suggested.

Hypothesis 4: Organisations with strong technological resource competency have a high degree of BDA adoption.

Organizational size

Extant studies on innovation adoption have found that organizational size facilitates innovation (Tornatzky et al., 1990; Grover, 1993; Damanpour, 1992; Moon et al., 1997). Especially bigger firms generally have more resources to try out with new innovations and therefore have greater ability to absorb the risks and costs of implementing innovations (Thong, 1999; Sharma, 2003). Since the cost of BDA systems is still an important issue, only capable organizations have the financial resources to invest in BDA installations at present time. This translates into following hypothesis.

Hypothesis 5. Large organizations have a high degree of BDA adoption.

Absorptive Capacity

An organization's absorptive capacity is represented by its ability to recognize the value of new, external information, absorb it, and apply it for commercial ends (Cohen & Levinthal, 2006). Also effective absorptive capacity can be determined by prior relevant knowledge and intensity of effort (Cohen & Levinthal, 2006).

Existing literature regard absorptive capacity as a knowledge base, especially the extent of prior knowledge the firm possess (Lane et al., 2001b). This is similar to path dependency, which is a firm's ability and incentive to adopt an innovation. It can be largely determined by its level of related experience with prior relevant technologies (Hassan & Chatterjee, 2006). Such skills and knowledge are critical for successful adoption of new technology standards (Cohen & Levinthal, 2006). Thus, firms which have prior experiences and knowledge with related technology may have developed technical and managerial skills for deploying BDA technology compared with those firms without such experiences. Accordingly, following hypothesis is suggested.

Hypothesis 6: Organisations with strong absorptive capacity have a high degree of BDA adoption.

Predictions Related to Environmental Factors

In this section, environmental factors are introduced that can impact BDA adoption processes. In the proposed research model, environmental factors include competition intensity, regulatory support as well as environmental uncertainty. The reasons to include these factors are illustrated in the following part, and based on these factors three hypothesis are proposed.

Environmental uncertainty

As indicated in an earlier research, firms facing environmental uncertainty have greater incentives to adopt IOS (inter-organizational innovation) to improve information exchange and to reduce uncertainty between trading partners. Firms facing higher environmental uncertainty will sense more opportunities, are proactive and innovate more than other firms (Sharma, 2000). Furthermore, environmental and/or market uncertainty forces organizations to adopt and implement new technological innovations to stay competitive (Bolloju & Turban, 2007).

However, this situation might be different in developing countries. Environmental uncertainty may have a negative influence on such firm's proactive and innovative strategies and behaviors. The reason is that firms in these emerging economies are more risk averse than say, firms in western developed countries. Consequently, without external support from their business partners in the industry they are less likely to take initiative to adopt BDA and associated technologies.

Moreover, adopting BDA technology requires considerable irreversible investment costs which mean risk to the enterprises of emerging economies. Compared to traditional analytics system, the cost of implementing BDA technology would be much higher especially for low-profit making organizations. Thus they are less likely to run the risk and be pioneer to adopt BDA technology.

Regarding standards uncertainty, the governments of such economies are yet to develop their own BDA standard, which adds unique uncertainty to the market. Additionally, there is still challenge about who is responsible for drafting the BDA standards. Currently this unclear responsibility inhibits the standards confirmation and thus inhibits the adoption process. Taking these factors into consideration, following hypothesis is suggested.

Hypothesis 7. Environmental uncertainty negatively influences BDA adoption.

Competition intensity

It is "the degree that the company is affected by competitors in the market" (Zhu et al., 2004). The classic five-force competitive model (Porter, 1980) indicates that competitive pressure is an important external driver to initiate the deployment of IOS (inter-organizational innovation) among trading partners. Hence, competition intensity is likely to play a role in BDA adoption.

This may be understood with an example of economic reform practices followed by one of the Asian economies, China. China's economic reforms towards a market economy promote more trade and encourage more foreign direct investment (FDI) since its economic reforms in 1979. These incremental trade and FDI contribute to China's economic growth. China has become the second largest FDI recipient in the world—after the United States—and is the largest host country among developing countries (Fu, 2008). These FDIs bring capital, knowledge, and new managerial skills to the country. Their participation increases competition in the domestic markets which raises challenges to Chinese enterprises' technology and managerial capabilities. Recent opening of FDI in India too would likely to have more or less similar challenges in the long run. To meet these challenges, adoption of new technology such as BDA is necessary to increase their competitive advantage. Thus, following hypothesis is suggested.

Hypothesis 8: Competition intensity positively influences BDA adoption.

Regulatory support

Regulatory support is a critical factor influencing innovation diffusion (Zhu & Kraemer 2005; Zhu et al., 2006b). There are two ways which could affect innovation diffusion. One way is to take tax and other measures to increase or decrease payoff, the other way is to alter the climate in which they are received (Williamson, 1983). Another study investigates the adoption of e-business and finds that governments can encourage e-business legislation by supportive regulations and policies (Zhu et al., 2006b).

These issues are particularly important in Asian countries. Another study investigates, for example, the adoption process of Internet technologies in China and finds that Chinese companies have the highest concern for the regulatory environment in which they and their business reside (Chau et al., 2008). In current research, since presently Indian government is executing the twelfth five-year plan and has plans to invest in R&D of the Internet and allied sectors like cloud computing, and develop digital and virtual technologies, BDA technology would be the key enabler of the Internet and digital world. Regulatory support from the government can form an encouraging environment that will make decision makers aware of this technology and consider adopting it in their enterprises. Therefore, following hypothesis is suggested.

Hypothesis 9: Regulatory support positively influences adoption of BDA technology.

Research Methodology

Construct Measures

Existing instruments were used for the principal construct measures. Some of the items were modified to fit the BDA context. Items for the relative advantage, complexity, and compatibility were adapted from Grover (1993) and Ramamurthy et al. (1999). The measures for technology resource competence, competitive pressure, and partner pressure were adapted from Iacovou et al. (1995) and Lin (2006). Items for the organizational size and complexity, and regulatory support were adapted from Grover (1993). Four items pertaining to the absorptive capacity construct were taken from Soliman and Janz (2004). A five-point Likert scale ranging from 1. Strongly disagree to 5. Strongly agree was used for all items. The dichotomous dependent variable, assimilation, measured whether an organization was an adopter or non-adopter of BDA technology. Table 1 summarizes the measurement items of the independent variables.

Absorptive capacity
AC1. My organization is likely to invest funds in BDA technologies.
AC2. My organization has prior knowledge and experience with related technologies.
AC3. My organization is likely to be interested in assimilating the BDA technologies in order to gain competitive advantage.
AC4. My organization is likely to consider the assimilation of the BDA technologies as strategically important.

Organizational size
OS1. Total capital of my organization is more compared to the industry.
OS2. Returns of my organization are high compared to the industry.
OS3. Employee strength at my organization is more compared to the industry.

Technological resource competency
TRC1. IT infrastructure of my organization is available to support BDA-related applications.
TRC2. My organization is committed in ensuring that employees are familiar with BDA technologies.
TRC3. My organization has a sound knowledge of BDA technologies.

Regulatory support
RS1. The use of BDA technologies is driven by the government influence.
RS2. Standards/laws support adoption of BDA technologies.
RS3. Adequate legal protection supports post-BDA technology adoption.

Competition intensity
CI1. My organization experienced competition intensity to implement BDA technology.
CI2. My organization would have faced competitive disadvantage if BDA technology had not been adopted.

Environmental uncertainty
EU1. The key trading partners of my organization encouraged BDA implementation.
EU2. The key trading partners of my organization recommended BDA implementation.
EU3. The key trading partners of my organization requested BDA implementation.

Complexity
CPX1. My organization believes that BDA technology is complex to use.
CPX2. My organization believes that BDA adoption is a complex process.

Compatibility
CMP1. Existing beliefs/values of my organization are consistent with the changes introduced by BDA technology.
CMP2. BDA technology is compatible with existing infrastructure.
CMP3. The changes introduced by BDA are consistent with existing practices.
CMP4. The development of BDA system is compatible with the existing experiences of my organization on similar systems.

Relative advantage
RA1. My organization expects BDA technology to help in reducing costs.
RA2. My organization expects BDA technology to help in quick real-time data capturing and analysis.
RA3. My organization expects BDA technology to help reduce paperwork

Table 1. Independent Variables and Measurement Items

Sample Profile and Instrument Validation

A questionnaire, comprising of business-related items, items for assessing the predictors, and item for asking whether the organization was a BDA adopter, survey was administered in randomly selected

300 firms from the leading 400 firms in China and India to collect data for this study. 106 useful responses were received with a response rate of 35.4%. Table 2 shows the sample profile.

Category	Number	Percentage
Firm age (years)		
<10	28	26.4
10-20	29	27.4
20-30	36	34.0
>=30	13	12.2
Employee strength (Number)		
<500	60	56.6
500-1500	15	14.2
>=1500	31	29.2
Capital ($ million)		
<1000	33	31.1
1000-3000	51	48.1
>=3000	22	20.8
BDA adoption		
Yes	44	41.5
No	62	58.5
Period of BDA adoption(Year)		
< 1	31	70.5
>= 1	13	29.5

Table 2. Sample Profile of the Organisations

All useful responses were investigated using principal components factor analysis as the extraction technique and varimax as the orthogonal rotation method to assess the construct validity of the measures. Only one item, i.e. EU1 The key trading partners of my organization encouraged BDA implementation, was dropped because of cross-loadings. Table 3 shows a good match between each factor and all other related items having the primary factor loadings greater than 0.5 without cross-loadings (Hair, Anderson, Tatham, Black, 1998). Also the Cronbach α coefficients for the constructs used to measure the reliability are higher than the threshold value.

Analysis and Findings

Table 4 presents the composite scores of all the factors calculated by taking the means of the original item scores.

Despite of being multicollinearity sensitive, the logistic regression technique was used to test the research model as the two-part process used to diagnose the multicollinearity (Hair et al., 1998) could not find any support for the existence of multicollinearity in the independent variables because all condition indices were below the threshold i.e. 30 with variance proportion less than 90%. This is presented in Table 5.

	AC	OS	TRC	RS	CI	EU	CPX	CMP	RA
AC1	0.75								
AC2	0.77								
AC3	0.71								
AC4	0.81								
OS1		0.89							
OS2		0.88							
OS3		0.87							
TRC1			0.86						
TRC2			0.88						
TRC3			0.74						
RS1				0.52					
RS2				0.79					
RS3				0.78					
CI1					0.82				
CI2					0.79				
EU2						0.81			
EU3						0.67			
CPX1							0.92		
CPX2							0.89		
CMP1								0.61	
CMP2								0.82	
CMP3								0.88	
CMP4								0.89	
RA1									0.81
RA2									0.83
RA3									0.56
$\propto$ coefficient	0.81	0.89	0.88	0.71	0.75	0.71	0.91	0.87	0.76

AC: Absorptive capacity; OS: Organizational size; TRC: Technological resource competency; RS: Regulatory support; CI: Competition intensity; EU: Environmental uncertainty; CPX: Complexity; CMP: Compatibility; RA: Relative advantage

Table 3. Findings of Factor Analysis and $\propto$ coefficients

Independent variables	BDA Adopter	BDA Non-adopter	All
AC	3.61	3.55	3.59
OS	3.81	3.11	3.39
TRC	3.37	3.19	3.27
RS	3.24	3.78	3.57
CI	3.09	3.04	3.07
EU	3.44	3.41	3.43
CPX	2.42	3.25	2.89
CMP	3.26	3.18	3.22
RA	3.41	3.49	3.49

Table 4. Means of all independent variables

	Variance proportion									Condition index
	AC	OS	TRC	RS	CI	EU	CPX	CMP	RA	
AC	.00	.23	.01	.00	.01	.00	.04	.01	.00	5.50
OS	.00	.19	.12	.00	.02	.18	.40	.02	.01	12.21
TRC	.00	.03	.07	.00	.07	.29	.13	.12	.01	13.67
RS	.02	.01	.10	.02	.68	.01	.06	.02	.01	14.34
CI	.12	.30	.06	.02	.01	.36	.02	.07	.00	14.98
EU	.06	.03	.22	.01	.07	.01	.24	.01	.36	15.96
CPX	.14	.24	.01	.00	.12	.00	.04	.46	.01	17.71
CMP	.33	.01	.00	.73	.00	.18	.02	.11	.02	22.11
RA	.30	.03	.42	.25	.04	.02	.08	.19	.57	23.93

AC: Absorptive capacity; OS: Organizational size; TRC: Technological resource competency; RS: Regulatory support; CI: Competition intensity; EU: Environmental uncertainty; CPX: Complexity; CMP: Compatibility; RA: Relative advantage

Table 5. Multicollinearity findings with condition index

The research model also shows a good fit with the data as the goodness of fit of the logistic regression model has a small value for −2LL (-2log likelihood). As null model using only the mean of the dependent variable provides the baseline for comparison, the −2LL of the null model was 171.26 whereas the −2LL of the research model comprising of the nine predictors was 79.64. There was one measure of improvement from the null model to the research model as the chi-square test recorded the drop in the −2LL value. Also the two Pseudo R2, Cox and Snell R2=0.53 and Nagelkerke R2=0.67, were satisfactory and the test was significant ($p<0.001$).

Actual	Predicted		Correct (%)
	BDA Adopters	BDA Non-adopters	
BDA Adopters	37	7	84.1
BDA Non-adopters	6	56	90.3

Table 6. Classification matrix showing accuracy of the prediction model

Predictor	Wald statistics	β coefficient
AC	.28	-.27
OS	6.21	.66 [b]
TRC	.03	.08
RS	22.94	-3.61 [b]
CI	3.85	.90 [a]
EU	2.61	.84 [a]
CPX	21.42	-2.45 [c]
CMP	4.42	1.29 [a]
RA	.12	-.20

AC: Absorptive capacity; OS: Organizational size; TRC: Technological resource competency; RS: Regulatory support; CI: Competition intensity; EU: Environmental uncertainty; CPX: Complexity; CMP: Compatibility; RA: Relative advantage

[a] $p<0.05$; [b] $p<0.01$; [c] $p<0.001$

Table 7. Wald statistics and β coefficient findings from the logistic regression analysis

To ensure the accuracy of the prediction model over random guessing, Table 6 shows that the model correctly predicted 84.1% of the BDA adopters and 90.3% of the BDA non-adopters along with an overall accuracy rate of 87.2%. With accuracy ratios over 50% level it also shows how well the research model classified the BDA adopters and non-adopters.

To determine support for the hypotheses, the Wald statistics was used to examine the significance of the regression coefficients of the hypothesized predictors. As presented in Table 7, at 0.05 significance level, six factors viz. compatibility, organizational size, competition intensity, environmental uncertainty, complexity, and regulatory support were identified. Out of these, as the sign of the regression coefficient represents, the first four factors were positively related to organizational likelihood to adopt BDA technology and the last two were negatively related to the same. However, relative advantage, absorptive capacity, and technological resource competence were found to be non-significant discriminators.

Discussion

The empirical results presented significant determinants in each context of the TOE framework used to understand the innovative BDA technology. It also signalled that the BDA adoption by the firms should consider factors related to the internal organization and the external environment along with the characteristics of the technology itself.

Technology context

As discussed, complexity was observed to have a significantly negative influence on BDA adoption. It is certainly more complex to implement as the immaturity of the this technology, the lack of common or established standards, and the difficulty of integrating BDA with the existing information systems and business processes contribute to the complexity of BDA adoption turning out as a barrier to its adoption.

Compatibility, on the other hand, was found to have a significantly positive effect on organizational decisions to assimilate BDA. If organizations' existing experiences with information systems are compatible with BDA applications and match with existing information infrastructure, the changes introduced by BDA adoption will be consistent with existing practices and a positive impact of BDA is likely to occur and facilitate BDA adoption in a favourable way.

Relative advantage, in this study, was found to be a non-significant discriminator. Extant research investigating innovation adoption also supported the similar finding (Grover, 1993). A meta-analysis of innovation adoption (Tornatzky & Klein, 1982) also reported that relative advantage of an innovation was not absolutely significantly relevant to its adoption in all cases. Despite of not being a significant discriminator in this study, the mean value of perceived relative advantage levels of BDA adopters and non-adopters are respectively 3.41 and 3.49 implying that both categories of organizations believe adopting BDA is beneficial for their competitive advantage.

As it is relatively new and still in its infant stage, presently organizations may not have strong confidence in the BDA system. As long as organizations think that they do not have adequate technical capabilities to assimilate new technology, they would rather maintain their current systems (Chau, Tam, 1997) making relative advantage a non-significant discriminator. Therefore to decide whether or not to adopt the new technology, findings of the present study also suggested that firms seemed to pay more attention to the potential problems or risks of BDA technology, i.e. complexity, than to the potential competitive advantages of BDA systems, i.e. relative advantage.

Organization context

The finding from organizational size is reasonable and has emerged as a key variable influencing BDA adoption. Firms adopting BDA technology were less concerned about the acquisition costs, replacement costs, and ongoing costs while those that had not yet adopted were more concerned about these costs. In other words, the cost of software, hardware, consultancy support, installation and integration are obstacles to BDA adoption. Since bigger firms have greater resources and knowledge to assimilate BDA and also the economies of scale to derive maximum benefit (Gibbs et.al, 2004), so firm size has a positive effect on BDA adoption.

The organizational characteristics of absorptive capacity and technological resource competence, unexpectedly, did not significantly impact BDA adoption. This result may be due to the fact that BDA technologies are emerging and common standards are also lacking. Following this uncertainty and believing that more cases of organizational use and validation are needed, organizations from the emerging economies may prefer to wait and see how well and in what direction BDA technology develops. Thus, absorptive capacity and technological resource competence of the organizations would not be significant discriminators of BDA adoption in the early stage of its development.

Environment context

Unexpectedly, finding of regulatory support has a significantly negative effect on BDA adoption and this is against the notion that firms in more regulatory supported environments are more likely to assimilate emerging BDA technologies. Since regulatory support may be more complicated to introduce and manage, they generally require more accompanying knowledge and more complex processing as well. Therefore, regulatory support may encourage adoption of emerging BDA technologies in more technology intensive organizations. Thus, additional research needs to be done before more concrete conclusions can be drawn.

Environmental uncertainty, surprisingly, was found to be a significant facilitator of BDA adoption in the emerging economies of Asia. This may be because the firms facing higher environmental uncertainty from trading partners will sense more opportunities, are proactive, innovate and implement more than other firms (Sharma, 2000) to stay competitive (Bolloju et.al, 2007).

The findings from competition intensity indicate that firms adopting BDA perceived significantly higher competitive pressure than non-adopter firms. Competition intensity, being an environmental stimulator, positively influences the firms and makes more receptive to BDA when competitors implement BDA as a competitive weapon, thereby making BDA adopters more concerned about the competitive differentiation than non-adopters.

Conclusion

Big Data Analytics (BDA), an emerging technology that can provide strategic, operational and other advantages is yet to see significant rates of adoption in the organizations across the industries. Since recent IS research lack focus about this technology and the determinants that impact its organizational adoption, present study has developed and validated a research model to examine the contextual factors that influence BDA adoption in the context of two emerging economies of Asia drawing upon diffusion of innovation (DoI) theory (Rogers, 1995), institutional theory (Paul et.al, 1983), and Technology-Organization-Environment (TOE) framework (Tornatzky et.al, 1990).

There are several contributions of this study. As TOE framework presents a reasonable skeleton to analyze and consider suitable factors that can influence business innovation-adoption decisions, this study empirically verifies and supports the applicability of the TOE framework in understanding BDA adoption in emerging economies.

Out of several key findings, six variables i.e., complexity, compatibility, regulatory support, organizational size, competition intensity, and environmental uncertainty were found to be significant determinants of BDA adoption, and three variables i.e., relative advantage, absorptive capacity, and technological resource competence were found to be non-significant determinants. Out of the six determinants, regulatory support and complexity are inhibitors, and other determinants are facilitators of BDA adoption. In this study, regulatory support was found to be the most influential factor affecting BDA adoption and complexity was the next most influential predictor.

This study also found two significant determinants of BDA adoption, environmental uncertainty and regulatory support, which were little explored in the prior technology adoption research. Thus, this study has contributed several valuable and important implications for BDA adoption research and practice.

There are some limitations of this study also that represent opportunities for future research. Since the sample is based on only two emerging economies from Asia, it may not be sufficient to generalize the findings in other parts of the world.

Since the sampling frame of this study consisted of top 400 firms in China and India, these firms might have more resources and capabilities to be able to afford BDA investments and risks and due to this, the BDA adoption rate in the sample may be higher than the adoption rate in context of Chinese and Indian businesses. Therefore, caution needs to be exercised in generalizing the findings of this study to the entire population in these two or other countries. And to validate or refine present model, samples from different nations and/or industries should be collected.

To identify the predictors that distinguish between adopters and non-adopters, current study employed the logistic regression technique that only focuses on the single relationship between the independent and dependent variables (Hair et. al., 1998). So in this study the interrelationships among the independent variables were not analyzed. Future research can simultaneously examine a series of dependence relationships into a predictive model to enhance understanding of the causality and interrelationships between the predictors.

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