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An empirical study on business analytics affordances enhancing the management of cloud computing data security

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ABSTRACT

The mechanism of business analytics affordances enhancing the management of cloud computing data security is a key antecedent in improving cloud computing security. Based on information value chain theory and IT affordances theory, a research model is built to investigate the underlying mechanism of business analytics affordances enhancing the management of cloud computing data security. The model includes business analytics affordances, decision-making affordances of cloud computing data security, decision-making rationality of cloud computing data security, and the management of cloud computing data security. Simultaneously, the model considers the role of data-driven culture and IT business process integration. It is empirically tested using data collected from 316 enterprises by Partial Least Squares-based structural equation model. Without data-driven culture and IT business process integration, the results suggest that there is a process from business analytics affordances to decision-making affordances of cloud computing data security, decision-making rationality of cloud computing data security, and to the management of cloud computing data security. Moreover, Data-driven culture and IT business process integration have a positive mediation effect on the relationship between business analytics affordances and decision-making affordances of cloud computing data security. The conclusions in this study provide useful references for the enterprise to strengthen the management of cloud computing data security using business analytics.

1. Introduction

The traditional internal information systems, which need continuous investments, is becoming less attractive to the enterprise, while on-demand information technology services based on cloud computing are increasingly becoming popular (Mircea, 2012). The sensitive data is stored in the internal data center in the traditional internal information system, which is protected by the enterprise. Cloud migration denotes that the enterprise will lose the right to control data security. Data is the basis for the survival of an enterprise, and the loss of control over data results in greater security risks than the traditional internal information systems (Ali, Khan, & Vasilakos, 2015). Existing studies mainly set up the protection measures of cloud computing data security according to knowledge based on experience and intuition, which makes it difficult to manage cloud computing data security effectively and rationally. Presently, data becomes increasingly available because most enterprises have implemented an internal information system based on client/server. When data is more available, the rational decision is superior to the intuitive decision (Miller, 2008), and the decision-making is less dependent on intuition, but more dependent on business analytics (Cao, 2015). Therefore, business analytics provides an opportunity to enhance the management of cloud computing data security (MCCDS) using the insights driven by data (Kiron & Shockley, 2011).

Although some studies have indicated that the enterprise that adopts business analytics operates better than the enterprise that does not adopt business analytics [57], and that business analytics can improve decision rationality (Dhami & Thomson, 2012), many enterprises are still trying to determine when, in what ways, and how to use business analytics (Kiron, Prentice, & Ferguson, 2012), or are still trying to identify how to use business analysis to improve management performance. Given that the MCCDS is also an important part of the management performance, the enterprise is also exploring using business analysis to enhance the MCCDS rationally. However, there is still a lack of theoretical analysis on how to strengthen the MCCDS through business analytics affordances(BAAs). Therefore, from the perspective of cloud computing enterprise users, this study builds the research model based on information value chain theory and information technology (IT) affordances theory, including BAAs, decision-making affordance of cloud computing data security (DAC), decision-making rationality of cloud computing data security (DRC), and the management

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of cloud computing data security (MCCDS), to investigate the underlying mechanism of BAAs influencing the MCCDS using empirical research methods. Simultaneously, this study will test the role of data-driven culture (DDC) and IT business process integration (IBI). This study aims to help the enterprise improve the MCCDS using business analytics.

2. Literature reviews

To establish the theoretical model, the following is a literature review covered in this study. According to the key issues of this paper, cloud computing data security and business analytics, IT affordances, and decision-making rationality will be reviewed.

2.1. Cloud computing data security and business analytics

After outsourcing data to cloud service provider, the enterprise will have difficulty in directly monitoring data security. However, for the enterprise, not all data requires equal levels of security protection (Mircea, 2012). Data classification is the premise of the effective MCCDS, which also prevents inadequate protection or over protection (Shaikh & Sasikumar, 2015; Zardari, Jung, & Zakaria, 2013). Data security is an interesting topic for cloud service providers and enterprise users (Shaikh & Sasikumar, 2015), but the existing studies are mainly from the perspective of cloud service providers. For example, (Mircea, 2012) combined confidentiality and risk to divide data into three categories including public, private, and secret. Misra and Mondal (2011) provided the corresponding weights to different data sensitivities based on empirical knowledge. These studies focused on managing data security from the perspective of cloud service providers using empirical knowledge or intuition, which makes it difficult to manage cloud computing data security rationally and objectively.

Recently, with the development of business analytics, more and more enterprises try to use data to support rational decisions (Davenport, 2006). Business analytics emphasizes rational decisions driven by objective data rather than relying solely on intuition (Provost & Fawcett, 2013). To deploy cloud model, Mircea (2012) indicated that it is necessary to perform business analytics to manage cloud computing data security effectively. Kiron and Shockley (2011), Kiron et al. (2012), and LaValle, Lesser, and Shockley (2011) showed that business analytics could help the enterprise capture data, integrate data, analyze data, and use the insights based on data. Business analytics can also help the enterprise objectively identify data security requirements Mircea (2012), which can further improve the effective MCCDS. DDC and IBI are two of the most important factors that provide clear organizational strategy, policies, and regulations to guide the enterprise how to use business analytics. In order to use business analytics to gain competitive advantages, the enterprise needs to develop DDC (Kiron & Shockley, 2011; Kiron et al., 2012; LaValle et al., 2011). In DDC, decision-making relies more on rational insights driven by data, and less on intuitions (Kiron & Shockley, 2011; Kiron et al., 2012; LaValle et al., 2011). The well-defined IBI will help the enterprise apply business analytics to obtain the views related to business data (Kiron et al., 2012). So the tight integration of IT and business processes is another important driver which help the enterprise how to use business analytics (Lu & Ramamurthy, 2011).

2.2. IT affordances

Gibson (1979), the ecological psychologist, pointed out what organisms (subjects) perceive is not the nature of things (objects), but the possibility of behavior that the things (objects) can provide. The possibility of behavior is referred to as affordances. Stoffregen (2000) concluded the typical features of affordances into three aspects, namely, affordances are an implicit possibility, affordances emphasize the interaction between subjects and objects, and affordances are determined by the purpose of the subjects. Affordances have been widely used in the fields, such as cognitive psychology, environmental psychology, industrial design, and humancomputer interaction (Lu & Cheng, 2013).

Recently, affordances theory has attracted significant attention in IT research and is used to discuss how users interact with IT. IT affordances are the behavior possibility provided by IT technology to a specific user group. It is also the dynamic interaction between the organization and the IT components, rather than the respective attributes of the organization and the IT components (Markus & Silver, 2008). Affordances depend on the relationship between the system and the user during the process of using the information system. These IT affordances reflect the kind where users perceive the relevance to their goals (Leonardi, 2011). Existing studies have conducted extensive research on IT affordances. The scenarios covered by these studies include change process of the organization (Volkoff & Strong, 2013), electronic health records (Strong, Johnson, & Tulu, 2014), and the impact of business analytics on organizational performance (Cao, 2015). In the context of cloud computing, the affordances on platform-as-a-service have been explored (Krancher & Luther, 2015). Some studies have explored the transformation from low-level affordances to high-level affordances (Cao, 2015; Krancher & Luther, 2015; Volkoff & Strong, 2013). The research methods of IT affordances include empirical research (Cao, 2015) and grounded theory (Krancher & Luther, 2015; Strong et al., 2014). These studies highlight the important extensions of affordances theory from ecological psychology to IT fields.

2.3. Decision-making rationality

Decision-making is a behavior where people make decisions in practice. It is also the process of selecting the best solution from multiple alternatives. As data becomes increasingly available, decisions are increasingly dependent on rational factors. With the development of business analytics technology, the channels where the enterprise obtains data are increasing, and the decision-making is gradually changing from an irrational process to a rational process. Dhami and Thomson (2012) analyzed the evolutionary process of decision-making cognition from intuition to analysis based on cognitive continuation theory. Decision-making rationality is characterized by collecting the appropriate data, developing the possible alternatives, assessing the alternatives, and selecting the best alternatives (Rahman & Feis, 2009). Determining how to use business analytics to assist decision-making rationality has received significant attention. For example, Mcafee and Brynjolfsson (2012) stressed the importance of decision-making based on business analytics. Dhami and Thomson (2012) compared the rational processes and intuitive processes, and indicated that rational decision-making is better than intuitive decision-making when data is available and reliable.

Above studies provide a good reference for the enterprise to manage cloud computing data security using BAAs. However, there are still some limitations. First, there is a lack of comprehensive disclosure on how BAAs improve the MCCDS. Although existing studies show that BAAs can improve the decision rationality and cloud computing data security, the mechanisms on how BAAs improve the MCCDS is unclear. Second, the conversion process from low-level affordances to high-level affordances has yet to be further explored in the MCCDS. In practice, it's the data owner who defines the data security policy before uploading the data to cloud (Fatemi Moghaddam, Yezdanpanah, & Khodadadi, 2014). Therefore, focusing on the perspective of cloud computing enterprise users, the study constructs the research model to explore how BAAs improve the effectiveness MCCDS based on information value chain theory and IT affordances theory. This study aims to fill the following deficiencies: What's the mechanism on how BAAs improve the effectiveness MCCDS? What's the conversion process from low-level affordances to high-level affordances in the MCCDS? What's the role of DDC and IBI?

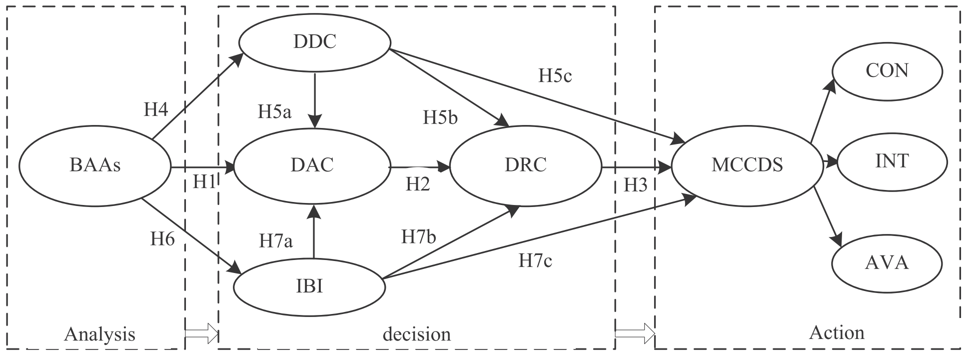

Fig. 1. Research model.

3. Research models and hypothesis

The key to enhancing the effectiveness MCCDS using BAAs is not the amount of data, but mining data value, which effectively guides the security management actions. The process from analytics to decision-making to actions is the core concept of information value chain theory (Abbasi, Sarker, & Chiang, 2016). Therefore, from the perspective of cloud computing enterprise users, this study argues that BAAs support DRC through DAC, and then strengthen the effectiveness MCCDS. Simultaneously, the direct and indirect effects of DDC and IBI are also considered in the model as shown in Fig. 1.

3.1. Relationship between BAAs and DAC

Affordances are especially useful in examining how technology introduction affects the organizational changes because it explains the organizational level affordances (Volkoff & Strong, 2013). This study uses BAAs to examine the behavioral possibilities, which are provided by business analytics for the MCCDS. BAAs are features of business analytics technology, and are also the interaction between business analytics and the organizational actions on MCCDS.

From the level of affordances, BAAs are the basic low-level affordances, which include data processing and decision supporting. It's difficult to explain the usage and impact of BAAs using business analytics (Cao, 2015). In fact, there will be multiple affordances over time, and the high-level affordances occur only when the low-level affordances has been perceived and implemented (Volkoff & Strong, 2013). Cardwell (2009) also studied how the perception of one affordance affected the perception of another affordance. When the enterprise uses business analytics to manage cloud computing data security, the enterprise will also be aware of the DAC. Decision-making is one of the important components of IT affordances (Sebastian & Bui, 2012). Compared with decision-making affordances, BAAs are the low-level affordances that are favorable for implementing the high-level affordances (Cao, 2015). The high-level affordances are DAC. In the dynamic business environment, one of the key factors that determine success is the potential where the enterprise uses business analytics to gather useful insights for decision-making (LaValle et al., 2011). Similarly, the enterprise may use business analysis to develop better data security decisions for cloud computing. Krancher and Luther (2015) indicated that high-level affordances depend on low-level affordances. Consistent with these literatures, the study states that DAC are dependent on BAAs. Therefore, the following assumption is derived:

H1. BAAs have significant impact on DAC.

3.2. Relationship between DAC and DRC

Based on the definition of IT affordances (Markus & Silver, 2008; Strong et al., 2014), DAC are defined as the possibility of decision-making of cloud computing data security driven by data. Cloud computing data security decisions include identifying the issues and opportunities of data security management, making strategic goals and standards of data security, and developing and evaluating data security alternatives.

Inputs from decision-making affordances help the enterprise rationally make decisions (Bell, 2013). Cao (2015) indicated that data-driven decision provides an opportunity for the enterprise to formulate rational decisions quickly by mastering customer and operations based on data-driven insights. The feasible decisions will be made only when complete information associated with the choice and outcome is fully considered (Dean & Sharfman, 1996). When the enterprise perceives DAC, the enterprise will use the affordances to accurately analyze data, rationally identify the issues and opportunities, rationally develop the goals and standards, and rationally evaluate the alternatives in the MCCDS. Cao (2015) also demonstrated that decision-making affordances could be positively influenced by strategic decision comprehensiveness. Moreover, the uncertainty faced by decision-making will decrease when the amount of data gradually increases, and the decision-making affordances are improved. Consistent with the previous literatures, the study suggests that the enterprise with high DAC will have high DRC. Then, the following hypothesis is derived:

H2. DAC have a positive impact on DRC.

3.3. Relationship between DRC and the effective MCCDS

Decision-making rationality includes the universality of data acquisition during the process of decision-making, the dependence on business analytics, and the comprehensiveness of alternatives (Dean & Sharfman, 1993). Therefore, DRC includes the universality of data acquisition during the process of cloud computing data security decision-making, the dependence on business analytics, and the comprehensiveness of alternatives on MCCDS.

Effectiveness is one of the most critical factors in information systems. The effectiveness of an information system is often evaluated according to whether the target is completed (Choi & Park, 2016). The goal of MCCDS is to protect confidentiality(CON), integrity(INT), and availability(AVA) of data from various threats. Armbrust, Fox, and Griffith (2010)) also pointed out that the protection of CON, INI, and AVA of data is the core of cloud computing data security. CON refers to ensuring that the data in cloud is accessible only to authorized users and unavailable to unauthorized users. INT refers to ensuring that the data in the cloud is not deleted, modified, or fabricated by unauthorized users. AVA refers to ensuring that the normal request of authorized users can obtain the immediate, correct, and secure service or response uninterruptedly (Ackermann, Widjaja, & Benlian, 2012; Loske, Widjaja, & Buxmann, 2013).

Although there is a complex relationship between decision-making and organizational performance (Cao, 2015), existing literatures agreed that the extensive decision processes lead to better organizational performance (Miller, 2008). Rational management is more convinced of objective results by business analytics. Decision-making rationality plays an important role when the enterprise effectively manages cloud computing data security based on the existing information. When the relationship between strategic decisions affordances and business analytics is investigated by (Cao, 2015), it was shown that the comprehensiveness of strategic decisions has a positive impact on organizational performance. The effective management of CON, INI, and AVA can be seen as an important branch of organizational performance. Consistent with the above literatures, the study suggests that the enterprise with high DRC will have high effectiveness of MCCDS. Then, the following hypothesis is derived:

H3. DRC has a positive impact on the effective MCCDS.

3.4. Data-driven culture and its role

DDC denotes a group of people having the same beliefs on sharing, owning, understanding, and using certain types of data (Kiron & Shockley, 2011). Cao (2015) and Cao and Duan (2014) pointed out DDC refers to the combination of organizational factors such as strategy, regulation, structure, and business process to facilitate the application of business analytics. In the study, DDC is specifically used to facilitate the application of business analytics in the effective MCCDS.

As data becomes increasingly available, the relationship between business analytics and decision-making has become increasingly close. When BAAs provide scenarios and trends on past or current data, provide accurate predictions, and recommend one or more actions to what is going to happen and why it is going to happen, the enterprise will combine the clear codes of conduct, norms, principles, and incentives to be more supportive of the DDC (Kiron & Shockley, 2011). Enterprise personnel, especially managers, are more likely to agree on beliefs, which own, understand, and use data. Davenport (2006) suggested that business analytics create real business value, which leads to the change in culture, process, behavior, and skills. BAAs help the enterprise become more aware of the importance of DDC. Therefore, the following hypothesis is derived:

H4. BAAs have a significant positive impact on DDC.

Davenport (2006) believed that DDC stimulates the enterprise to consider the quantitative measurement, test, and evaluation of data. Kiron and Shockley (2011) showed that the enterprise with DDC has data-driven leadership characteristics and takes business analytics as the premise of the strategic assets and strategic operation by taking DDC as an indirect direction. Simultaneously, the enterprise with DDC follows the practice to build all kinds of data sources without controversy, provide timely feedback on various types of decisions, and consciously expresses business rules based on data.

DDC allows the enterprise to achieve a high degree of agreement on the role of data, and encourages the enterprise to explore how to rely on DDC to manage cloud computing data security. Existing literatures on information security also show that DDC provides useful support to manage data security. Winkel (2007) pointed out that security culture significantly affects information security compliance and effective security management. Cao (2015) also pointed out that DDC have a significant positive impact on the comprehensiveness of strategic decisions. Chang and Lin (2007) concluded that the culture have a significant positive impact on the management of CON, INI, and AVA of data. Consistent with the above literatures, the study believes that DDC is conducive to support DAC, improve DRC, and promote the effective MCCDS. Therefore, the following hypotheses are derived:

H5a. DDC has a significant positive impact on DAC.

H5b. DDC has a significant positive impact on DRC.

H5c. DDC has a significant positive impact on the effective MCCDS.

Organizational culture is the medium between the management layer and organizational behavior (Chang & Lin, 2007). The commercial value of business analytics requires the support of DDC (Kiron & Shockley, 2011; Kiron et al., 2012; LaValle et al., 2011). A clear organizational strategy, rules, and regulations should be able to guide business analytics activities. Designing an organizational structure and business process is convenient for capturing, integrating, and analyzing data, where the gained insights contribute to decision-making affordances. Cao (2015) pointed out that BAAs have an indirect impact on decision-making affordances through DDC. Based on existing literatures, the study argues that the matching degree between BAAs and DDC will have a positive impact on DAC. Then, DDC may play a moderating role in the relationship between BAAs and DAC. Therefore, the following hypothesis is derived:

H8. DDC plays a mediating role in the relationship between BAAs and DAC.

3.5. IT business process integration and its role

IBI refers to the ability to organize business processes using IT, which is the matching degree between business processes and IT applications. This matching allows the enterprise to improve cross-departmental business process collaboration to increase the flexibility. IT is part of business process management. The successful guarantee of IT implementation is to carry out system analysis, design, implementation and operation, and maintenance around the business process. One of the roles of implementing IT is managing and integrating data (Lycett, 2013). The advantage of business analytics is to obtain objective insights by analyzing data. Significant value can be obtained by analyzing the data generated by IT and business process integration (Shuradze & Wagner, 2016a). Leonardi (2011) indicated that business analytics help the enterprise identify the different potential for action. Spears and Barki (2010) also confirmed that user participation could align information security risk management with the business situation. BAAs are the important expression for the enterprise to participate in MCCDS after losing the right to control data, such as analyzing data in information system, understanding the security requirements of business data, allowing business executives or business process managers clearly understand cloud computing data security policies, and identifying the correlation and dependence among the data of various departments. BAAs will promote the integration of IT and business process. Therefore, the following hypothesis is derived:

H6. BAAs significantly positively impact IBI.

IBI emphasizes the collaboration between IT and business to support DAC. The close cooperation between IT and business promote mutual respect and trust between the business department and IT department over time, which would encourage knowledge sharing and communication between IT and business executives. Cloud computing has revolutionized the way that the enterprise use IT, and existing literatures focus on cloud computing data security technology from the perspective of cloud service providers. Given that cloud service providers are difficult to understand the nature of data security of the enterprise, cloud service providers have to rely on intuition to develop data security technology. The mutual respect and trust between business department and IT department facilitate the changes in MCCDS from the intuitive processes to the rational processes.

IBI helps the enterprise to adjust the existing business and IT to improve the effectiveness and efficiency. IBI focuses on the consistency of business process applications and business processes reconfiguration, which are good for the enterprise to use business analytics to improve the MCCDS. In addition, the close collaboration between IT and business is an important driver of organizational agility (Lu & Ramamurthy, 2011), which also indirectly promotes the identification of data security requirements. In this way, IT executives and business process managers are more clear on MCCDS, including the effective management of CON, INI, and AVA. Therefore, the following hypothesis is derived:

H7 a. IBI has a positive impact on DAC.

H7 b. IBI has a positive impact on DRC.

H7 c. IBI has a positive impact on the effective MCCDS.

BAAs highlight the need to strengthen business processes (Davenport, 2006), particularly the integration of IT and business processes. In this way, the enterprise may use business analysis to deal with the data generated by IT to improve the business process and achieve strategic competitive advantage. Wixom, Watson, and Werner (2011)) pointed out that the value generated by BAAs be different from cost savings, but rather to improve business processes and provide possibilities for better decision-making. Data is the core asset of the enterprise. The enterprise use business analysis to mine data value to gain competitive advantages and innovation sources, and then to strengthen business operations to support decision-making more effectively (Kiron & Shockley, 2011; Kiron et al., 2012; LaValle et al., 2011). The enterprise may also use BAAs to identify cloud computing data security requirements to protect all kinds of business data properly. Therefore, the study proposes that BAAs also emphasize the integration of IT and business process to provide services for DAC. Then, the following hypothesis is derived:

H9. IBI plays a mediating role in the relationship between BAAs and DAC.

4. Research method

4.1. Questionnaire design and measurement tools

The study developed a questionnaire based on the existing literatures. In addition to the basic information on the enterprise, the Likert 7 point scale, which uses “1″ to “7″ to represent "least agree" to "most agree" was also used. The study obtains the measurement items of variable sources as shown in Table 1.

4.2. Data collection

The study used web-based online surveys to collect data. A total of 327 questionnaires were withdrawn, and 316 valid questionnaires were obtained after rejecting questionnaires that did not meet the requirement. The recovery rate was 96.6%. The sample enterprises cover 27 provinces, autonomous regions, and municipalities directly under the central government in Chinese, such as Beijing, Shanghai, Chongqing, Tianjin, Jiangsu, Henan, Shanxi, Xinjiang, and Inner Mongolia. The sample enterprises include 99 manufacturing enterprises, 34 IT enterprises, 9 textile and garment enterprises, 16 chemical enterprises, 13 pharmaceutical enterprises, 22 financial enterprises, 28 wholesale and retail enterprises, 9 logistics enterprises, 7 new materials enterprises, 7 food enterprises, 5 government departments, 19 the home building and real estate enterprises, 3 educational enterprises, and 36 other types of enterprises. The number of employees is as follows: 63 enterprises have less than 100 employees, 80 enterprises have 101–300 employees, 64 enterprises have 301–500 employees, 62 enterprises have 501–2000 employees, 19 enterprises have 2001–3000 employees, and 28 enterprises have more than 3000 employees. According to the basic analysis, there are no significant differences in the hierarchical feature distribution between the subjects and the normal enterprises, and the subjects have been included in the major enterprises that need to be investigated.

4.3. Data analysis method

Structural equation model (SEM) is often used to analyze data and test hypotheses in IT research fields. Given that the study involves exploratory analysis, SEM based on Partial Least Squares is used for data analysis. Simultaneously, SmartPLS is chosen as the data analysis software to evaluate the rationality of the theoretical model and investigate the relationship between the latent variables.

5. Data analysis results

5.1. Measurement model

The reliability and convergence validity of the measurement model are shown in Table 2. In addition to Cronbach's a coefficient of AVA is 0.640 and slightly less than 0.7. The Cronbach's a coefficient of the other variables is greater than 0.7. The composite reliability of all variables is greater than 0.7. In addition to average variance extracted (AVE) of the MCCDS, which is slightly less than 0.5, AVE of the other variables is greater than 0.5. These results show that the measurement model has good reliability and convergent validity.

The study calculated the correlation coefficients of the variables, and then compared the square root values of AVE, which were placed on the diagonal of the correlation coefficient matrix table. The results are shown in Table 3. The square root values of AVE for all variables are greater than the absolute value of the correlation coefficient between the row and the column. These results show that the measurement model has good reliability and convergent validity, which indicates that each scale is checked by discriminant validity.

Based on the analysis of Tables 2 and 3, the reliability and discriminant validity were tested.

5.2. Common method variance

Given that the data in the study are derived from self-contained questionnaires, there may be common method variance(CMV) which possibly leads to the reduction in variable validity, and even affecting the acceptance or rejection of the hypotheses. Confirmatory factor analysis is often used to assess CMV using Harman single factor test method. All variable items are put together using the Statistical Product and Service Solutions (SPSS) 19.0 for factor analysis without specifying the rotation and extracting several factors. The running results by SPSS show that a number of factors are extracted, and the variance of the first principal component is 34.174% without rotation, which is not accounted for the majority. Therefore, CMV is not serious and will not

Table 1
Variable sources.

Codes	Variables	Sources
BAAs	Business analytics affordances	Kiron and Shockley (2011), Kiron et al. (2012), Delen and Demirkan (2013), Cao (2015)
DAC	Decision-making affordances of cloud computing data security	Cao (2015)
DRC	Decision-making rationality of cloud computing data security	Dean and Sharfman (1996), Dean and Sharfman (1993)
MCCDS	Management of cloud computing data security	Chang and Lin (2007)
DDC	Data-driven culture	Kiron and Shockley (2011), Kiron et al. (2012), LaValle et al. (2011)
IBI	IT business process integration	LaValle et al. (2011), Shuradze and Wagner (2016a), Shuradze and Wagner (2016b)

Table 2
Reliability and convergence validity.

Codes	Variables	Items	Cronbach's α	CR	AVE
BAA	Business analytics affordances	3	0.726	0.845	0.645
DAC	Decision-making affordances of cloud computing data security	3	0.766	0.865	0.681
DRC	Decision-making rationality of cloud computing data security	4	0.779	0.858	0.602
MCCDS	Management of cloud computing data security	12	0.909	0.925	0.494
CON	Confidentiality	4	0.844	0.896	0.683
INT	Integrity	5	0.846	0.891	0.621
AVA	Availability	3	0.640	0.804	0.589
DDC	Data-driven culture	4	0.745	0.839	0.566
IBI	IT business process integration	3	0.796	0.880	0.709

Table 3
Discriminant validity test.

Codes	BAAs	DAC	DRC	MCCDS	DDC	IBI
BAAs	0.803					
DAC	0.344	0.825				
DRC	0.306	0.469	0.776			
MCCDS	0.531	0.317	0.483	0.703		
DDC	0.509	0.373	0.370	0.641	0.753	
IBI	0.300	0.408	0.442	0.419	0.3462	0.842

Table 4
Hypothesis test results without mediating variables.

Hypothesis	Hypothesis path	Path coefficient	T-Values	Empirical evidence
H1	BAAs → DAC	0.346	4.733	Supported
H2	DAC → DRC	0.469	8.207	Supported
H3	DRC → MCCDS	0.484	6.867	Supported

have a serious impact on the path coefficients between the variables.

5.3. Structural equation model analysis

This study used the SmartPLS to construct SEM without mediation variables, such as DDC and IBI, to validate hypotheses 1, 2 and 3. The mediation effects of DDC and IBI can only be tested after hypothesis 1 has been established. The hypothesis test results without mediation variables are shown in Table 4.

The test results are shown in Fig. 2 without mediation variables. BAAs have a significant impact on DAC ($R = 0.346^{***}$, $T = 4.733$), which shows that hypothesis 1 is supported. DAC has a significant impact on DRC($R = 0.469^{***}$, $T = 8.207$), which shows that hypothesis 2 is supported. DRC has a significant impact on the effective MCCDS ($R = 0.484^{***}$, $T = 6.867$), which shows that hypothesis 3 is supported.

After hypothesis 1 is supported, the study will verify the direct and mediating role of DDC and IBI. The hypothesis test results are shown in Table 5.

Based on Table 5, hypotheses 1, 2, and 3 remain true after adding DDC and IBI.

BAAs have a significant positive impact on DDC ($R = 0.509^{***}$, $T = 9.637$), which supports hypothesis H4. DDC has a significant positive impact on DAC ($R = 0.189^{**}$, $T = 3.148$), which supports hypothesis H5a. Therefore, DDC plays a partial mediating role, which supports hypothesis H8. The influence coefficient of BAAs on DAC is significantly positive and decreases from 0.346 to 0.160. The proportion of mediating effects to the total effects is shown below (Preacher & Kelley, 2011):

$$a_1b_1/c = 0.509 \times 0.189/0.346 = 0.278 \quad (1)$$

In Eq. (1), c is the total effect of BAAs on DAC, a_1 is the total effect of BAAs on DDC, b_1 is the effect of DDC on DAC after controlling the impact of BAAs.

BAAs have a significant positive impact on IBI ($R = 0.299^{***}$, $T = 4.328$), which supports hypothesis H6. IBI has a significant positive impact on DAC ($R = 0.294^{***}$, $T = 4.549$), which supports hypothesis H7a. IBI plays a partial mediating role, which supports hypothesis H9. The influence coefficient of BAAs on DAC is significantly positive and decreases from 0.346 to 0.160. The proportion of mediating effects to the total effects is shown below (Preacher & Kelley, 2011):

$$a_2b_2/c = 0.299 \times 0.294/0.346 = 0.254 \quad (2)$$

In Eq. (2), c is the total effect of BAAs on DAC, a_2 is the total effect of BAAs on IBI, b_2 is the effect of IBI on DAC after controlling the impact of IBI.

DDC has a significant positive impact on DRC ($R = 0.167^{*}$, $T = 2.258$), which supports hypothesis 5b. DDC has a significant positive impact on the effective MCCDS ($R = 0.506^{***}$, $T = 7.746$), which supports hypothesis 5c. IBI has a positive impact on DRC ($R = 0.262^{**}$, $T = 3.260$), which supports hypothesis 7b. IBI has a positive impact on the effective MCCDS ($R = 0.140^{*}$, $T = 2.144$), which supports hypothesis 7c. In summary, after adding DDC and IBI, the test results are shown in Fig. 3.

Table 5
Hypothesis test results with mediating variables.

Hypothesis	Hypothesis path	Path coefficient	T-Values	Empirical evidence
H1	BAAs→ DAC	0.160	2.141	Supported
H2	DAC → DRC	0.300	3.514	Supported
H3	DRC → MCCDS	0.234	3.521	Supported
H4	BAAs → DDC	0.509	9.637	Supported
H5a	DDC → DAC	0.189	3.148	Supported
H5b	DDC → DRC	0.167	2.258	Supported
H5c	DDC → MCCDS	0.506	7.746	Supported
H6	BAAs → IBI	0.299	4.328	Supported
H7a	IBI → DAC	0.294	4.549	Supported
H7b	IBI → DRC	0.262	3.260	Supported
H7c	IBI → MCCDS	0.140	2.144	Supported

6. Discussions and implications

Based on the above analysis, the results have both theoretical contributions and practical implications for the MCCDS.

6.1. Theoretical contributions

(1) The results reveal the mechanism on how BAAs strengthen the MCCDS.

Although business analytics provides data-driven objective insights to strengthen the MCCDS for the enterprise which loses the control right of data, and IT researchers have also shown that BAAs are an important and useful concept, there are still few literatures to reveal how BAAs rationally improve the MCCDS. The study sets up a theoretical model from the perspective of cloud computing enterprise users, and reveals the mechanism including BAAs→ DRC→MCCDS through empirical

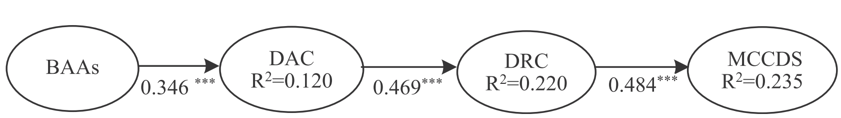

Fig. 2. Research model without mediation variables.

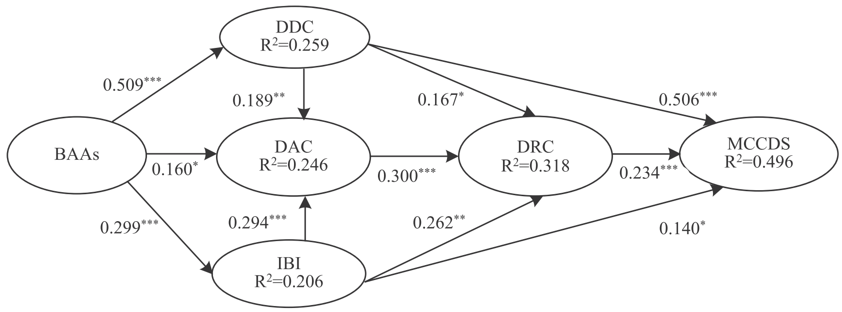

Fig. 3. Test results with mediation variables.

analysis. The results provide a new perspective for the enterprise to improve the effective MCCDS by business analytics, extend IT affordances to the field of cloud computing data security, and further enrich the research on IT affordances in the emerging IT fields.

(2) The results reveal the transformation mechanism from low-level affordances to high-level affordances in the MCCDS.

After affordances theory is extended to the IT fields from ecological psychology, there are many literatures exploring IT affordances in the organizational level (Leonardi, 2011). However, how low-level affordances turn into high-level affordances in the MCCDS also remains to be further elucidated (Cao, 2015; Strong et al., 2014). Compared to DAC, BAAs are low-level affordances. Based on IT affordances theory, this study establishes the theoretical model that includes BAAs and DAC. Moreover, the results reveal how BAAs improve MCCDS through DAC and DRC under the combined effect of DDC and IBI, which enriches the conversion mechanism from low-level affordances to high-level affordances in the MCCDS.

6.2. Practical implications

The results also provide some important practical implications for the MCCDS.

(1) The results help the enterprise rationally enhance the MCCDS by business analytics.

Although the existing literatures show that the rational decision-making based on business analytics is better than the intuitive decision-making based on experience, there is still a lack of literatures on how to guide the enterprise rationally enhance the MCCDS using business analytics. Based IT affordances, the study makes up for the lack of experience, time, and energy for the enterprise to improve the MCCDS using business analytic. Simultaneously, the results help the enterprise search, explain, evaluate and identify data security requirements by business analytics, and then help the enterprise improve DRC and rationally enhance the MCCDS by business analytics.

(2) The results guide the enterprise to pay attention to the role of DDC and IBI.

The decision evolution process from intuition to analysis shows that business analytics play an important role, which is the source for the enterprise to strengthen the MCCDS. However, the application of business analytics is also restricted by some factors, and many enterprises are faced with the dilemma of how to use business analytics (Kiron et al., 2012). The study makes an empirical analysis about the research model including DDC and IBI. The results reveal that DDC and IBI play an important role in the MCCDS using business analytics. DDC facilitates the use of business analytics. The goals of the enterprise with a strong culture are more likely to reach a broad consensus (Yilmaz & Ergun, 2008). When the enterprise is confident in where data comes from, and how and who developed the data (Kiron et al., 2012), the enterprise is more likely to use business analytics to rationally strengthen the MCCDS. Furthermore, IT departments and business departments with high integration are more collaborative, which makes it easier to build data-driven business rules and help the enterprise use business analytics to clearly define the data security requirements and rationally improve the MCCDS.

7. Conclusions and limitations

This study reveals the mechanism on how BAAs affect the effective MCCDS through DAC and DRC by the empirical analysis. However, this study has some limitations which provide a possible approach for the future research. First, the future research may extensively sample the enterprises with different data security requirements to fundamentally eliminate CMV and obtain a more universal conclusion. Second, this study considered only the role of DDC and IBI, and the future research may consider more factors on MCCDS, such as data analysis ability, data quality and so on.

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References

Abbasi, A., Sarker, S., & Chiang, R. H. L. (2016). Big data research in information systems: Toward an inclusive research agenda. *Journal of the Association for Information Systems, 17*(2), 1–32.

Ackermann, T., Widjaja, T., Benlian, A., et al. (2012). Perceived IT security risks of cloud computing: Conceptualization and scale development. *Thirty Third International Conference on Information Systems,* 1–20.

Ali, M., Khan, S. U., & Vasilakos, A. V. (2015). Security in cloud computing: Opportunities and challenges. *Information Sciences, 305*, 357–383.

Armbrust, M., Fox, A., Griffith, R., et al. (2010). A view of cloud computing. *Communications of the ACM,* (4), 50–58.

Bell, P. (2013). Creating competitive advantage using big data. *Ivey Business Journal, 77*(3), 4–8.

Cao, G. (2015). The affordances of business analytics for strategic decision-making and their impact on organisational performance. *Pacific Asia Conference on Information Systems,* 1–17.

Cao, G., & Duan, Y. (2014). A path model linking business analytics, data- driven culture, and competitive advantage. *European Conference on Information Systems,* 1–17.

Cardwell, W. (2009). Perceiving multiple affordances for objects. *Ecological Psychology, 21*(3), 185–217.

Chang, S. E., & Lin, C. (2007). Exploring organizational culture for information security management. *Industrial Management & Data Systems, 107*(3), 438–458.

Choi, M., & Park, E. (2016). The influences of enterprise management strategy on information security effectiveness. *International Journal of Applied Engineering Research and Development, 11*(15), 8686–8694.

Davenport, T. J. (2006). Competing on analytics. *Harvard Business Review, 84*(1), 98–107.

Dean, J. W., & Sharfman, M. P. (1993). The relationship between procedural rationality and political behavior in strategic decision making. *Decision Sciences, 24*(6), 1069–1083.

Dean, J. W., & Sharfman, M. P. (1996). Does decision process matter? A study of strategic decision making effectiveness. *The Academy of Management Journal, 39*(2), 368–392.

Delen, D., & Demirkan, H. (2013). Data, information and analytics as services. *Decision Support Systems, 55*(1), 359–363.

Dhami, M. K., & Thomson, M. E. (2012). On the relevance of cognitive continuum theory and quasirationality for understanding management judgment and decision making. *European Management Journal, 30*(4), 316–326.

Fatemi Moghaddam, F., Yezdanpanah, M., Khodadadi, T., et al. (2014). VDCI: Variable data classification index to ensure data protection in cloud computing environments. *IEEE Conference on Systems, Process and Control,* 53–57.

Gibson, J. J. (1979). *The ecological approach to visual perception.* Boston: Houghton Miffiin80–86.

Kiron, D., & Shockley, R. (2011). Creating business value with analytics. *MIT Sloan Management Review, 53*(1), 28–31.

Kiron, D., Prentice, P. K., & Ferguson, R. B. (2012). Innovating with analytics. *MIT Sloan Management Review, 54*(1), 47–52.

Krancher, O., & Luther, P. (2015). Software development in the cloud: Exploring the affordances of platform-as-a-service. *Thirty Sixth International Conference on Information Systems,* 1–19.

LaValle, S., Lesser, E., Shockley, R., et al. (2011). Big data, analytics and the path from insights to value. *MIT Sloan Management Review, 52*(2), 21–32.

Leonardi, P. M. (2011). When flexible routines meet flexible technologies: Affordance, constraint, and the imbrication of human and material agencies. *MIS Quarterly, 35*(1), 147–168.

Loske, A., Widjaja, T., & Buxmann, P. (2013). Cloud computing providers' unrealistic optimism regarding IT security risks: A threat to users? *Thirty Fourth International Conference on Information Systems,* 1–20.

Lu, J., & Cheng, L. (2013). Perceiving and interacting affordances: A new model of human–Affordance interactions[J]. *Integrative Psychological & Behavioral Science, 47*(1), 142–155.

Lu, Y., & Ramamurthy, K. (2011). Understanding the link between information technology capability and organizational agility: An empirical examination. *MIS Quarterly, 35*(4), 931–954.

Lycett, M. (2013). "Datafication": making sense of (big) data in a complex world. *European Journal of Information Systems, 22*(4), 381–386.

Markus, M. L., & Silver, M. S. (2008). A foundation for the study of it effects: A new look at desanctis and poole's concepts of structural features and spirit. *Journal of the Association for Information Systems, 9*(10), 609–632.

Mcafee, A., & Brynjolfsson, E. (2012). Big data: The management revolution. *Harvard Business Review, 90*(10), 60–66 68.

Miller, C. C. (2008). Decisional comprehensiveness and firm performance: Towards a more complete understanding. *Journal of Behavioral Decision Making, 21*(5), 598–620.

Mircea, M. (2012). Addressing data security in the cloud. *World Academy of Science, Engineering and Technology, 6*, 504–511.

Misra, S. C., & Mondal, A. (2011). Identification of a company's suitability for the adoption of cloud computing and modelling its corresponding Return on Investment. *Mathematical & Computer Modelling An International Journal, 53*(3), 504–521.

Preacher, K. J., & Kelley, K. (2011). Effect size measures for mediation models: Quantitative strategies for communicating indirect effects. *Psychological Methods, 16*, 93–115.

Provost, F., & Fawcett, T. (2013). Data science and its relationship to big data and data-driven decision making. *Big Data, 1*(1), 51–59.

Rahman, N., & Feis, G. L. D. (2009). Strategic decision-making: Models and methods in the face of complexity and time pressure. *Journal of General Management, 35*(4), 43–59.

Sebastian, I. M., & Bui, T. X. (2012). The influence of is affordances on work practices in health care: A relational coordination approach. *Thirty Third International Conference on Information Systems* (pp. 1–11).

Shaikh, R., & Sasikumar, M. (2015). Data classification for achieving security in cloud computing. *Procedia Computer Science, 45*, 493–498.

Shuradze, G., & Wagner, H. T. (2016a). Towards a conceptualization of data analytics capabilities. *49th Hawaii International Conference on System Sciences,* 5052–5064.

Shuradze, G., & Wagner, H. T. (2016b). Governing for agility and innovation in data-rich environments: The role of data analytics capabilities. *Twenty-Fourth European Conference on Information Systems (ECIS),* 1–13.

Spears, J. L., & Barki, H. (2010). User participation in information systems security risk management. *MIS Quarterly,* 503–522.

Stoffregen, T. A. (2000). Affordances and events. *Ecological Psychology, 12*(1), 1–28.

Strong, D. M., Johnson, S. A., Tulu, B., et al. (2014). A theory of organization-EHR affordance actualization. *Journal of the Association for Information Systems, 15*(2), 53–85.

Volkoff, O., & Strong, D. M. (2013). Critical realism and affordances: Theorizing IT-associated organizational change processes. *MIS Quarterly, 37*(3), 819–834.

Winkel, O. (2007). Electronic government and network security: A viewpoint. *Transforming Government People Process and Policy, 1*(3), 220–229.

Wixom, B. H., Watson, H. J., & Werner, T. (2011). Developing an enterprise business intelligence capability: The norfolk southern journey. *MIS Quarterly Executive, 10*(2), 61–71.

Yilmaz, C., & Ergun, E. (2008). Organizational culture and firm effectiveness: An examination of relative effects of culture traits and the balanced culture hypothesis in an emerging economy. *Journal of World Business, 43*(3), 290–306.

Zardari, M. A., Jung, L. T., & Zakaria, M. N. B. (2013). Hybrid Multi-Cloud Data Security (HMCDS) model and data classification. *International Conference on Advanced Computer Science Applications and Technologies,* 166–171.