

Considerations for the Adoption of Cloud-based Big Data Analytics in Small Business Enterprises

Olufemi J. Ajimoko DCS

Associate Professor of Computer Science at King University, Bristol, TN, USA

ojajimoko@king.edu

Abstract: This study explores the various adoption criteria that would guide the information technology (IT) professionals in small business enterprises (SBEs) in their decision to adopt cloud-based big data analytics (CBBDA). The research was guided by three major theories of technology adoption, which were: diffusion of innovation, theory of technology acceptance model, and the theory of technology-organization-environment framework. The study was based on a sample of 20 IT professionals from 10 SBEs in the state of New Jersey in the United States. The exploratory qualitative research used semi-structure questionnaires to conduct one-on-one interviews with the participants. The results were coded to identify the emergent themes. The study found two categories of CBBDA adoption criteria; they were: (a) internal technology adoption criteria, which were found to be unique to each SBE and (b) external technology adoption criteria, which were found to be uniform to all the SBEs. The internal criteria consisted of technological and organizational factors, while the external criteria consisted of vendor-related and environmental factors. Further, the study found that some of the prominent internal factors played a dominant role in CBBDA adoption in SBEs. They were: (a) technology/organization alignment and fit; (b) SBE data environment and need; (c) SBE financial standing and (d) SBE owner/top management support. It was also found that no matter how useful the innovation, the lack of SBE owner/top management support can easily obstruct the adoption of CBBDA and other similar future technology.

Keywords: big data analytics, cloud computing, cloud-based big data analytics, small business enterprise

1. Introduction

The current trend in Big Data Analytics (BDA) is the increasing popularity of Cloud-based Big Data Analytics (CBBDA), which is the hosting of BDA tools over the cloud (Glick, 2013; Preez, 2014; Henschen, 2015; Marr, 2015; Scheck, 2016). BDA itself is the systematic process of evaluating a large heterogeneous data, to identifying patterns, relationships, unknown correlations and other useful information that can improve the business decision-making process (Minelli et al, 2013; Morabito, 2015). Big data is the term that describes massive structured and unstructured data that exceeded the processing capacity of the traditional database system. It is particularly complex for the traditional database system in terms of volume, variety, velocity, and its influx from multiple sources, which makes it difficult to link, match, cleanse, analyze, and transform from one state to another. Moreover, large datasets present intricate issues regarding policies for historical record management, data retention, and prioritization of data to be backed up (Khan et al., 2014; Halaweh and Massry, 2015). The growing of data among individuals, business organizations, and governments at all levels is so enormous that about 90% of the global data were generated in the last two years (ScienceDaily, 2013). According to Akbay (2015), as data evolves from being human-generated to machine-generated due to the increasing popularity of the Internet, we need a new way to turn this data into actionable events that can improve the decision-making processes of the organizations. Therefore, the innovation of BDA was invented to conveniently handle the growing heterogeneous data. It has been found that BDA has the potential of helping business organizations to achieve efficiency improvement, fraud reduction, increased sales, enhance better customer relation, improve organization productivity, and lower their total costs if it is properly captured, processed, and analyzed (Navint, 2012).

Unfortunately, the use of Big data analytics has been restricted mainly to datacenters of large and multi-national companies due to the huge investment involved (Carter, farmer and Siegel, 2014; Baldwin, 2015; Morabito, 2015; King, 2016). However, in recent times, the popularity of the cloud computing has made it possible for small companies to have access to CBBDA, which is the hosting of BDA over the cloud, at an affordable cost. The entire CBBDA infrastructure has already been setup in the cloud for the potential customers; they only pay based on the usage (Minelli, Chamber and Dhiraj, 2014; Kaur 2015; IBM, 2016). Moreover, the Big Data experts are available to provide the necessary technical support that customers may need (Rajesh, 2014). Therefore, various organizations especially the large companies have been adopting

CBBDA due to its convenience, cost effectiveness, and affordability. The Table 1 highlights the major differences between the datacenter BDA and CBBDA.

Technology plays a crucial role in how modern businesses start, operate, and grow; nevertheless, current research revealed that more than half of the small businesses in the United States do not have right technology to move with the current global business trend (SBA, 2015). Currently, the major issue facing the small business enterprises (SBEs) is related to identifying technology adoption criteria, which can guide their decision in the adoption of CBBDA innovation to manage their big data (Beheshti, 2004; Cataldo, McQueen and Sepulveda, 2011; Smithers, 2013; Schaefer and Oslo, 2014; Cervone, 2015). This issue is particularly significant because unlike the large corporations, SBEs have unique characteristics, such as limited income, limited project scope in relation to technology, and limited profit (Jiang, Chen and Lai, 2010; Cataldo et al. 2011; Davenport and Dyche, 2013). The goal of this study is to explore the adoption criteria needed by IT professionals in SBEs to guide their decision in the adoption of CBBDA, which is a type of affordable big data analytics (BDA) that is hosted in the cloud (Sharma and Batra, 2016). This move will eventually improve the overall business processes of SBEs and enable them to experience growth in the current competitive global economy (Ghobakloo, Hong, Sabouri & Sulkifli, 2012; McKendrick, 2014; Liu, (2015); Scheck, 2016).

The United States Small Business Administration (SBA, 2015) defined SBEs as independently owned and operated businesses with a total number of employees below 500 and an income not exceeding \$21.5 million. Although large corporations get most of the media attention, there are some indications that SBEs are one of the major players in the United States economy (Schaeffer and Olson, 2014; Delgado, 2016). Small business enterprises make up 99.7% of all employers nationally (SBA, 2018). According to the Statistics of U.S businesses of SBA (2018), the United States has 30.2 million small businesses, which is 99.9% of the total and those businesses employed 58.9 million people or 45.7% of the nation’s private workforce in 2015. Likewise, SBA (2018) stated that New Jersey, which is the study area, has 861,373 small businesses or 99.6% of the total businesses in the state and those businesses employed 1.8 million people or 49.8% of the state’s private workforce in 2015. Moreover, the firms with fewer than 100 employees constituted the largest share of small business employment in both the Federal and the State of New Jersey (SBA, 2018). Thus, with such abundance of small businesses, the research has shown that these business organizations are jointly generating massive data roughly the same proportion as large enterprises (Davenport and Dyche, 2013; Smithers, 2013; King, 2016). Therefore, by adopting the right big data technology, small business organizations would be able to analyze their gigantic structured and unstructured data to derive insights needed to improve their business processes thereby enable them to gain competitive advantage in the current fast-paced global economy (Scheck, 2016).

Table 1: On-site BDA and CBBDA Comparison

Features	BDA on-site	CBBDA
Datcenter ownership	Owned by the company; Locally on site	Owned by CBBDA provider; Located in offsite
Cost of initial investment	High cost of initial setup	Lower cost of initial setup for customers (pay-as-you-go). Customer can start at any time.
Server infrastructure	Physically locally on site	Virtually located in the cloud
BDA Applications	Locally on site	Virtually located in the cloud
Corporate data	Locally in on-site in the datacenter	Located in the cloud
BDA deployment	Very complex deployment with a lot of configurations	Nothing to configure; customer only connect through their client browsers
Maintenance	Provided by the company	Provided by CBBDA provider
Expertise	Provided by the company	Customer support provided by CBBDA provider. However, the usage depends on the in-house experience of the cloud customer side.
Data security	Adequate security	Security is not guarantee as the space is shared by many customers
Scalability / new innovation	Scalable at the expense of the company	Flexible and easily scalable
Internet Access	Not required	Required. Low bandwidth can lead to bottleneck of large amount of data.
Government regulations and compliance	Fully compliance based on business needs	May or may not be in compliance

Features	BDA on-site	CBBDA
Big Data Analytics infrastructures	Limited infrastructures	Sophisticated and latest infrastructures
Organization affiliation	Big Companies	Big and small companies

Note: BDA – Big Data Analytics; CBBDA – Cloud-based Big Data Analytics

Small business enterprises (SBEs) are often lack the capability of managing and controlling large servers and data operations; consequently, a solution of public cloud servers such as Amazon Web Services or Microsoft Azure HDInsight has been suggested to reduce their costs and improve their decision-making processes (Sultan, 2011; Rising et al., 2014). This exploratory qualitative study explored the criteria that are needed to assist the IT professionals in SBEs when deciding to adopt CBBDA services in order to avoid future catastrophe, unforeseen contingencies, and future regrets that are usually associated with technological adoption in SBEs. Further, the study highlighted various supporting and challenging forces that may influence the adoption of CBBDA adoption by Small Business Enterprise.

2. Problem Statement

Previous studies have been focusing mainly on BDA and CBBDA adoption criteria in large corporations with little attention given to SBEs (Ghobakhloo et al., 2012; Davenport and Dyche, 2013; Dhar and Mazumder, 2014; Khan et al., 2014; Palem, 2014; Sakr and Gaber, 2014; Schaeffer and Olson, 2014; Morabito, 2015; Delgado, 2016; Scheck, 2016). According to Halawah and Massry (2015), the rapid advancement of technological innovation has caused major changes in the technological adoption criteria especially for SBEs. Consequently, previous studies are inadequate to address the current technology adoption trends (Chebrolu and Ness, 2013; Dhar & Mazumder, 2014; Rajesh, 2014; Baldwin, (2015); Hoti, 2015; King, 2016). This problem makes it difficult for IT professionals in small businesses to understand the necessary criteria that can guide them in the adoption of the new technology (Bruque and Moyano, 2007; Oliveira and Martins, 2011; Smithers, 2013; Preez, 2014; Baldwin, 2015; King, 2016). Consequently, as the CBBDA continues to grow at a rapid pace, SBEs are unwilling to accept the new technology until technology acceptance criteria have been established (Premkumar, 2003; Oliveira and Martins 2011; Baldwin, 2015; Delgado, 2016).

Moreover, the unique features of SBE essentially make the adoption of its new technology different from large corporation. These features include their limited capability in terms of small size, small capital, small income, and few or no technical expertise (Cataldo, McQueen and Sepulveda, 2011). Other SBE features include the tendency to employ generalists rather than specialists; limited access to research and market information; informal and unreliable strategies in decision-making processes; and a limited project scope (Qian, Baharrudin and Kanaan-Jebna, 2016). Those exclusive characteristics make the technology adoption of SBEs to be significantly complex and prone to higher risk compared to large corporations (Srinivasan, 2010; Schaeffer and Olson, 2014; Scheck, 2016;). This problem statement is depicted in a conceptual framework in Fig. 1. The study was particularly interesting because the process of adopting a new idea is difficult, even when it has obvious advantages (Rogers, 1983).

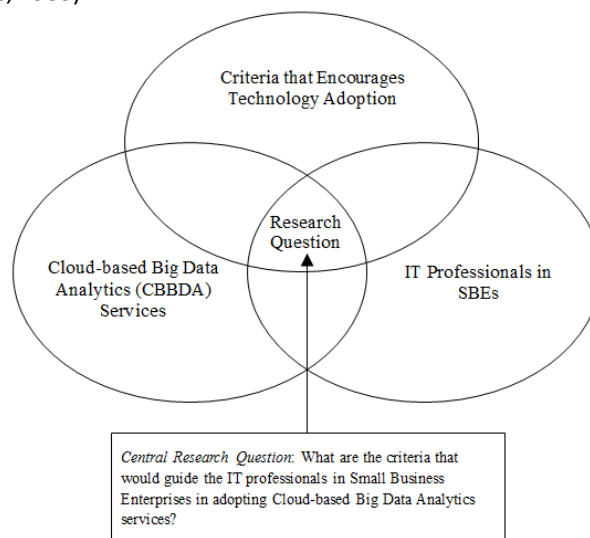


Figure 1: Conceptual Framework

Thus, this qualitative study explored the adoption criteria that would guide IT professionals in SBEs to make the right decision as to whether or not to adopt CBBDA services in their business organization.

3. Theoretical Background

The review of literature revealed many theories on technology adoption. Some of the existing concepts include Diffusion of Innovation - DoI (Roger, 1962; 1983; 2003), the theory of Technology Acceptance Model - TAM (Davis, 1986; Davis, Bagozzi and Warshaw, 1989), the theory Technology-Organization-Environment (TOE) framework (Tornatzky & Fleisher, 1990), the Theory of Planned Behavior - TPB (Ajzen, 1985; 1991), the Unified Theory of Acceptance and Use of Technology - UTAUT (Venkatesh, 2003), and the Institutional Theory (Scott, 2004), which emphasized the role of norms, rules, culture, and social structure as authoritative guidelines for social behaviors that play major roles in technology adoption. The literature revealed that most of these technology adoption theories focused on individuals rather than organizations (Arpaci, Yardimci, Ozkan and Turestken, 2012). Also, it was revealed that the adoption of innovation is more complex at the organizational level than at individual level (Premkumar, 2003; Rajesh, 2013; Neaga and Liu, 2015). This is because the organization consists of the aggregate of individuals and its own system with a set of procedures and norms (Rogers, 1983, Kelly, 2007; Khan, Anjum, Soomro and Tahir, 2015). Further, the review of the literature showed that none of the previous adoption theories provide unified criteria that influence the technology adoption of organizations and SBEs that correspond to the current level of technological development (Brancheau and Wetherbe, 1990).

Consequently, the theoretical framework of this study was based on three popular innovation theories: (a) the DoI theory (Rogers, 1983); (b) the TAM theory (Davis, 1986); and (c) the TOE theory (Tornatzky & Fleischer, 1990). The combination of these three theories provided a broad analysis of the technology adoption criteria that are likely to influence the decision of IT professionals in SBEs to make the appropriate choices regarding adoption of a particular innovation into an organization. Thus, the theories served as the foundation for exploring the technological adoption criteria that would guide the IT professionals in SBEs in their decision whether to adopt or not to adopt the CBBDA and any other future innovation in their organizations.

4. Diffusion of Innovation (DoI)

Rogers (1983) noted that diffusion occurs through a 5-step decision-making process, which includes (a) the knowledge of technology through awareness, (b) persuasion that the idea will be beneficial, (c) decision to accept or not accept it, (d) implementation, and (e) confirmation to check whether the technology is satisfactory or not. With that background, the theory proposed five main elements that influence the spreading of innovation: the innovation itself, the adopters, communication channels, time, and social system, which is the societal environment where the adoption is happening. Thus, if the new invention is very useful, if it is very easy to use, and if it is affordable, the society will accept it and start spreading the news among each other (Rogers, 1983).

Moreover, the theory categorized innovation adopters into five categories, which are innovators, early adopters, early majority, late majority, and the laggards, who are the last adopters. The innovators are the originators of innovation; they are willing to take the risk to introduce the technology. The early adopters are the first group that adopted the innovation; the group usually consists of a few organizations and swiftly moves along with the new trend. The early majority is interested in seeing the evidence of its usefulness before adopting the new technology. The late majority is skeptical to change and will only adopt innovation after it has been tried by the majority; this group must be convinced that the innovation proved to be useful. The laggards are the last group that adopt an innovation; they are very skeptical to change and are the hardest group to bring on board in the adoption path. In this study, the SBEs are the laggards as they are the last group to adopt the CBBDA, while the large corporations are the early adopters. Researchers have generally found that people or organizations who adopt innovation early have different characteristics than those who adopt the innovation later (Rogers, 1983; Chau, 1996; Gong et al., 2004; Budak, 2012; Hoti, 2015). The theory of DoI has been applied to many technological innovation adoptions. The proponents of the theory maintained that DoI clearly distinguished between the various processes by which individuals or organizations adopt new invention amid of diffusion of innovation, and the processes are still very much applicable to the present time (Hernandez, Jimenez and Martin, 2008). Moreover, the DoI processes are applicable to the adoption of CBBDA by the SBEs. These include (a) the awareness of CBBDA through the DoI, (b) the decision to adopt by first trying

the initial free version, (c) the decision to continue to use of the technology if its meet the SBE needs, or (d) the decision to reject it at the end of the evaluation period.

However, the DoI theory has been criticized for the following reasons. First, Chau (1997) noted that the major weakness of this theory is that technology adoption is not as simple as put forward by Rogers (1983); the adopters could not exert equal amount of influence on various groups as suggested by Rogers (Tornatzky and Klein, 1982). The theory does not consider individual organization resource or social support needed to adopt new invention. Budak (2012) noted that DoI failed to provide possible clear adoption criteria that individuals or organizations needed to make decision to adopt a new invention such as CBBDA. This implies that the decision to adopt innovation includes far more than the awareness of the innovation through only diffusion as Rogers claimed (Bradford and Florin, 2003). For example, it is possible for SBEs to be aware of the CBBDA through the process of diffusion; however, other critical factors such as inability to afford it may prevent SBEs from adopting the CBBDA innovation. These weaknesses explained why DoI alone is inadequate to explore SBE adoption criteria for CBBDA innovation. This is a major reason why it is necessary to explore other theories such as the theory of TAM.

5. Theory of Technology Acceptance Model (TAM)

Next is the theory of TAM, asserted by Davis, Bagozzi and Warshaw (1989). The model attempts to provide an explanation regarding how users tend to accept and use technology. The model suggested several factors that influence the users' decision when accepting a new technology. The first of these factors is perceived useful (PU), which is the degree to which a person believes that using a particular system would enhance the job performance. The second factor is the perceived ease of use (PEOU), which is the degree to which a person or organization believes that using a particular system required minimum effort (Davis et al., 1989). Other factors are attitude toward use, behavioral intention to use, and the actual use of the system. Lala (2014) noted that TAM provides simplified model of various factors that motivate users to adopt new technology. Oliveira and Martins (2011) argued that the model is applicable to a wide range of technology ranging from simple application like Microsoft Word to cloud-based technology such as CBBDA. Dostal (2015) supported TAM by argued those who accept any technology did so because they perceived its usefulness as a tool that could bring process improvement. Moreover, Min, Xu, and Yu (2004) utilized TAM to conduct technology acceptance of web-based learning among 280 full-time primary school teachers in rural area of China, who were also part-time students. They found that their behavioral intention for accepting web-based learning were in consistent with TAM theory.

However, Brancheau and Wetherbe (1990) reported that even though the theory of TAM is able to explain the reaction of the individual to technological acceptance, the theory omitted some of the major critical technology adoption criteria of business organizations such as management support and the organizational culture (Junglas, Goel, Abraham, and Ives 2011). Moreover, the theory omitted the cost of the technology, which a major determinant of its affordability (Fisher & Howell, 2004). For example, the major reason SBEs did not accept BDA earlier was that they could not afford it (Baldwin, 2015). Venkatesh, Morris, Davis, and Davis (2003) noted that even though TAM has identified some of the major elements that can influence the adoption of innovation, the theory failed to provide unified technology adoption criteria due to the omission of other critical adoption factors such as effort expectancy and social influence. Due to the weaknesses of TAM, another extended theory has emerged as notable—the theory of TOE (Tornatzky and Fleischer, 1990).=

6. Theory of Technology Organization Environment (TOE) Framework

Unlike the theory of TAM, the TOE framework (Tornatzky and Fleisher, 1990) is an organizational-level innovation adoption theory. TOE framework adoption piece describes the various factors that influence the choice of whether to adopt a new technology by organization or not. The model suggests that when organizations are confronted with the choice to adopt a new technology, such decision is influenced by the technological context, organizational context, and environmental context. The elements present both constraint and opportunity for technological innovation adoption (Tornatzky and Fleisher, 1990). The three groups were postulated to influence the adoption of technological innovation such as CBBDA in an organization.

The technological context includes the internal and external technologies that are relevant to the organization. Technology context includes critical elements that associated with technological functionalities and usage

(Davis, 1986). These include both equipment and processes (Khan et al., 2014). This context also includes all the technologies relevant to the organization, which include the current technologies owned by the organization and those that are available in the marketplace that are yet to be adopted. According to Tornatzky and Fleisher (1990), the adoption criteria that fall under this category include the availability of the new technology such as CBBDA and their motivating characteristics features that encourage the organization to adopt it. The existing technologies in the organization are particularly important in the adoption process because they set a broad limit on the scope and pace of technological changes that an organization could undertake (Baker, 2011). Thus, the inherent attributes of innovation inform of technological context is important to CBBDA adoption. The characteristics features of CBBDA such as perceived ease of use, affordable cost, and easy accessibility are vital elements that would influence the SBEs to adopt the technology (Schaefer and Olson, 2014).

The organizational context refers to the characteristics of the organization, which include formal and informal linking structure, communication processes, size, culture, and the level of eagerness of organization to strive for change (Tornatzky and Fleisher, 1990). Organizations that have the urge to move with the new technological changes are more likely to adopt new innovation than those that care less (Bruque and Moyano-Fuentes, 2007; Pillania, 2008; Ghobakhloo et al., 2012). The organizational context is very relevant to the adoption of CBBDA in SBEs due to their small size and low income (Halaweh and El Massry, 2015). For example, the level of the financial standing of SBEs, their organizational structure and size, managerial beliefs, and level of expertise of the organizational IT professionals play a vital role in influencing SBEs whether to adopt a new innovation in their organization (Micheni, 2015).

The environmental context is seen as group of exclusive forces outside the control of the organization such as industry characteristics and market structure, competition pressure, technology support infrastructure such as electricity and reliability of the Internet connection; and government regulation pressure (Tornatzky and Fleisher, 1990). Many scholars believed that environmental factors play a crucial role in any activity of an organization especially in the area of innovation adoption. Oliveira and Martin (2010) discovered that competitors—the degree of stress within the industry—are crucial environmental factors that influence the adoption of a new technology. Further, Acheampong and Moyaid (2016) in their integrated model for determining business intelligence systems adoption in banking sector noted that government regulation was one of the major environmental factors that can either stimulate or discourage the adoption of new technology. In addition, environmental adoption criteria such as technology support infrastructure, like electricity and Internet connection reliability, are critical factors that determine the adoption of technologies in developing and underdeveloped countries due to their poor infrastructural development (Acheampong and Moyaid, 2016). Thus, environment context has been seen as very critical to CBBDA adoption (Ghobakhloo et al., 2012; Khan et al., 2015).

Many scholars have either conducted research using TOE or have combined it with other innovation adoption theories such as DoI and TAM. For example, Ryan and Prybutok (2001) utilized TOE to conduct a quantitative study of knowledge management technology among United States executives using sample of 1515 executives. The authors found that TOE organizational and technological context variables are important in the adoption of knowledge management technologies among executives nationwide. The environmental context variable was not significant in the sample. Next, Scupola (2004) combined DoI with TOE to study the adoption of e-commerce among small and medium enterprises (SMEs) in Southern Italy and found that TOE environmental context played a dominant role (when compared with the technology context or organization context) in the adoption and implementation of e-commerce by SMEs.

Puklavec, Olivera, and Popovic (2014) utilized TOE to conduct a qualitative study of business intelligent application adoption processes and adoption determination in four SMEs located in European Union. The authors utilized a face-to-face semi-structured questionnaire to interview 10 staff in four different SMEs who have experienced business intelligence adoption. The study showed that the technology context (innovation usefulness and cost) combined with organizational context (management support) significantly influenced business intelligence technology adoption, while the environmental context such as regulatory influence was less significant.

7. Research Methodology

The research methodology used an exploratory qualitative design. The choice of this method was based on the fact that the research falls under the nascent continuum of research with very few previous studies and with acute shortage of data (Edmondson and McManus, 2007). Moreover, the study was grounded on an in-depth literature review with reference to three related technology adoption models, which were DoI, TAM, and TOE, in order to identify the holistic and unified adoption criteria that are likely to influence the choice of CBBDA among the SBEs. The population for the study consisted of 20 IT professionals in 10 SBEs across the state of New Jersey who have successfully adopted CBBDA. The definition of SBEs in this study consisted of small companies with sizes ranges from 10 to 50 employees.

The distribution of the participants based on their business types is shown in Table 2. The major instruments of the qualitative study consisted of open-ended questions (see APPENDIX A). The questions were made available to the participants through face-to-face, online chat, and over the telephone interview. During the interview, a special attention was paid to how the various adoption criteria highlighted in Diffusion of Innovation (DoI), theory of Technology Accepted Model (TAM), and theory of Technology Organization Environment (TOE) influence the adoption of CBBDA. The coding analysis was conducted using NVivo software. Coding is the grouping of the similar words or phrases that provide answer to the research questions (Bernard & Ryan, 2010; Rubin and Rubin, 2012). Using computer software such NVivo helped to speed up the coding analysis.

Table 2: The Distribution of the Participants Based on Business Types

Type of Business	Number of SBEs (10)	Number of Participants (20)	Percentage of participants
Mortgage	1	3	15%
Healthcare	2	4	20%
IT Solution	1	3	15%
Insurance	2	4	20%
Real Estate	2	4	20%
Retail	1	1	5%
Car Dealer	1	1	5%

Note: SBEs=Small Business Enterprises

As we can see from Table 2, mortgage company is one of the seven categories of SBEs that were interviewed. The group consists of 10 employees and engages in lending money to home buyers. The company relies in Big Data Analytics and Business Intelligence tools to source its clients around the country. The second category of company interviewed was healthcare with 15 employees. Two IT professionals from two health care SBEs were interviewed. The third category of company was IT Solution with 12 employees; one employee with knowledge of CBBDA was interviewed. Another category of company was insurance company, which relies on Big Data Analytics to not only source for their clients, but to also to detect fraud and determine the their level of trustworthiness. Two IT professionals from two insurance SBEs were interviewed. The last categories of the SBE participants are real estate, retail, and car dealer, which are very common in South Jersey. Two IT professionals from two real estate companies with employee size ranging from 15 to 20 were interviewed, while one participant was interviewed in the retail sector and one in a car dealer business.

8. Research Findings

The finding of the study revealed two major adoption consideration factors, which are: (a) CBBDA internal adoption criteria, and (b) CBBDA external adoption criteria. While the internal adoption criteria were found to be unique to each SBE, the external criteria factors were found to be common to all the SBEs. The thematic analysis showed that internal criteria were divided into two sub-themes of *technological factors* and *SBE organization factors* as shown in Table 4 below.

Table 4: CBBDA Internal Adoption Criteria and Sub-theme Occurrences

Theme Category	Major Theme	Sub-theme [CBBDA Adoption Criteria]	Sub-theme occurrences	Number of participants out of 20	Percentage of the total participants
Internal Criteria	<i>Technological factors</i>	Perceived usefulness	53	20	100%
		Technology/Organizational operations alignment and fit	50	20	100%
		Cost of implementation	45	20	100%
		CBBDA security	42	18	90%
		Perceived ease of use	41	15	75%
		CBBDA Learning curve	21	11	55%
	<i>Organizational factors</i>	Organization awareness of CBBDA	55	20	100%
		Owner/Top management support	51	20	100%
		Organization financial standing	48	20	100%
		Organization data environment/ needs	45	20	100%
		CBBDA Adoption Sponsor	44	19	95%
		Organization readiness	41	19	95%
		Organization type	39	18	90%
		Organization size	37	18	90%
		Organization level of satisfaction with the existing system	35	15	75%
Organization innovativeness	30	13	65%		
Organization culture	27	12	60%		
Organization IT Professional competence, expertise and experience	26	12	60%		

Note: BDA=Big Data Analytics; CBBDA=Cloud-based Big Data Analytics

The findings of technological factors include the following, based on the level of importance: a) the perceived usefulness of the technology; b) technology/organization alignment and fit; c) cost of implementation; d) CBBDA security; e) Perceive ease of use (PEOU) of the technology; and f) CBBDA learning curve. Most of the participants are particularly more interested in technology/organizational alignment and fit because of the close integration between technological innovation and business operations. The study found that the alignment of IT innovation and business processes is so crucial to SBEs and failure to match new innovation with business operations could hamper the organizations’ performance and viability. Thus, the starting point of new innovation adoption for SBEs should be the matching of innovation with their business operations in order to avoid costly and irreversible investment errors, considering their limited capability in terms of income and profit.

On the other hand, the study revealed the following organizational factors played role in CBBDA adoption based on their rank from the highest to the lowest. They are (a) organization awareness of the CBBDA—the SBEs cannot adopt innovation that they do not have the awareness of it; (b) owner/top management support, (c) organization financial standing, (d) organization data environment and needs, (e) organization CBBDA adoption sponsor, (f) organization readiness, (g) organization type, (h) organization level of satisfaction with the existing system, (i) organization innovativeness, (j) organization culture, and (k) organizational IT professionals’ competence, expertise, and experience.

Likewise, CBBDA external adoption criteria emerged as a major category with two primary themes. They were *environmental factors* and *vendor-related factors* as shown in Table 8. The environmental factors include the concerns for the untapped exponential growing Internet data such as social media data, sensor data, text messages, audio, and video messages over the web as there are valuable insights such as marketing information in such massive raw data. Other environmental factors include the competitor/industry pressure; customers’ pressure; the need for government regulations and compliances; and pressure from CBBDA vendor to market their technology to SBEs. The external adoption criteria identified in this study agreed with environmental context of TOE framework (Tornatzky and Fleischer, 1990). However, while TOE recognized

industry adoption criteria such as characteristics and market structure, technology support infrastructure, and government regulation, the model failed to mention the role of vendor-related factors such as marketing pressure as one of the major adoption criteria that influence new innovation adoption.

Table 5: CBBDA External Adoption Criteria and Sub-theme Occurrences

Theme Category	Major Theme	Sub-theme [CBBDA Adoption Criteria]	Sub-theme occurrences	Number of participants out of 20	Percentage of the total participants
External criteria	Environmental factors	The untapped exponential growing of Internet data	53	20	100%
		Competitor/Industry pressure	48	20	100%
		Customers pressure	41	20	100%
		Government regulations and compliances	35	16	80%
		Quality of CBBDA supporting infrastructure – Internet connection & electricity	32	15	75%
	Vendor-related factors	Trustworthiness of CBBDA vendor	49	20	100%
		Perceived quality of service	45	20	100%
		CBBDA vendor marketing pressure	41	20	100%

Note: BDA=Big Data Analytics; CBBDA=Cloud-based Big Data Analytics

The vendor related factors include the trustworthiness of the CBBDA vendor, the perceived vendor’s quality of service, and CBBDA vendor marketing pressure. It was interesting to see that CBBDA vendor marketing pressure play a major external role in CBBDA adoption. The high-level abstract of the internal and external technology adoption criteria are depicted Figure 2.

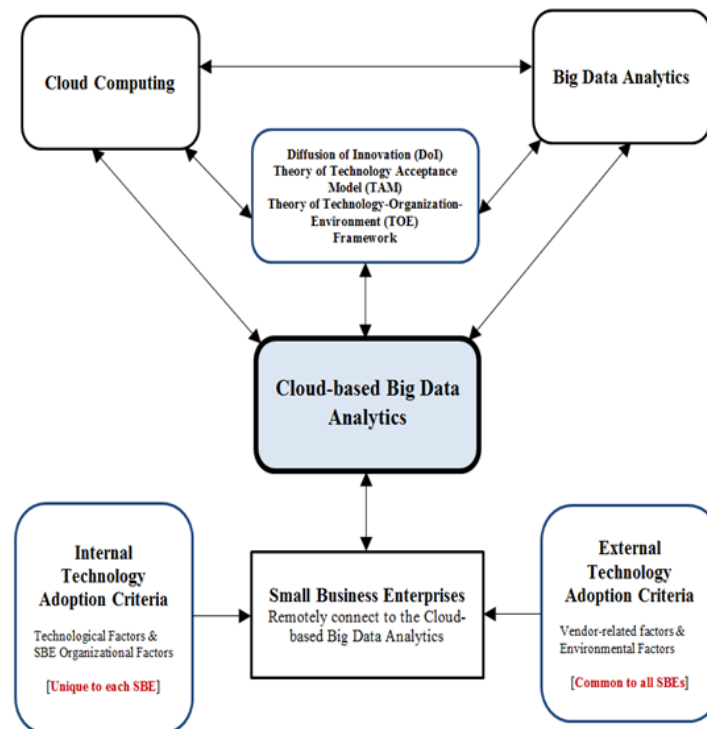


Figure 2: High-level Abstraction of CBBDA Adoption Criteria in SBEs (Ajimoko, 2017)

As shown in Figure 2, the internal technology adoption criterial were found to be unique to each SBE, while the external technology adoption criteria were found to be common to all the SBEs. The detail summary of internal and external CBBDA technology adoption is shown in Figure 3.

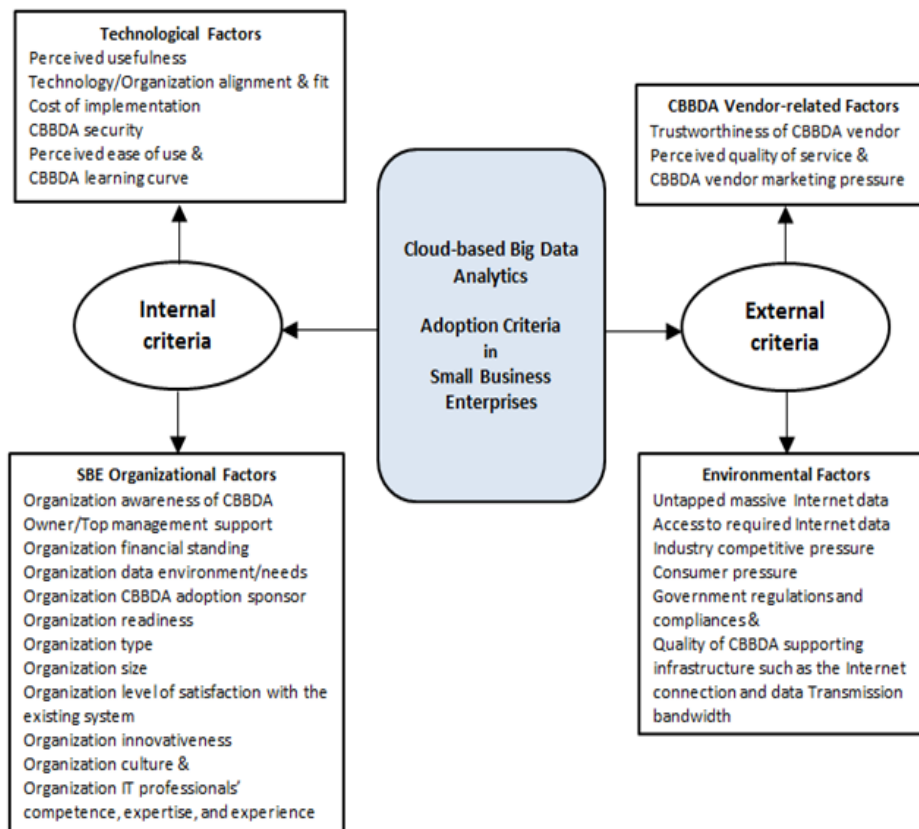


Figure 3: High-level Summary of CBBDA Adoption Criteria for SBE (Ajimoko, 2017)

Based on the above findings, the study revealed that the perception of technology and organizational criteria varied from one SBE to another. Consequently, the two sub-themes were grouped as internal criteria; and this was a major improvement over TOE framework that treats each of the adoption criteria independently in isolation. On the other hand, TOE framework environmental factors were seen as external criteria that are common to all the SBEs. In addition to the environment factors, this study discovered vendor specific factors as other major external criteria that were not referenced by any of the previous adoption theories. All the SBEs have a uniform view and perception of the external criteria consisting of the environmental and vendor specific factors. This was a great improvement over TOE framework that viewed the three adoption criteria of technology context, organization context, and environmental context as independents criteria that carried the same perception in all the organizations. However, this study confirmed that this was not the case. It was found that technological and organizational factors were found to be internal criteria and their perceptions are varied from one SBE to another. Also, the environmental factors and vendor specific factors were found to be external criteria, which are exterior to the business organization and they were viewed the same way by all the SBEs.

The findings of the study revealed several supporting forces and challenging forces as shown in Figure 4. The supporting forces include (a) the affordable cost of CBBDA over cloud compared to setting up BDA in individual datacenter, which is far beyond the reach of SBEs, (b) SBE owner/top management support, (c) perceived usefulness (PU), (d) perceive ease of use (PEOU), (e) flexible and unrestricted data storage, (f) zero-configuration and zero maintenance cost, (g) accessible anytime anywhere with guaranteed availability, (h) no maintenance cost, (i) on-demand services such disaster recovery through the available technical expertise, and (j) lower total cost of ownership since SBEs only pay for the services they use.

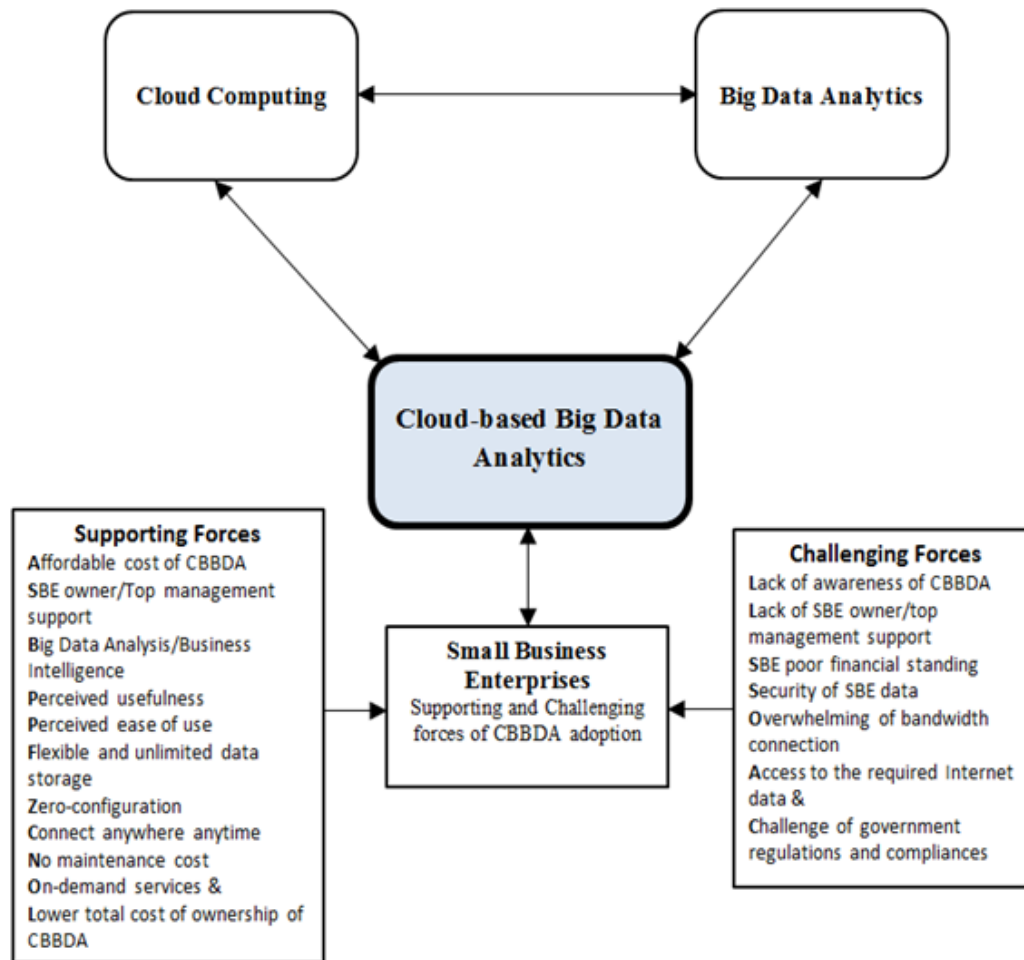


Figure 4: CBBDA Adoption Supporting and Challenging Forces for SBEs (Ajimoko, 2017)

On the other hand, the following challenging forces were found by the study. They are (a) lack of awareness of CBBDA, (b) lack of SBEs owner/top management support, (c) SBE poor financial standing, (d) security of SBE data, (e) overwhelming of bandwidth connection, (f) access to the required Internet data, and (g) challenge of government regulations and compliances. It was found that lack of SBE owner or top management support would obstruct the adoption of CBBDA no matter how useful CBBDA might be. Also, SBEs poor financial standing was found to be a major challenge that would not let most SBEs adopt CBBDA. Also, it was found that another major challenge of technological innovation was the lack of awareness of the innovation and its functionalities, how to operate it, and its weaknesses. Due to their limited research capability, SBEs are still lacking awareness of major innovation that can benefit their organization unlike the large corporations (Qian, Baharrudin, and Kanaan-Jebna, 2016). Small business enterprises cannot adopt the technology that they are not aware of its existence (Bruque and Moyano, 2007). Further, it was found that no matter how useful and cost effective an innovation might be, the lack of SBEs owner/top management support can easily obstruct the adoption of the innovation.

Further, Table 7 shows the analysis of the various CBBDA services among the SBEs. Some of the major services that SBEs were subscribing from the CBBDA vendors were big data storage; BDA/business intelligence to mine vital insights and useful patterns to enhance their decisions; prediction of business operations and trends; prediction of market and the activities of their competitors; prediction customers' behavior and customer relationship management; ideas and knowledge management; achieving business continuity from disaster through data cloud backup and data recovery. Other vital CBBDA services that SBEs were subscribing include fraud prevention and security; risk management especially the SBEs engage in insurance and mortgage businesses; and monitoring government regulatory compliances and reporting especially for SBEs in health sector.

Table 7: The Themes for CBBDA Services in Small Business

Theme	Supporting Forces description	Theme Occurrences	Number of participants out of 20	Percentage of the total participants
Big Data Storage	To store organization data	89	20	100%
Big Data Analytics/Business Intelligence	Insight filtering/Data Mining from Big Data	71	20	100%
Predict business operations and trends	To predict business operation and future changes	72	20	100%
Predict market insights	Helps to locate the potential customers	82	20	100%
Fraud prevention and security	To store and manage the security camera data	47	17	85%
Predict customer behavior	To monitor customer behavior	63	20	100%
Risk management	To search insight that will predict business risks	41	15	75%
Ideas and knowledge management	Serve as the reservoir of ideas and knowledge	59	20	100%
Data backup and recovery	Serves as disaster recovery tool	75	20	100%
Regulatory compliances and reporting	Reporting network and regulatory compliance updates	36	11	55%

Note: CBBDA=Cloud-based Big Data Analytics

The study found that CBBDA were beneficial to SBEs in the following ways: a) it provides centralized data storage, b) facilitates the extraction of vital business insights from their big data; c) to generation marketing insights and revelation of the competitors’ strategies; d) customer relationship management; e) fraud detection; g) provides easy analysis of massive security surveillance data; h) enables disaster recovery and business continuity through CBBDA efficient data backup and data recovery; and i) idea and knowledge management. Table 8 below shows the perception of SBEs participants to the various CBBDA vendors.

Table 8: The Percentage of CBBDA Service Providers among SBEs

CBBDA Service Provider	Total Number of Participants = 20	Percentage
Microsoft Azure	7	35%
AWS	4	20%
Tableau	3	15%
QlikView	2	10%
Google Cloud Platform	2	10%
SAS	2	10%

Note: AWS=Amazon Web Services, SAS=Statistical Analysis System

As one can see from Table 8, 35% of the participants favored Microsoft Azure. It was found that this was attributed to the popularity of Microsoft software such Microsoft Operating System and Microsoft Office Suites among the SBEs. Also, 20% use Amazon Web Service (AWS), 15% favored Tableau while QlikView, Google Cloud and SAS respectively have 10%.

In summary, this research built on previous theories. The study reveals crucial role of *technology/organization alignment and fit*, and the importance of SBE owner/top management support, unlike the previous theories such as (a) DoI, which stressed only the variables that influence the spread of innovation, (b) TAM, which emphasized only on perceived usefulness (PU) and perceived ease of use (PEOU) as the only adoption criteria, or (c) TOE framework, which addressed the three independent factors of technology, organization, and environment. While those adoption factors were necessary, this study found that such factors were not sufficient criteria for technology adoption. Thus, this study identified holistic and unified technology criteria that are likely to influence SBEs to either adopt or not adopt the CBBDA. Further, the study found that SBEs are

likely to adopt CBBDA if the technology functionalities and their organizational operations combined and their data management needs were in proper alignment.

9. Conclusion

This qualitative research builds on the existing theories of technology adoption. It explores the various adoption criteria that would guide the IT professionals in SBEs to make the right choices in their decision as to whether or not to adopt CBBDA or any other future technological innovation. The findings of the study revealed various adoption criteria that the previous theories did not put into consideration. The study found that internal and external criteria (Figure 2 and Figure 3) are the driving forces that influence the adoption of CBBDA in SBEs. The *Internal criteria* consist of the technological and organization factors, which are unique to each SBE, while *external criteria*, which consist of CBBDA vendor related factors and environmental factors are common to all SBEs.

The key *internal criteria* are a) perceived usefulness (PU); b) *technology/organization alignment and fit*; c) organization data environment and needs; d) organization financial standing and e) organization owner/top management support. The entire participant overwhelmingly agreed that *technology/organization alignment and fit* was the critical internal driving force that influences SBEs to adopt CBBDA. Thus, SBEs that (a) give high priority to their data, (b) have the potential to rely on insights from Big Data to generate customer leads, and (c) have the potential to store and analyze a massive amount of surveillance security data are likely to adopt the CBBDA. Further, the entire participant overwhelmingly agreed that no matter how useful is CBBDA to SBE, the lack of SBE owner/top management support can easily obstruct the adoption of the technology.

On the other hand, the study discovered two categories of *external criteria*, which include CBBDA vendor related factors and environmental factors. The CBBDA vendor related factors are a) trustworthiness of the CBBDA vendors; b) perceived CBBDA vendor quality of service; and c) CBBDA vendor marketing pressure. Likewise, the environment factors include a) the desire of SBEs to extract vital insights from the massive Internet data to improve their businesses; b) accessibility to the required Internet data; c) industry competitive pressure; d) consumer pressure in areas of lead generation and customer service improvement; e) government regulations; and f) quality of CBBDA supporting infrastructures such as Internet connection and the speed of data transmission bandwidth.

In addition, the study identified the CBBDA adoption criteria that were either served as *supporting forces* and or *challenging forces* in influencing SBEs to adopt the technology. The supporting forces of CBBDA include a) its perceived usefulness, b) SBE owner/top management support, c) affordable initial investment unlike datacenter setup, d) the need for data storage and Business Intelligence tool; e) zero configuration of CBBDA and f) on-demand feature of CBBDA, g) CBBDA accessibility anywhere anytime, and h) lower total cost of CBBDA ownership; SBEs only pay based on usage. On the other hand, the challenge forces are the inherent obstacles that can discourage the adoption of CBBDA. These include a) lack of awareness of CBBDA, b) lack of SBE owner/top management support; c) SBE poor financial standing; d) security of SBE data; e) difficulty in getting access to the required Internet data, f) overwhelming of bandwidth connection and g) the challenge of government regulations and compliances.

Moreover, the study found that SBEs derive the following benefits from CBBDA adoption: (a) provision of adequate central storage to integrate and store their massive data from various sources; (b) use CBBDA engine to instantly filter Big Data for any desired information patterns and insights; (c) derive marketing insight for their products; (d) for customer relationship management; (e) risk management and fraud detection; (f) filtering and analysis of massive security surveillance data; (g) disaster recovery and business continuity through data backup and data restoration during emergency; and (h) idea and knowledge management. Most of the participating SBEs use CBBDA not only to store massive security video recording of their business environment 24/7, but also aid in searching for specific security occurrences among the gigantic video recording data. SBEs use CBBDA to mine critical insights to for fast and enhanced decision making of their business operations. Some of such insights include marketing information, customer behavior and loyalty insights, and fraud detection. The result of query and filter would be displayed in user interface dashboard in simplified statistical and graphical reports that are very easy to read and understand.

Further, it was discovered that wrong technological adoption choices can be very devastating and disastrous for SBEs due to lack knowledge of the technology adoption criteria among their IT staff (Srinivasan, 2010; Scheck, 2016). This is because unlike the large organizations, SBEs are known for their small capital, small income, small investment, small market share, and small profit. These attributes call for prudent choices in their innovation investments in order to avoid catastrophic mistakes in their technology investments. Technology adoption mistakes can be very costly for the SBEs due to their very little capital. Therefore, to avoid such catastrophe, SBEs should educate their IT professionals, management, and project managers on the importance of technology innovation adoption criteria and technology adoption strategies. In addition, IT professionals should make an extensive inquiry about any desired new innovation before the adoption. They should find out and seek the opinions of the other SBEs that have successfully used the technology and find out about its effectiveness and efficiency.

Lastly, study found that not all SBEs would want to adopt CBBDA. Thus, SBEs that are currently not generating large volume of data such as security surveillance data, or that do not have any possibility of extracting insight from Big Data for making a predictive analysis, do not need to adopt CBBDA. For example, SBEs such as corner stores or landscaping businesses with a very small data needs, small income, and small business size, would not want to adopt CBBDA because of the *technology/organizational alignment and fit*.

In closing, the finding of this study revealed that it was important for SBEs to first ensure that their potential new innovation they were aspiring to adopt meet the *technology/organization alignment and fit* before embarking on plan to adopt such innovation. The advancement of technological innovation has triggered major changes in the technological adoption criteria especially for the SBEs. As such, previous theories were inadequate to address the current technology adoption trend. This research revealed various additional criteria that are very crucial and should be considered by the IT professionals in SBEs before making decision to adopt CBBDA or any other related future technological innovations in their business organizations. Thus, the findings of the study would enable them to adopt an ideal innovation for their organizations and protect them from any future regret.

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Appendix A

Interview Questions

1. Describe how you and your organization know about Cloud-based Big Data Analytics technology?
2. Describe your experience with the quality of services that you are getting from your CBBDA Service Provider?
3. Describe the situation of the current exponential growth of data in your organization and the role of Cloud-based Big Data Analytics technology in managing the data?
4. Describe the process of adopting a new technology in your organization?
5. What are the internal technology adoption criteria that motivate your organization to adopt CBBDA services?
6. What are the external technology adoption criteria that motivate your organization to adopt CBBDA?
7. What are the supporting forces that encourage your organization to adopt CBBDA technology?
8. What are challenge forces did your organization encountered during the process of adopting the CBBDA technology?
9. What are the CBBDA services that your company subscribes to from CBBDA service provider?
10. What are the benefits that your organization is deriving from adopting CBBDA technology?
11. What are the major impacts that the adoption of CBBDA services has made to your organization in the area of Big Data?
12. Based on your experience, describe the readiness of SBEs in the adoption of CBBDA.