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Business Analytics/Business Intelligence and IT Infrastructure: Impact on Organizational Agility

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ABSTRACT

This is an empirical research investigating the impact of business analytics (BA) and business intelligence (BI) use, IT infrastructure flexibility, and their interactions on organizational agility. Synthesizing the systems theory and awareness-motivation-capability framework, the authors propose that BA-Use, IT infrastructure flexibility, and their interactions significantly influence organizational agility. The results show the significant association of BA use and IT infrastructure flexibility with organizational agility. The results also suggest that BA use may demand corporations to build a more flexible IT infrastructure. However, the data does not reveal the proposed interaction between the two drivers of organizational agility.

KEYWORDS

Business Analytics, Business Intelligence, IT Infrastructure Flexibility, Organizational Agility, Strategic Value

INTRODUCTION

Business analytics (BA) and business intelligence (BI) have been credited for better management decisions in business. Business intelligence (BI) became a popular term in the 1990s (Chen et al., 2012). In the 2000s, business analytics (BA) was introduced to emphasize the analytic component in BI (Davenport, 2006; Adeborna & Siau, 2014). BA has a very subtle distinction from BI in today's literature. Sometime, the unified term BI&A is used (Chen et al., 2012). We view BA and BI as two synonymous terms. In this study, we use the term BA throughout the paper because it is more commonly used in the current literature and it reflects the unique characteristic of the information systems. Organizations have spent millions, if not billions, of dollars and sometimes made significant organizational changes to implement BA. BA is popular in practice. However, empirical studies on BA and its business value are relatively scarce in academic research compared to studies on analytical and mathematical modeling, statistical methods, and mining algorithms (Jourdan et al., 2008). Although the last 15 years have witnessed a rise in the number of empirical studies on the business value of BA, only 3% of prior BA studies empirically investigated the impact of BA-Use (Trieu, 2016). In this study, we theorize that BA use has a direct implication on organizational performance based on the synthesis of systems theory, awareness-motivation-capability (AMC) framework, and extant IS research.

Based on the literature review, we theorize that the organizational agility (OA) perspective is a promising lens for studying the significance of BA in organizational performance (Chen & Siau, 2012). OA was defined as the organizational ability that can be measured by factors from two dimensions: the

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dimension of detecting and the dimension of responding to opportunities and threats (Nevo & Wade, 2010; Sambamurthy et al., 2003). However, our literature review also shows that the definition was presented without theoretical justifications on why the two dimensions possess factors that affect OA. Are there other factors from other dimensions that may also affect OA? While investigating the business value of BA-Use through the lens of OA, we also want to closely examine the theoretical foundation of the OA definition that has been used in the IS field. The research questions of this study include: (1) Is there a theoretical foundation for the current OA definition? (2) What is the role of BA-Use in converting BA assets into BA impacts? (3) How BA-Use and IT flexibility influence each other and interact with each other to influence the OA? In this study, we use the systems theory and AMC framework to elaborate on why the OA definition should include the organizational ability to detect and respond to opportunities and threats. We also propose that the existing OA definition may need to be expanded to include the motivation dimension. Chen and Siau (Chen & Siau, 2012) proposed, and this study further elaborates, that BA-Use and IT infrastructure flexibility (IIF) are two enabling components that can help to improve OA. In this study, according to the systems theory, we theorize that BA-Use will interact with IIF to affect an organization's agility. Based on the AMC framework, we further propose that in the new data-driven world, BA-Use requires flexible IT infrastructure for organizations to be and remain agile.

The results show that both BA-Use and IIF have a significant impact on OA. The results also show that BA-Use is a driving factor for improving IIF, and BA-Use has a significant influence on organizational agility through IIF. However, the data does not show the interaction effect between BA-Use and IIF on OA. This study contributes to the academic research in a number of ways. First, although OA has been defined as "an organization's detecting and responding ability to opportunities and threats with speed" (Nevo & Wade, 2010; Sambamurthy et al., 2003) and tested in the IS literature, no prior study has provided a theoretical explanation on why OA should be defined by the organizational abilities in the detecting and responding dimensions. This study uses a new perspective, AMC framework, to provide theoretical support for the two existing dimensions of OA definition and proposes a possible modification of the OA definition to include the third dimension: motivation. Second, this study provides theoretical foundations to answer the fundamental question of why BA is important in the business context. Third, it provides theoretical supports to connect IIF with OA from a new perspective: AMC framework. And fourth, through the lens of the AMC framework, it connects BA-Use with IT infrastructure and proposes and empirically suggests that in the new data-driven environment, BA-Use demands a more flexible IT infrastructure through which BA-Use exerts a strong influence on OA. Practical contributions of the study includes (1) that the results provide supports for BA managers to justify their requests for resources to implement BA systems; (2) strategic planners need to consider BA-Use as a crucial asset in the strategic blueprint for improving and enhancing organizational competitive advantage; and (3) in the new data-driven environment, building a flexible IT infrastructure is crucial for OA because BA-Use demands a flexible IT infrastructure and both BA-Use and IIF have direct influence on OA.

The paper is organized as follows. Section 2 presents and discusses the theoretical background. Section 3 describes the research model. Section 4 presents the literature review and hypothesis development. Section 5 describes the research method. Section 6 puts forward the measurement analysis results. Section 7 presents the structural model analysis results and discusses the findings. Section 8 highlights the research contributions. Section 9 discusses the limitations of the research and suggests potential future research directions.

THEORETICAL BACKGROUND

Systems Theory and Organizational Agility (OA)

The systems theory defines that systems are composite things and that systems possess properties that are derived from the interaction among the composing components (Ackoff, 1971; Checkland, 1981). The systems theory asserts that (1) the world is made up of things; (2) things possess properties; and (3) each property is represented by some value at any point in time (Nevo & Wade, 2010, p. 165). Extending the systems theory, Nevo and Wade (2010) proposed "some system properties may be properties of their components but with new values" while "other system properties are new in the sense that no individual component possesses them in isolation." (Nevo & Wade, 2010, p. 166). The latter system properties are called emergent properties (Nevo & Wade, 2010). The value of emergent properties is determined by both the composing components and their relationships (Nevo & Wade, 2010).

Most OA definitions in the information systems (IS) literature explicitly or implicitly defines OA as an organization's abilities to detect and respond to opportunities and threats with speed (e.g., Li et al., 2008; Lu & Ramamurthy, 2011; Sambamurthy et al., 2003; Tallon & Pinsonneault, 2011). One of the representative OA definitions is "the ability to detect and respond to opportunities and threats with ease, speed, and dexterity" (Tallon & Pinsonneault, 2011, p. 464). However, no theoretical justification in the literature was given on why OA is defined by the two dimensions. In conjunction with the introduction of the AMC framework below, we explain why OA should include the two dimensions of abilities and should another dimension of ability be added. Since there is no single component that can define OA, we propose that OA is an emergent property. Therefore, the value of OA comes from its composing components. Since OA is an emergent property, we cannot ignore the interaction effect of the composing components according to the systems theory. Therefore, in this study, we also examine the interaction effect of the OA's composing components on OA.

Awareness-Motivation-Capability (AMC) Framework

Chen (1996) first introduced the AMC framework. Competitive dynamics researchers have used it to study the antecedents of competitive actions. The AMC perspective suggests that three behavioral drivers influence a firm's decision to act: awareness, motivation, and capability (Chen, 1996). The definition of OA and the literature indicate that the essence of OA is to respond to opportunities and threats with speed. Responding is an action. Therefore, it is going to be influenced by the three behavioral drivers as suggested by the AMC framework. The original AMC framework did not explicitly describe the dynamics of the three drivers. Chen and Miller (2015) further refined the AMC framework. They indicated that for an organization to take action, it must be aware of the opportunities and threats, motivated to react, and capable of reacting. It implies that awareness is the premise to motivation, then to capability building before taking action. Because OA is about an organization's ability to take action with speed, based on the AMC framework, we propose that OA should be determined by the awareness, motivation, and capability drivers for action.

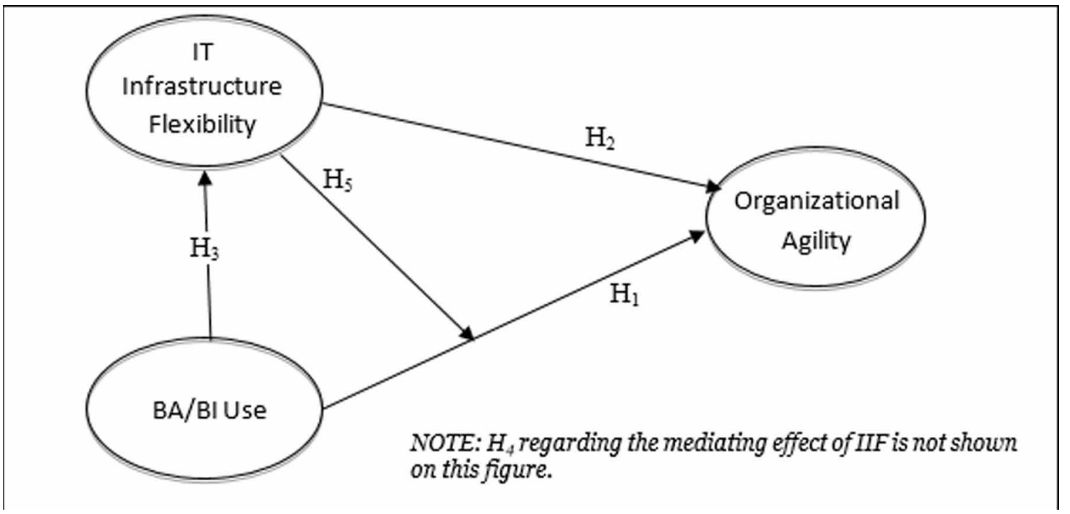
Synthesizing the systems theory and AMC framework, we theorize that OA is an emergent system property whose value is determined by its composing components and their interactions. We further propose that detecting ability is part of the awareness driver and responding ability is part of the capability driver. Because awareness can help an organization to intentionally build its capability, detecting ability will have a direct influence on an organization's capability building. Therefore, detecting ability will influence an organization's ability to take action through capability. The current OA definition only emphasizes the factors from the detecting and responding dimensions. From the AMC perspective, an OA definition should be broadened to include the component from the motivation driver. Therefore, we propose a slightly modified OA definition as "the ability to detect and to be motivated to rightfully respond to opportunities and threats with ease, speed, and dexterity". Because both awareness and capability drivers measure an organization's ability and can be built by IT assets,

this study focuses on how factors in these two drivers influence OA. Specifically, we propose that BA-Use in an organization is one of the factors that influence an organization's detecting ability. IT infrastructure flexibility can improve an organization's capability to respond. We propose that BA-Use and IIF are two direct influential factors on OA; BA-Use will influence IIF in the new data-driven environment. Because BA-Use is one of the detecting factors of OA and IIF is one of the responding factors of OA, they will interact with each other to influence OA.

RESEARCH MODEL

Drawing on systems theory, AMC framework, and current literature on BA, IT flexibility, OA, and competitive performance, this study has developed a research model as shown in Figure 1. This research model is further explained below in the literature review and hypothesis development.

Figure 1. Conceptual model



LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Organizational Agility (OA)

OA has been defined in the information systems literature as the organizational "ability to detect and respond to opportunities and threats with ease, speed, and dexterity" (Tallon & Pinsonneault, 2011, p. 464). The literature showed that two dimensions determined agility: the ability to detect opportunities and threats and to respond with speed (Li et al., 2008; Lu & Ramamurthy, 2011; Sambamurthy et al., 2003; Tallon & Pinsonneault, 2011). According to the systems theory, we theorize that OA is not only determined by the two dimensions but also the interaction of the two dimensions. The AMC framework indicates that to take action, an organization needs to be aware of opportunities/threats, then be motivated to take action, and ultimately have the capability to take action. Therefore, capability is the premise to respond.

Sambamurthy et al. (Sambamurthy et al., 2003) theoretically argued that OA comprised three interrelated capabilities: customer agility, partner agility, and operational agility. Furthermore, Sambamurthy et al. (Sambamurthy et al., 2003) defined customer agility as "the co-opting of customers

in the exploration and exploitation of opportunities for innovation and competitive action moves" (p. 245). Their definition of customer agility narrowly relates to the co-creation of new ideas, products, and services. We view customer agility in a broader sense as an organization's ability to sense and respond to customer changes in demand for products and services. Based on Venkatraman & Henderson (1998)'s research, partner agility is defined as the "ability to leverage the assets, knowledge, and competencies of suppliers, distributors, contract manufacturers, and logistics providers through alliances, partnerships, and joint ventures" (Sambamurthy et al., 2003, p. 245). Operational agility concerns the ability of an organization's operational processes to innovate and compete with speed, accuracy, and cost-effectiveness. Tallon and Pinsonneault (2011) devised a set of indicators with which to measure the three capabilities of OA. We based our measurement indicators on (Tallon & Pinsonneault, 2011).

Research on dynamic capability from the strategic management field provides the theoretical foundation on why OA, which has been studied in the IS field for decades, is a critical competitive factor and a source of competitive advantage (e.g., Sambamurthy et al., 2003). These studies demonstrate the role of OA in creating strategic business values. We choose OA as the dependent variable in this study to illustrate the strategic values of the two studied IS/IT components by theoretically connecting BA-Use and IT infrastructure with the strategically important organizational property: organizational agility.

BA-Use and its Impact on OA

In this research, we adopt an inclusive definition of BA as defined by Watson (Watson, 2009, p. 491) "a broad category of applications, technologies, and processes for gathering, storing, accessing, and analyzing data to help business users make better decisions." This definition indicates that BA has three components. The first is the application component, which analyzes the data to produce insights/new knowledge so that specific business processes can use the insights/new knowledge to increase business value. The second is the technology component, which helps to collect, store, and deliver information. The third is the human process component, which empowers users to effectively and efficiently retrieve data and deliver it as information, thus helping with the generation of knowledge and the making of better decisions (Laursen & Thorlund, 2010). In this study, BA-Use refers to the extent users in an organization employ the broad BA application and technology for better decisions. This includes the use of reporting and query capabilities for reports, application of statistical methods in analyzing data, and employment of data mining capability for identifying patterns (Lee & Siau, 2001).

Many prior research efforts on the business value of BA have focused primarily on exploratory research: formal theory and literature reviews (Jourdan et al., 2008). Since 2008, BA research has blossomed. Chen et al. (2012) outlined the key emerging research areas. Although those areas are critical in advancing BA, they focus on the applications and technology components of BA, including the areas of (big) data analytics, text analytics, web analytics, network analytics, and mobile analytics. Since then, there has been a considerable amount of research on specific BA applications and technologies. However, research from management and strategy perspectives, especially on the business value of BA for organizational performance, is relatively underexplored. In the IT impact literature, findings are mixed regarding the impacts of general IT on organizational agility. For example, Chakravarty et al. (2016) and Lu and Ramamurthy (2011) found that IT capabilities positively influence organizational agility, whereas Liu et al. (2013) and Swafford et al. (2008) found there is no direct link between IT capabilities and organizational agility. Ghasemaghaei et al. (2018) found the positive impact of data analytics competency on decision making performance. Through interviews with the stakeholders in the mining industry, Zeshan et al. (2019) found that BA benefits the industry through improving efficiency and productivity among others. BA systems have been considered to be strategic information technologies in many organizations. Nevertheless, how BA systems contribute to organizational competitive strength and how BA-Use converts BA systems into BA impacts are under-researched subjects in the current BA literature. Integrating the three

most popular IT business value models from (Schrven, 2013; Soh & Markus, 1995), Trieu (2016) proposed a BA business value framework for classifying prior BA research. It was a process model that described a chain of outcomes and their relationships. The chain includes BA investment, BA assets, BA impacts, and organizational performance. Each downstream chain element was a value that an upstream chain element created through a business process. For example, BA investments created BA assets through the BA conversion process, and BA assets created BA impacts through the BA-Use process (Trieu, 2016). According to Trieu (2016), only 3% of prior research investigated BA impact through BA-Use. It further demonstrates BA-Use was understudied in the BA value literature.

Our review of prior studies reveals that most of the prior studies on BA value either were not empirical studies or focused on BA applications and technologies (e.g., Abbasi et al., 2012; Chae et al., 2014; Hu et al., 2012; Popovic et al., 2014). There are some recent BA use studies that investigate BA use as a dependent variable (e.g., Daradkeh, 2019). Few of the prior BA value studies empirically investigated BA impacts from a BA-Use perspective and treated BA-Use as an independent variable for business performance (e.g., Akter et al., 2016; Elbashir et al., 2008; Ghasemaghaei et al., 2017; Popovic et al., 2012; Sangari & Razmi, 2015; Shollo & Galliers, 2016). Elbashir et al. (2008) investigated the impact of BA-Use on business process performance and organizational performance. It was one of the pioneer studies that empirically investigated the value of BA-Use. However, Elbashir et al. (2008) measured the perceived impact of BA-Use on business processes and organizational performance when the systems were first implemented. It did not address the impact of how the BA systems were used. Ghasemaghaei et al. (2017) investigated the impact of the use of data analytics on OA. They found that the link between the use of data analytics and OA is significantly moderated by the fit between task and technology, person and technology, and data and technology. This finding provides the base for us to investigate other moderating variables on the link between BA-Use and OA. Some recent empirical studies that investigate the role of BA systems from the managerial perspective include (Popovic et al., 2012; Sangari & Razmi, 2015; Shollo & Galliers, 2016). However, these studies do not address how complementary resources, especially other technological resources, interacted with BA-Use and the contribution of BA-Use to an organization's competitive performance. The limited number of empirical studies on BA business value, especially on how BA-Use converts BA systems into BA impacts, made it challenging for managers to justify their requests for resources to initiate and implement BA projects and to promote the use of BA for business operational efficiency and organizational performance at the strategic level. Therefore, although there are numerous BA studies, there is still a need for a conceptual foundation that helps to understand the value of BA systems, to connect theoretically BA-Use with business process and organizational performance, and to find out the factors thataffect the impact of BA-Use on organizational performance (Ghasemaghaei et al., 2017). This is because prior BA studies mainly focused on what BA impacts were, but did not address the question of how BA systems were converted into BA impacts through BA-Use. This study is one attempt to build the foundation. It aims to investigate the significance of BA by theoretically and empirically demonstrating how and why BA-Use can help organizations and what other organizational resources affect the benefits of using BA in organizations.

The purpose of BA systems is to gather, store, access, and analyze data, which includes data about customers, partners, operations, and other environment change information. For decision making, we argue that the use of BA in organizations will help to increase OA by improving an organization's ability to detect the changes reflected in the data in BA systems. There is also empirical evidence of BA's contribution to OA in current IS research on the topic. For example, (Ghasemaghaei et al., 2017) directly found the moderated impact of BA-Use on organizational agility. The construct of information management capability (IMC) from Mithas et al. (2011) is encompassing and includes capabilities that BA provides. Mithas et al. (2011) found significant positive influences of IMC on three organizational capabilities: performance management capability, customer management capability, and process management capability, which can be measured by proposed OA of customer, partner, and operation (Sambamurthy et al., 2003).

Strategic IT alignment literature also provides support for the positive effect of BA-Use on OA. For example, studies have shown knowledge creation, sharing, and use to be enablers of strategic IT alignment (Preston & Karahanna, 2009; Siau et al. 2010, Nah et al. 2005). Due to knowledge sharing between business and IT executives, an organization can respond quickly to changes in marketplaces and, thus, increase an organization's agility. Knowledge creation, sharing, and use are the arguments for the positive effect of strategic IT alignment on agility (Tallon & Pinsonneault, 2011). Since BA-Use can create an environment for generating, sharing, and using newly found/created knowledge, BA-Use can help increase OA. Therefore, we postulate that BA-Use can enhance an organization's agility to detect changes:

H_1: BA-Use will positively influence an organization's agility.

IIF and its Impact on OA

Flexibility is the degree to which a thing is malleable. Flexibility was viewed as one of the firm's capabilities that influence a firm's speed to act or respond (e.g., Tiwana & Konsvnski, 2010). Studies have shown that flexibility is a key antecedent of agility in a business context (e.g., Li et al., 2008; Tiwana & Konsvnski, 2010).

IT infrastructure was consistently defined in literature as a set of shared IT resources that are a foundation for enabling communication across an organization and enabling present and future business applications (Byrd & Turner, 2001; Duncan, 1995). IT infrastructure may include (1) platform technology (e.g., hardware and operating systems); (2) network and telecommunication technologies; and (3) data and data management systems (Duncan, 1995). IIF refers to the degree to which the firm's IT resources are malleable (Duncan, 1995). The definition of IIF from Byrd & Turner (2001) emphasizes IT infrastructure's ability to easily and readily support a wide variety of hardware, software, and communication technologies, to distribute information to anywhere inside an organization and beyond, and to support the design, development, and implementation of a heterogeneity of business applications. There are four key components of IIF: connectivity, compatibility, modularity, and IT personnel competency (Byrd & Turner, 2001; Duncan, 1995). Most commonly accepted technical (static) dimensions of IIF are connectivity, compatibility, and modularity.

Because contemporary organizations are mostly IT-enabled, organizational capabilities are often inseparable from IT (Pavlou & El Sawy, 2010). Today, organizational actions are rarely executed without information technology. Sambamurthy et al. (Sambamurthy et al., 2003) theoretically argued that there should be a positive relationship between IIF and OA. The AMC framework suggests that to take action, an organization must have the capability to do it in addition to the awareness of opportunity and threat, and motivation to take action. Flexible IT infrastructure can help an organization quickly and economically integrate and reconfigure internal and external IT-enabled resources to respond to ever-changing requests from functional lines of business. Prior research (El Sawy & Pavlou, 2008; Rai et al. 2006) also empirically supports the view of the positive role of IIF in integrating and reconfiguring internal and external resources to respond to changes. Therefore, we can view a flexible IT infrastructure as part of the organizational capability to respond to changes in the IT-enabled business environment. Because capability is the driver for taking action with speed, which is OA's responding dimension, a flexible IT infrastructure can be naturally connected with the responding dimension of OA.

Scholars in IS field have studied IIF as an independent variable as well as a moderator (Byrd & Turner, 2001; Tallon & Pinsonneault, 2011; Tiwana & Konsvnski, 2010). However, direct investigation of the relationship between IIF and OA is scarce although there is a direct link between flexibility and agility in general (e.g., Tiwana & Konsvnski, 2010). We only found a few investigations of this kind in IS field (Bhatt et al., 2010; Tallon & Pinsonneault, 2011). The others studied various aspects of IT infrastructure, but not the IIF on OA (e.g., Lee et al. 2015). Kumar (2004) proposed that the real

values of IIF lie in the flexible interaction between an IT infrastructure and its organizational context. This study extends that proposition by specifying the organizational capability that IIF contributes. This study emphasizes that IIF is one of two contributing factors that can improve OA. Based on a case study, Richardson et al. (Richardson et al., 2014) proposed that an IT platform based on open source tools could lead to higher levels of customer, operational, and partner agility. The open source IT platform implied better connectivity and more compatibility among subsystems. Therefore, the study of (Richardson et al., 2014) can be viewed as supporting the positive impact of IIF on OA.

Synthesizing the system theory, AMC framework, and prior IS research, we propose that IIF is a critical contributor to an organization's agility to respond to changes in competitive environments whether the changes originate from customers, partners, or operations. Therefore, theoretical arguments and IS literature suggest the following hypothesis:

H_2: IT infrastructure flexibility will positively influence organizational agility.

The Relationship Between IIF and BA-Use

The AMC framework suggests that three forces drive an organization to take action: awareness, motivation, and capability. It further theorizes that to take an action, an organization must first be aware of the changes of the environment and within its own operation to be motivated to take action, and then it must have or build the required capability before taking action (Chen, 1996; Chen & Miller, 2015). We discussed above that BA-Use can contribute to an organization's ability to detect changes. Therefore, it can help increase an organization's awareness. The above discussion also shows that IIF is one of the key organizational capabilities in the IT-enabled business environment for organizations to act quickly and economically.

In addition, BA is an information system that is built on an IT infrastructure. Thus, we can connect BA-Use from the awareness force with IIF from the capability force for organization's actions. Also, BA-Use requires users to be able to access a variety of data sources and distribute data to different users and data interfaces, such as web browsers on desktop computers, small screens on mobile devices, or send data produced in the BA systems to other information systems. Thereby, BA-Use demands a flexible IT infrastructure to facilitate the integration of existing and new data sources and distributing the generated information to users whenever and wherever it is needed. A flexible IT infrastructure can provide good connections and compatible resources among subsystems (Bharadwaj & Bendoly, 2007). In summary, increased BA-Use will drive organizations to build more flexible IT. Therefore, we propose that BA-Use in an organization demands higher IIF:

H_3: BA-Use will positively influence IT infrastructure flexibility.

The systems theory suggests that the value of an emergent property of a system is determined by the values of composing components and the interactions of the composing components. OA is an emergent property of an organization. Its value is determined by the values of the composing components from two dimensions: detecting and responding as well as the interactions of the source components. We postulate that BA-Use, one of the detecting components, and IIF, one of the responding components, will interact with each other to influence the value of OA.

From the AMC perspective, we have theorized that both BA-Use and IIF may have a direct positive influence on OA. Based on the above argument regarding the relationship between BA-Use and IIF, we demonstrate how BA-Use may also positively influence IT infrastructure flexibility. As a result, we can theoretically propose that the effect of BA-Use on OA may be facilitated through IIF. Thus, we also propose that IIF mediates the effect of BA-Use on OA. Therefore, our fourth hypothesis is:

H_4: BA-Use and its impact on OA is mediated by IT infrastructure flexibility.

Moderated mediation studies show that there is a possibility that an independent variable may interact with its mediator to influence the dependent variable (Preacher et al., 2007). In the current study, we proposed that IIF may be a mediator for the independent variable BA-Use and the dependent variable OA. Therefore, from the moderated mediation perspective, there is a possibility that BA-Use may interact with IIF to influence OA. From the perspective of the system theory, we also argue above that OA is an emergent property of an organization. The value of the emergent system property OA is determined by the values of the composing dimensions and their interactions. Therefore, the factors from the two composing dimensions may interact with each other to influence the value of OA. When studying the impact of business analytics on organizational agility, from the dynamic capability perspective, Ghasemaghaei et al. (2017) argued that both OA and business analytics use are a firm's dynamic capabilities. OA is a higher order of dynamic capability and business analytics use is a lower order of dynamic capability. They proposed that business analytics use would increase OA. The fit perspective suggests that organizational outcomes are the results of fit between two or more factors (Goodhue & Thompson, 1995). From the fit perspective, they also theorized that the fit between analytics tools and data, tasks, and people may influence the direct relationship between business analytics use and OA. Therefore, the fit variable may moderate the relationship between business analytics and OA. Their data support the moderation effect of the fit variables on the relationship between business analytics use and OA. We argue that IIF is one of the organization's IT resources, which has a close relationship with BA-Use, which is a task performed by business users. Thus, the fit between these two will have a consequence on OA. Therefore, combining the three perspectives of moderated mediation, system theory, and fit, we postulate that the BA-Use and IIF may interact with each other to influence the outcome of OA. Based on the arguments above, we propose the following hypothesis for the interaction term between BA-Use and IIF on OA:

H_5: IT infrastructure flexibility moderates the relationship between BA-Use and Organizational Agility.

RESEARCH METHOD

Survey Instrument Development

A cross-sectional survey study was employed to test the research model. This study uses the existing survey instruments whenever it is possible. We examined the existing measurement scales according to well recognized and standard scale development procedure, such as the procedure proposed by (Churchill, 1979). The instrument for BA-Use was developed in this study following the same procedure proposed by (Churchill, 1979). All other instruments used in this study are adapted from existing measures. Appendix A lists the survey instruments in this study.

Scale for BA-Use

Burton-Jones and Straub (2006) proposed that system usage is an activity that involves three elements: a user, a system, and a task. They recommended conceptualizing system usage with two stages. The first is the definition stage and the second is the select stage. According to Burton-Jones and Straub (Burton-Jones & Straub, 2006), the system usage can be captured by two sub-constructs: cognitive absorption that represents the extent to which a user is absorbed, and deep structure usage that represents the extent to which features in the system that relate to the core aspects of the task are used (Burton-Jones & Straub, 2006, p. 236). They suggest that the select stages should include two steps:
Step 1: Select the elements of usage that are most relevant to the research model and context.
Step 2: Select measures for the chosen elements that are tied to other constructs in the nomological network.

We believe that cognitive absorption is more related to individual task performance than the extent to which a system is used by a user. We are interested in which BA system components a

user is using so that we can gauge the extent to which a BA system is used in an organization. Thus, our measurement indicators for BA-Use are mostly in the deep structure usage category. We first selected features of BA information systems that would be used by users. Then we combined the selected features with corresponding tasks to measure the extent of BA-Use in an organization. The selected features were based on the common functionalities outlined by industrial groups, such as the functionalities presented in the report provided by *The Data Warehousing Institute* (Eckerson, 2009). We further refined the features and the instrument with help from several academic researchers who had done various studies on BA and taught BA classes in universities. A convenience sample of 22 business and IT staff from various industries and three academic IS researchers pre-tested the questionnaire. Then, we further refined the measurement scale based on their suggestions. We also used pilot study to ensure the survey website was functioning as expected. The measurement reliability and validity of this instrument are discussed in the Measurement Analysis Results section.

Scale for IIF

IIF has been measured as a second order variable in the literature. There are three dimensions in IIF. The three dimensions of IIF are connectivity, hardware compatibility, and IT modularity. The IIF instrument was adapted from Duncan (1995), Tallon & Pinsonneault (2011), and Tiwana & Konsvnski (2010).

Scale for OA

Sambamurthy et al. (2003) first theoretically proposed that there are three dimensions of OA. Tallon and Pinsonneault (2011) devised a set of eight indicators to assess the OA. The OA instrument was adapted from Tallon & Pinsonneault (2011)'s survey instrument.

Participants and Data Collection

The population of interest for this study is business leaders whose companies are using BA. 18,000 senior business leaders were selected from U.S. companies that had at least 20 million dollars in annual revenue. These senior business leaders include CEOs, CFOs, CTOs, CIOs, VPs for business functions, and senior business directors or managers. We received email addresses along with other information, such as the title of a contact in a company, the company name, and the company's annual revenue through a commercial direct marketing company, ConsumerBase, LLC. All emails from ConsumerBase are 100% opt-in and 100% guaranteed deliverable within 30 days of purchase.

Qualtrics.com was used to host our survey, which is a leading web-based marketing research provider. The initial invitation email and several rounds of reminding emails were sent out to the selected executives. The data collection period was one month.

Tables 1 and 2 display the industry and company information of the participants in this study.

Sample Size and Data Analysis Technique

A total of 237 completed entries were collected during the four week data collection period. Twenty-one cases were eliminated from the sample because they were either incomplete responses or the organizations were not using any BA system. One subject selected "1" and another subject selected "7" for all the questions. These two subjects were removed from the sample too. Our final sample size in this study is 214.

Partial Least Squares (PLS) was employed in this study to assess the measurement model and the structural model. PLS is appropriate for this study because it is variance-based and places minimal restrictions on measurement scales, sample sizes, and residual distributions (Chin et al., 2003). We chose PLS technique over the covariance-based SEM technique because of the sample-size requirement for each technique. Kline (2005) suggested that the desired sample size would be 20 times the number of free parameters for covariance-based SEM analysis. The sample size required for our model could reach more than 700 (7 first order constructs, 2 second order constructs, and a total of 35 indicators)

Table 1. Industries represented by participants

Industry	Number of Subjects	Percentage
Basic material (basic resources, chemicals)	5	2.3%
Consumer goods (auto & parts, food beverage, personal & household goods)	22	10.3%
Consumer services (media, retail, travel & leisure)	7	3.3%
Education (K-12 and higher education)	4	1.9%
Financials (banks, financial services, insurances)	31	14.5%
Government (federal and local governments)	7	3.3%
Healthcare	39	18.2%
Industrials (construction & materials, industrial goods & services)	22	10.3%
Oil & Gas	4	1.9%
Technology (software & computer services, technology hardware & equipment)	46	21.5%
Telecommunications	3	1.4%
Utilities	1	0.5%
Professional services	18	8.4%
Manufacturing	5	2.3%
Total	214	100%

Table 2. Number of employees in participants' companies

Number of employees	Number of Subjects	Percentage
Missing data	2	0.9%
1 – 49	26	12.1%
50 – 499	53	24.8%
500 or More	133	62.1%
Total	214	100%

if the covariance-based SEM technique was used. The rule of thumb for minimum sample size for the PLS technique is 10 times the largest number of structural paths directed at a particular construct in the structure model (Hair et al., 2013). The largest number of structural paths in the research model is 3. Therefore, the minimum sample size for this study is 30 using PLS. Following the suggestions from (Faul el al., 2007), a priori power analysis was conducted to determine the sample size for this study with the following criteria: effect size of 0.30 (medium), alpha of 0.05, and power of 0.95. The calculated sample size is 134 for two-tail *t*-tests. The sample from our survey is 214 and is sufficient for the PLS analysis. SmartPLS, a PLS software developed by (Ringle et al., 2005), was used for the PLS analysis.

MEASUREMENT ANALYSIS RESULTS

Common Method Bias and Multicollinearity Check

Common method bias is a potential problem in research, especially in survey research (Podsakoff et al. 2003). Several post hoc statistical analyses can help to determine if there is an exceedingly common method variance in data. Partial correlation method is a method to check common method bias in data (Podsakoff et al. 2003). Following the practice of Pavlou & EI Sawy (2006) for this method, we added the highest factor from the principal component analysis to the PLS model as a control variable on dependent variables. This factor did not produce a significant change in explained variance in the dependent variables in the model. Correlation analysis can also help to determine if there is an excessive common method variance in data (Bagozzi et al., 1991). Table 3 presents the correlation matrix of the main constructs as well as the average variance extracted (AVE) in this study. Bagozzi et al. (1991) suggested that a correlation that is > 0.9 would indicate evidence of common method bias. The highest correlation among the second order constructs is 0.67 and that is between operational agility and customer agility, which is less than the thresholds suggested by Bagozzi et al. (1991). This analysis also suggests no excessive common method bias in the data. The third method we employed to test if there is a common method bias in the data is Harman's one-factor test. We performed Harman's one-factor test in SPSS. The total variance explained by the single factor from the test is 30%. It indicates there is no excessive common method bias existing in the data.

Multicollinearity may also be an issue when a survey method is used for a research. We obtained the variance inflated factor (VIF) for BA-Use and IIF from SmartPLS 3. The VIF value for BA-Use is 1.15 and IIF is 1.16, indicating very low multicollinearity issue.

Table 3. Constructs' Average Variance Extracted (AVE) and correlation

AVE	SQRT of AVE	Construct Correlation							
			BA-Use	C-agility	O-Agility	P-Agility	IT Connectivity	IT Hardware Compatibility	IT Modularity
0.61	0.78	BA-Use	1.00						
0.66	0.81	C-Agility	0.28	1.00					
0.66	0.81	O-Agility	0.24	0.67	1.00				
0.72	0.85	P-Agility	0.27	0.58	0.65	1.00			
0.61	0.78	IT Connectivity	0.26	0.43	0.31	0.32	1.00		
0.65	0.80	IT Hardware compatibility	0.28	0.40	0.36	0.37	0.72	1.00	
0.71	0.84	IT Modularity	0.37	0.28	0.28	0.29	0.58	0.52	1.00

C-Agility=Customer Agility
O-Agility=Operational Agility
P-Agility=Partner Agility

Measurement Reliability and Validity

We used SmartPLS (Ringle et al., 2005) to perform the confirmatory factor analysis. Based on the loading scores of the indicators, we dropped several indicators from the IIF scale. The Cronbach's Alpha values for all constructs, except for Partner Agility, are above the recommended threshold value of 0.7 (Kline, 2005; Nunnally & Berbstein, 1994). The Cronbach's Alpha for Partner Agility is 0.61, which is still acceptable (Robinson et al., 1991). Furthermore, the construct, as well as all other constructs, has a composite reliability score above 0.83. The composite reliability scores are

above the recommended threshold value of 0.7 (Nunnally & Berbstein, 1994). These scores indicate that measurement scales are reliable.

All the kept indicators have loading scores of 0.6 or higher on their corresponding constructs and have at least one magnitude lower scores on other constructs. Table 3 presents the AVE values and constructs correlations for all the first order constructs in the proposed model after we dropped the indicators that cause discriminant and convergent validity issues for their theoretical constructs.

From Table 3, we can see that the square roots of all constructs' AVE are larger than any correlation among any pair of latent constructs.

From the analysis above, we can assume that the modified measurement scale for all first-order constructs in this study has discriminant and convergent validity. Therefore, we can continue with our model assessments.

STRUCTURAL MODEL ANALYSIS RESULTS AND DISCUSSIONS

The full structural model was assessed using SmartPLS (Ringle et al., 2005). The model was estimated with company size and industry as control variables. Company size was operationalized by annual revenue and employee number. We first performed PLS Algorithm tests in SmartPLS to obtain the path coefficients. Then, the significance of direct and indirect impacts of variables in the model were tested using bootstrapping with 5000 resamples and a 95% confidence interval as suggested by Vance et al. (Vance et al., 2015) and "bias-corrected bootstrap that have the least biased confidence intervals, greatest power to detect nonzero effects and contrasts, and the most accurate overall Type I error" as suggested by Chin et al. (Chin, 2010). Henseler and Chin (2010) recommended a two-stage approach to investigate the interaction effect of a model. We followed the recommendation to investigate the interaction in this research. The resulted path coefficients and significances with controlled company size and industry are displayed in Figure 2 and Table 4. The number in the endogenous variables, such as IT Infrastructure Flexibility and Organizational Agility in Figure 2, is the R^2 value.

BA-Use and OA

From the systems theory perspective, we theorize that OA is an emergent system property. OA measures how quickly an organization can act in a business environment. According to the AMC framework, the three drivers of action are awareness, motivation, and capability. Therefore, the antecedents of OA, measuring the ability of an organization to quickly act, should come from three dimensions: (1) detecting changes in business environment, (2) responding to the changes, and (3) being motivated to take actions. BA-Use helps decision makers gain more insights about changes in their operations and external environments. This contributes to the awareness behavior driver that helps determine an organization's actions, which matches well with the detecting changes dimension of OA. Therefore, this study proposes that BA-Use is one of the contributing components on the detecting dimension of OA. The PLS results in Figure 2 show that the path coefficient for the direct impact of BA-Use on OA is 0.175 and that is significant at the *0.05* significant level ($p = .017$). Hypothesis 1 (H_1) is supported in this study.

Soh and Markus (1995) defined the IT impact as a state an organization achieves. Due to the IT asset, new products/services are created, business processes have been redesigned for better performance, and decision-making and coordination and flexibility have been improved. We argue that although Soh and Markus (1995)'s definition of IT impact is comprehensive, an important aspect of outcomes, agility, should be included. As discussed in the literature review section of IIF, agility is different from flexibility. Flexibility does not necessarily lead to agility (Li et al., 2008; Tiwana & Konsvnski, 2010). The purpose of coordination and flexibility is to achieve OA. Therefore, we define IT impact as "a state an organization achieves, in which due to the IT asset, new products/services are created, business processes have been redesigned for better performance, decision-making and agility have been improved". As we discussed in the literature review section, although there are

Figure 2. Test Results of Full Structural Model NOTE: The result for H_4 regarding the mediation effect of IIF is not shown in this figure.

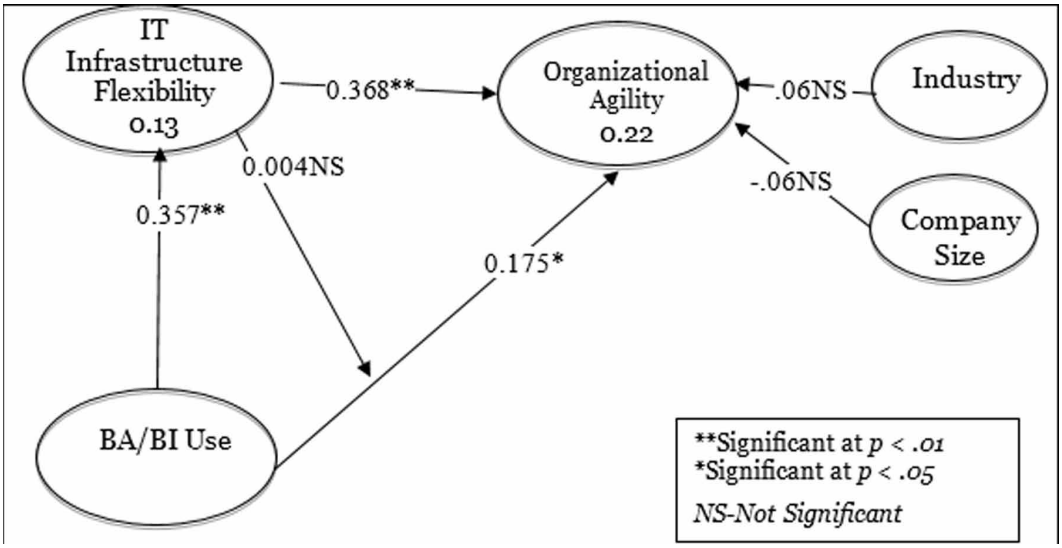


Table 4. Summarizes the results of hypothesis testing

Hypothesis	Independent Variable	Mediator	Moderator	Dependent Variable	Path Coefficient	Hypothesis Supported?
H_1	BA-Use	N/A	N/A	OA	0.175*	Yes
H_2	IIF	N/A	N/A	OA	0.368**	Yes
H_3	BA-Use	N/A	N/A	IIF	0.357**	Yes
H_4	BA-Use	IIF	N/A	OA	0.132(a)**	Yes
H_5	BA-Use	N/A	IIF	OA	0.004(b)^{NS}	NO

N/A=Not Applicable
NS=Not Significant
a=Total Indirect Path Coefficient
b=Moderation Path Coefficient

prior studies that empirically investigated the BA impacts (e.g., Elbashir et al., 2008), Trieu (Trieu, 2016) and our own literature review found only one empirical study (Ghasemaghaei et al., 2017) that examined the relationship between BA investment and OA through BA-Use, and no empirical study on BA enabled OA and organizational performance through a competitive process. This study provides the second empirical support that BA asset can help build OA through BA-Use.

Although Trieu (Trieu, 2016) indicated that there is no prior empirical study that examined the relationship between BA impacts and improved organizational performance through a competitive process, there are some studies that briefly mentioned the relationship (e.g., Lau et al., 2012). We speculate that one of the reasons for the lack of such studies in the literature may be due to the lack of empirical studies that show BA-Use enhanced OA (i.e., a BA impact). Sambamurthy et al. (2003) theoretically argued that OA is a critical contributor to business competitive advantage. The strategic and IT business value literature has theoretically justified and empirically demonstrated the direct relationship between competitive advantage and organizational performance (e.g., Vannoy & Salam, 2010). From this discussion, there is a clear connection from BA-Use enhanced OA to competitive

advantage, then to organizational performance. The lack of studies examining the relationship between BA impacts and improved organizational performance through a competitive process is partially due to the lack of studies investigating BA-Use enhanced competitive impacts, such as BA-Use enhanced OA. This study helps to initiate the research that investigates the BA value through the competitive process.

With the theoretical justification and empirical support from this study, we demonstrate the strategic value of BA-Use and argue that BA-Use should be treated as a critical component of an organization because of its contribution to OA, a key contributor to competitive advantage (Sambamurthy et al., 2003; Tallon & Pinsonneault, 2011).

IIF and OA

IIF has been extensively studied in IS research as an independent variable (Kumar, 2004; Sambamurthy et al., 2003; Tiwana & Konsvnski, 2010) as well as a moderator (Tallon & Pinsonneault, 2011). Bhatt et al. (2010) is one of the few studies that investigated the IIF and organizational responsiveness, which we view as one antecedent dimension of OA. The AMC framework shows that to take actions, organizations not only need to be aware of opportunities and threats but also need the capability for quick actions. Theories and empirical studies suggest that IIF can help increase the organizational capability to take competitive actions by enabling organizations to quickly integrate and reconfigure its internal and external resources (e.g., EI Sawy & Pavlou, 2008; Pavlou & El Sawy, 2010; Rai et al. 2006; Sambamurthy et al., 2003). This theoretically suggests that IIF is a critical part of an organization's capability in today's IT-enabled organizations. This statement is empirically supported by the data in this study. The PLS test results in Figure 2 show that there is a significant impact of IIF on OA: the path coefficient is 0.368, which is significant at the 0.01 significant level ($p < 0.01$).

Together, with the finding on the relationship between BA-Use and OA, this study lends support to the claim that IT still matters (Kumar, 2004). Although some IT components may be commoditized and not scarce anymore, the IIF is not just a simple combination of those components. IT infrastructure is not just a black box. The dimensions of IIF clearly show that many characteristics of IIF cannot be bought. They need to be carefully cultivated so that other organizational capabilities can benefit from a flexible IT infrastructure. This suggests that a flexible IT infrastructure is a strategic resource that can help improve an organization's business performance by enhancing its OA.

BA-Use and IIF can explain 22% of the variance in OA. Although the explained variance of OA is not very high, the impact of BA-Use and IIF is significant on OA. These findings are in line with the expectation that OA is a complex emergent system property whose value is influenced by many factors from the two dimensions, detecting and responding, which include factors such as IT, organizational, management, business process, and others. BA-Use is one of the factors in the sensing/directing dimension and IIF is one of the factors in the responding dimension. The findings of this study show the important roles of BA and IT infrastructure in enabling an agile organization.

Relationships Between BA-Use and IIF—Mediation and Moderation Analyses

BA systems are IT-enabled information systems. One of the key success factors of BA systems is its ability to access and integrate a variety of data sources, then analyzing the integrated data to produce insights that can help decision makers form better decisions. Therefore, the more BA is used in an organization, the more it demands a flexible IT infrastructure to help to quickly integrate heterogeneous data sources. Another key factor for the success of BA systems is its ability to share results with whoever needs them and deliver results to wherever they are needed. So, BA-Use demands a more flexible IT infrastructure to be built to facilitate the accurate delivery of information to decision makers where it is needed and when it is needed. These two demands from BA-Use may influence an IT department's focus on building a more flexible IT infrastructure, and the results of this study support this proposition. The direct effect of BA-Use on IIF is significant: the coefficient is 0.357, which is significant at 0.01 level ($p < 0.01$). The hypothesis 3 (H_3) in this study is the first proposition in the

literature that connects IIF with BA-Use. Although only 13% of variance in IIF can be explained by BA-Use, the impact of BA-Use on IIF is significant. The small explained variance of IIF by BA-Use is understandable since IIF is affected by many other factors because an organization's IIF is not just responsive to BA-Use. This finding shows that flexible IT infrastructure is not only a key contributor for OA but also an important helper for BA-Use. Chen and Siau (Chen & Siau, 2012) tested the impact of IIF on BA-Use. The results of that study also show the significant impact of IIF on BA-Use. These results demonstrate a mutual influence between IIF and BA-Use. It is impossible to determine the nature of the reciprocal relationship between IIF and BA-Use with the cross-sectional data from this study. A longitudinal study will be needed to find how IIF and BA-Use influence each other. But the mediating effect may shed some light on the nature, which is discussed below.

Our research model implies that there is a mediation effect of IIF on the relationship between BA-Use and OA. We also provide a theoretical explanation on how IIF may mediate the BA-Use and OA relationship. The bootstrap method developed by Preacher and Hayes (2008) was implemented in SmartPLS 3.0 for testing mediation. Because the direct effect of BA-Use on OA was significant, we added the mediating variable IIF and tested the model using the bootstrapping method in SmartPLS 3.0 to obtain the indirect effect of BA-Use on OA through IIF. The summary results of mediation tests are presented in Table 5. There is a significant indirect effect of BA-Use on OA through IIF: the indirect path coefficient is 0.13, which is significant ($p < 0.01$). According to Hair et al. (2014), if the indirect effect is significant, the Variance Accounted For (VAF) should be calculated to determine the strength of the mediation. VAF is calculated using this formula: VAF = indirect effect / total effect * 100 (Hair et al., 2014). According to (Hair et al., 2014), a VAF value of greater than 80% is full mediation, a value between 20% and 80% is partial mediation, and a value less than 20% indicates no mediation. The VAF for the mediation effect of IIF on BA-Use and OA is 43%. The result indicates that IIF only partially mediates the effect of BA-Use on OA. As part of a post-test process, we also examined the mediation effect of BA-Use on IIF and OA. The indirect effect of IIF on OA through BA-Use is insignificant: the indirect path coefficient is 0.061, *p=0.058*. It indicates there is no mediating effect through BA-Use. The calculated VAF, 14.2%, also indicates there is no mediating effect of BA-Use on IIF and OA. BA-Use is one of the OA's detecting factors and IIF is one of the responding factors. These test results indicate that the two dimensions of OA may exert major influences on OA on their own, but not necessarily through each other. However, the partial mediating effect of IIF on the relationship between BA-Use and OA indicates that BA-Use's effect on OA may be partly due to the improved IIF. This may indicate that BA-Use encourages organizations to improve their IIF. This result also supports the awareness driver is a premise to the capability driver in the AMC framework and provides the first empirical links among the action enablers of the AMC framework.

From the perspectives of moderated mediation, fit theory, and system theory, we theorized that the interaction term between BA-Use and IIF may influence the organizational outcome OA. The proposal suggests a possible moderation effect of IIF on the relationship between BA-Use and OA. We tested the interaction relationship in SmartPLS 3.0. The summary results are presented in Table 6.

Following the recommendations from (Henseler & Chin, 2010), we tested the moderation effect using a two-stage calculation method, which first calculates the latent variable scores of the latent predictor (IIF) and latent moderator variable (BA-Use) from the main effect model without the interaction variable. Then, these latent variable scores are used to calculate the interaction variable by multiplying the scores of the predictor and moderator. Then, the effects on OA of the interaction variable, the predictor, and, the moderator are analyzed (Hair et al., 2014; Ringle et al., 2005). Although theoretically, there is a possible moderating effect of IIF on the BA-Use and OA relationship, the data from this study does not support the claim with the two-stage method. One possible explanation may be that our survey instrument only included three static components of IIF: connectivity, compatibility, and modularity. The dynamic component of IIF: IT personnel competency (Byrd & Turner, 2001; Duncan, 1995) was not included. The BA-Use's impact on OA may be more sensitive to IT personnel competency since BA-Use involves with new IT resources and potentially

Table 5. Mediation test results

Effects	Path	Path coefficient	Mediator	*p-value*	VAF	Mediating effect
Direct	BA-Use→OA	0.175*	N/A	*.017*	N/A	N/A
Indirect	BA-Use→IIF→OA	0.132**	IIF	*<.01*	43%	Partial
Direct	IIF→OA	0.368**	N/A	*<.01*	N/A	N/A
Indirect	IIF→BA-Use→OA	0.061^{NS}	BA-Use	*.058*	14%	No

N/A=Not Applicable
NS=Not Significant
**Significant at $p < .01$
*Significant at $p < .05$

new procedures. IT personnel competency has potential to improve users' effectiveness and efficiency to use BA for obtaining new data, analyzing the data to produce useful information, and helping them make better decisions regarding how to respond to opportunities and threats. Future studies may further test this assumption when data is available.

RESEARCH CONTRIBUTIONS, LIMITATIONS, AND FUTURE RESEARCH

Theoretical and Conceptual Implications

This study is one of the few empirical studies that investigate the importance of BA from the perspective of BA-Use. It employs sound theoretical lenses to posit that IT and IS components can be key contributors to OA. Moreover, it uses empirical tests to validate those propositions. The theoretical contributions of this research are manifold.

First, it is the first study that utilize the AMC perspective to theoretically justify the proposal that the essential dimensions of OA include detecting and responding. We also propose the potential modification of the OA definition to include the motivation component. Future studies may test the influence on OA with factors from the motivation driver of an action. Through the lens of OA, we also theoretically proposed and empirically tested the effect of BA-Use on OA. This is also one of the very first empirical studies to investigate the impact of BA-Use on OA. It provides a theoretical foundation for the advancement of BA's importance. This theoretical foundation shows why organizations need to be BA-based. This research encourages more empirical research on the significance of BA, especially the strategic impacts of BA. The original definition of IT and BA impacts include the outcomes of (1) new products/services, (2) redesigned business processes, (3) better decision-making, and (4) improved coordination and flexibility (Soh & Markus, 1995). We propose that the definition of IT impact may be redefined by changing the fourth element: improved coordination and flexibility to IT-enabled OA. The reasons for the proposal include (1) OA is the ultimate goal of coordination and flexibility. Therefore, OA reflects on coordination and flexibility; (2) the other components of the

Table 6. Moderation test results

Independent Variable	Dependent Variable	Moderator	Moderating Path Coefficient	*p*-value	Moderating effect
BA-Use	OA	IIF	0.004^{NS}	0.918	NO

definition conceptually define higher levels of business goals. Therefore, it is appropriate to use the more strategic concept in the definition.

Second, following the guidelines for developing a measurement for system usage, we developed a survey instrument for BA-Use that measured the user's activity with different features of BA systems. We selected the features according to the recommendations of industry experts and academic researchers. The final instrument is valid, reliable, and ready for use in future research.

Third, by theorizing that IIF could help the responding dimension of OA, we suggested an alternative way of viewing IT infrastructure as a strategic component for organizations. Through the lenses of OA and the AMC framework, we asserted that flexible IT infrastructure was an essential part of an organization's responding capability. From this study, it is clear that IIF is a major antecedent to OA in today's IT-enabled organizations. Since OA has a direct impact on organizational performance (Sambamurthy et al., 2003), it can be argued that IIF has strategic implications for organizations.

Fourth, the findings from this study suggested that BA-Use may encourage organizations to improve their IIF because BA-Use has a significant impact on IIF and BA-Use's impact on OA may be partially due to IIF. The results further show that there is a mutual influence effect between BA-Use and IIF although, with the cross-sectional survey data, we cannot make any conclusion regarding the nature of the reciprocal relationship between BA-Use and IIF and how they influence each other. The mediating effect of IIF also shows the importance of IIF in today's IT-enabled operation environment. The newly found relationship could help renew the interest in studying the influences of IT infrastructure on business organizations and new technological phenomena. It seems that MIS researchers have ignored the topic of IT infrastructure in the last decade although the period has witnessed rapid technological advancements and changes.

Fifth, although the data does not support our moderating effects of IIF on the BA-Use and OA relationship, it presents an interesting question for future studies. We believe that there is a theoretical foundation for this hypothesis. It is not supported by the data, most likely because IIF data does not include the information about the dynamic component of IIF. However, this can be tested in future studies.

Finally, we extended the existing research on IT value by providing insights on how BA and IIF could be connected with OA and why they should be treated as strategic assets. This study answers the call to promote studies on specific information systems and their idiosyncratic effects (Mukhopadhyay et al., 1995). It also answers the call for studies "to unlock the mysteries of an increasingly important, but complex, set of relationships between IT investments and firm performance" (Sambamurthy et al., 2003, p. 256). We believe that IT value research is a topic that requires the constant attention of IS researchers for MIS to stay relevant.

Practical Implications

In addition to research, this study has implications for practice. First, it provides insights into how BA interacts with other organizational resources to enhance OA. BA can create values with the right conditions. As an information system, the values of BA are built on IT infrastructure. This study shows that to effectively use and promote BA, organizations should pay more attention to build a flexible IT infrastructure so that their organizational agility can be optimally improved. As for the significant impact of BA-Use on OA, it shows that BA needs to be viewed as a part of the organization's strategic assets. Without BA-Use, an organization's agility may suffer.

Second, the findings remind organizational executives that IT infrastructure is not only a valuable platform that helps to enable communication internally and externally and to enable present and future business applications, but IT infrastructure is also a strategic component because it can contribute to OA. Attention should be allocated to various areas of IT infrastructure, such as IIF, to fully take advantage of IT to enhance an organization's agility.

Third, although prior research showed inconsistent results of implementing BA systems, this study suggested that BA had strategic values because of its contribution to OA through IIF. Some

companies may not have garnered the fruits from their investments in BA because they have not created the right conditions for implementing and using BA systems. Business leaders need to continually investigate the factors affecting the performance of their BA systems and provide resources to tackle the problems and issues that hinder the successful implementation of BA systems.

Limitations of this Study and Future Research

This study used cross-sectional data from one point in time. This does not provide historical information on how the independent variables (IIF and BA-Use) impact the dependent variable (OA) over time. There is a reciprocal relationship between IIF and BA-Use from the data as reflected by the results of this study and Chen and Siau (2012). The cross-sectional survey data cannot answer the question of how IIF and BA-Use influence each other. Future studies may collect data at different points in time to help us to understand the nature of the reciprocal relationship. This study supports the claim that IIF and BA have strategic values because they are major antecedents to OA that directly impact strategic capabilities. But to answer the question of whether IIF and BA can help OA in a long run, a longitudinal study is required to compare the impacts of IIF and BA-Use on OA over time. This cross-sectional design also makes it necessary to treat the results with caution because causality cannot be inferred from cross-sectional data. But a solid cross-sectional study provides a strong foundation for future longitudinal studies.

A single subject filled up a questionnaire. This may suggest that the results are subjected to common method bias. We used statistical tests, such as Harman's One-Factor test, partial correction analysis, and correlation analysis, as the post hoc tests to check for common method bias. The results show that common method bias in this study is minimal. Future studies could use a matched-pair design that uses two informants from each organization. For example, one can be a technical executive and the other can be a business function executive to further alleviate common method bias.

The model in this study is general and it is not restricted to a specific business activity. Therefore, we believe that this model is generalizable to various aspects of organizational activities, but it will be better to have other independent studies to verify the claim. Future research can look at specific business contexts. For example, future research can study the model in operation or custom relationship management to verify or falsify the model in a specific business context.

Due to the space limitation, this study only presents the relationship between BA-Use and OA as a whole. Future studies may investigate specific aspects of BA systems, such as data visualization, predictive data mining, and prescriptive data mining, and their influences on different aspects of OA, such as customer agility, operational agility, and operational agility.

This study suggests that IIF may play a critical role in enabling OA and mediating effect on the BA-Use and OA relationship. We recommend that future research investigate approaches to and ways of building flexible IT infrastructure. This includes investigating how to create IT infrastructure that facilitates connection and increases compatibility among subsystems, and how to make subsystems more modular so that they can swap in or out quickly.

The newfound relationship between IIF and BA-Use also suggests that it is necessary to conduct more research on how organizations should build their IT infrastructure with the technological advancements of the last decade. These advancements include cloud computing, social networking, ubiquitous computing through mobile devices and sensors (Siau & Zhen, 2002, 2006), distributed and Big Data databases, the Internet of Things, artificial intelligence, and augmented reality (Wang & Siau, 2019; Hyder et al. 2019; Siau 2018; Siau et al. 2018; Siau & Wang 2018). The literature review shows that very few studies in the last decade have focused on the effects of these technological advancements on IT infrastructure or vice versa. We have not found a study that investigates whether these technological advancements warrant new IT infrastructure or if existing IT infrastructure is sufficient to support them. We suggest that time is ripe to re-examine the IT infrastructure and its relationship with new technology advancements and new business requirements.

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