

# IMPACT OF BUSINESS INTELLIGENCE AND IT INFRASTRUCTURE FLEXIBILITY ON COMPETITIVE PERFORMANCE: AN ORGANIZATIONAL AGILITY PERSPECTIVE

*Research-in-Progress*

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## **Abstract**

*There is a growing usage of business intelligence (BI) for better management decisions in different industries. However, empirical studies on BI are still scarce. In this research we study BI from an organizational agility perspective. Organizational agility is the ability to sense and respond to market opportunities and threats with speed and BI can help the sensing part of organizational agility. Drawing on systems theory, dynamic capabilities framework, and literature on competitive performance, organizational agility, business intelligence, and IT infrastructure flexibility, we hypothesize that BI usage and IT infrastructure flexibility are two important sources for an organization's agility. We developed a research model to examine the effects of BI and IT infrastructure flexibility on organizational agility, which in turn affects an organization's competitive performance. IS managers will be the main pool of subjects for this research. We will use PLS to analyze the data.*

**Keywords:** Business intelligence, IT infrastructure flexibility, organizational agility, competitive performance, environmental turbulence

## **Introduction**

Agility is defined as an organization trait (Christopher and Towill 2002). Organizational agility is an organizational ability to successfully sense and respond to market opportunities and threats in a timely manner (Sambamurthy et al. 2003; Overby et al. 2006; and Watson and Wixom 2007). There is an established link between organizational agility and firm performance in MIS literature (Benaroch 2002; Sambamurthy et al. 2003; Fichman 2004; Benaroch et al. 2006). In strategic management literature, the dynamic capability has been proposed to explain how firms gain and hold competitive advantage (Teece et al. 1997). The dynamic capability framework also implies that organizational agility is a direct contributor to a firm's competitive performance.

Systems theory states that systems are composite things and possess properties (Von Bertalanffy 1968; Ackoff 1971; Checkland 1981). System properties can be properties of individual system components or properties of interacting relationships among system components. The latter properties are called emergent properties (Nevo and Wade 2010). Organizations are complex social systems. Organizational agility is one of the emergent properties. The sources of emergent properties come from both the components and their relationships (Holland 1998; Jackson 2000). Since organizational agility is the ability to sense and respond to market opportunities and threats, we see two source components that can help improve organizational agility: (1) the component that can help sense and detect market opportunities and threats, and (2) the component that can help to respond to market opportunities and threats in timely manner. Based on prior literature, business intelligence can help sense market opportunities and threats, and flexible IT infrastructure flexibility can help respond to market opportunities and threats. Therefore, business intelligence and IT infrastructure flexibility are two source components that can help improve organizational agility.

The use of business intelligence to make better management decisions is becoming more widespread in firms of different industries. BI is an umbrella term that "describes the technologies, applications, and processes for gathering, storing, accessing, and analyzing data to help users make better decisions" (Wixom and Watson 2010, p. 14). Studies have shown that companies that invested in BI and coupled it with good practices have seen increased revenue and huge cost savings (Watson et al. 2006). Nevertheless some companies that invested in BI did not see the promised benefits (Gessner and Volonino 2005). Jourdan et al. (2008) reviewed the BI literature up to 2006 on BI and indicated that although much BI research had been published, much of the research was still in the early stage (i.e., exploratory state). Although BI-based organization has been proposed (Watson 2009; Wixom and Watson 2010), empirical studies are scarce on why firms need to be BI-based and how other internal resources interact with BI to produce superior return on investment. We investigate these questions from the organizational agility perspective. Since BI can help gain knowledge on the trend of product and customer change, it can contribute to organizational agility by providing timely information to detect changing trends. Because of the ability to contribute to organizational agility, BI becomes a strategic component for a firm's competitive performance. Literature has shown there is a direct link between organizational agility and competitive performance.

The other contributing component to organizational agility is IT infrastructure flexibility. IT infrastructure flexibility can help organizations integrate and reconfigure internal and external IT resources to respond to market opportunities and threats. Therefore, IT infrastructure flexibility becomes a direct contributor to organizational agility. Nowadays, most organizations are IT-enabled, especially in industries with rapid product and customer changes. Prior studies have shown that IT infrastructure flexibility is a key factor for organizational agility and organizational performance (Akkermans et al. 2003; Sambamurthy et al. 2003; Tiwana and Konsynski 2010; Lin 2010; Bush et al. 2010; etc.). In this study, we research the relationship between IT infrastructure flexibility and organizational agility by investigating why and how IT infrastructure flexibility contributes to organizational agility. We also propose that IT infrastructure flexibility will strengthen the BI practice since BI is an IT-enabled system that is built on top of a firm's IT infrastructure and a flexible IT infrastructure will improve BI performance by providing more accurate and timely data and information with easily integrated data sources.

In short, this research studies the relationships between IT infrastructure flexibility, business intelligence, organizational agility, and competitive performance.

The remainder of the paper is organized as follows. Section 2 reviews the current literature and identifies the knowledge gap in business intelligence, IT infrastructure flexibility, organizational agility, and competitive performance. Section 3 presents the research model and the development of hypotheses. Section 4 describes the research methodology for this study. Section 5 discusses the potential contributions of this research.

## Literature Review

### **Agility and Competitive Performance**

Summarizing the prior definitions of agility from D'Aveni (1994) and Goldman et al. (1995), Sambamuthy et al. (2003) defined agility as “the ability to detect opportunities for innovation and seize those competitive market opportunities by assembling requisite assets, knowledge, and relationships with speed and surprise” (p.245). Li et al. (2008) reviewed the agility literature and defined agility based on two factors: “the speed and the capabilities of the firm to use resources to respond to changes”. Holsapple and Li (2008) also identified two dimensions of agility: alertness and responsiveness. In short, these definitions of agility in the business context indicate that agility is a firm’s ability to sense/detect (alertness) and act/respond (responsiveness) to changes with speed. The two key dimensions of agility are the ability to detect environmental changes with speed and the ability to respond to environmental changes with speed.

Tece and Pisano (1994) proposed the dynamic capability framework to explain how competitive advantage is gained and held. They argued that the competitive advantage of firms stems from dynamic capabilities, which include timely responsiveness and rapid and flexible product innovation, along with the management’s ability to effectively coordinate and redeploy internal and external competences. Teece et al. (1997) theoretically argued the direct link between dynamic capability and competitive advantage. We believe that organizational agility is part of firms’ dynamic capability because the term agility used in MIS context indicates the ability to sense and respond to opportunities and threats in business environments. The link was also established in prior MIS research between organizational agility and competitive performance (Sambamuthy et al. 2003; Lee et al. 2008). Our literature review on strategic management research also reveals that agility is a key contributor to competitive advantage. For example, Zaheer and Zaheer (1997) introduced the concepts of alertness and responsiveness, the two dimensions of organizational agility, and how organizations with great alertness and responsiveness can exercise higher market influence, which is a competitive advantage, in their industries. Based on the dynamic capability framework and the prior MIS and strategic management research on agility and competitive performance, we suggest a positive relationship from agility to competitive performance.

### **Flexibility**

In many operations management and MIS research works, there is no distinction between agility and flexibility; and when those terms were used, no definitions were provided. Often, those two terms are used interchangeably in these research papers. Nevertheless, agility and flexibility are defined differently in many research papers (see agility definitions in D'Aveni 1994, Goldman et al. 1995, Sambamuthy et al. 2003; see flexibility definitions in Duncan 1995, Byrd and Turner 2000).

Flexibility is broadly defined as the degree to which a thing is malleable. It refers to the ability to quickly and economically adapt the IS applications to changing business requirements in the MIS context (Kumar 2004; Schlueter 2006). Flexibility has been viewed as one of the firm’s capabilities that has influence on the firm’s speed to act or respond (Yusuf et al. 1999; Zhang and Shariff 2000; Tiwana and Konsynski 2010) and as an antecedent of agility (Swofford et al. 2006). Although flexibility could lead to quick action, flexibility has other aspects that are not related to speed. For example, an inflexible IT system can be quickly reconfigured to respond to changes, but with great cost to do so. Thus, agility and flexibility are two different concepts. Agility is about the speed to detect/sense or respond to opportunities and threats in the business context. Flexibility is about malleability and the ability to help respond to change requests both quickly and economically, and is a key antecedent of agility in a business context (Li et al. 2008; Tiwana and Konsynski 2010).

IT infrastructure is consistently defined in the literature as a set of shared IT resources that is a foundation to enable communication across the organization and to enable present and future business applications (Niederman et al. 1991; Duncan 1995; Byrd and Turner 2000). It not only includes the technological component but also the human component (Duncan 1995; Chanopas et al. 2006). IT infrastructure flexibility refers to the degree to which the firm's IT resources are malleable (Duncan 1995). The definition of IT infrastructure flexibility from Byrd and Turner (2000) and Byrd (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. Four key components of IT infrastructure flexibility have been identified in the literature. Connectivity, compatibility, modularity, and IT personnel competency were first identified by Duncan (1995) and Byrd and Turner (2000). Mishra and Agarwal (2010) added organizational cognition of IT technologies (technological frame) as another component of IT infrastructure flexibility.

In this study, we review the definitions of agility and flexibility and clarify the differences between the two frequently used constructs in the MIS literature. We emphasize that flexibility is one of the two contributing factors that improves agility: flexibility contributes to the responding dimension of agility. We will use the key components of IT infrastructure flexibility identified in the MIS literature to develop survey instruments to measure IT infrastructure flexibility.

### ***Business Intelligence***

Business intelligence is a new business-driven phenomenon that can add value for organizations. Watson (2009) defined BI as "a broad category of applications, technologies, and processes for gathering, storing, accessing, and analyzing data to help business users make better decisions." In this study, we adopt this broad definition of BI. At the conceptual level, BI is an umbrella term for systems and procedures that transform raw data into useful information for managers to make better decisions (Wixom and Watson 2010). At the operational level, BI is an information system that has three elements (Laursen and Thorlund 2010): (1) a technological element that collects, stores, and delivers information; (2) a human competencies element on the abilities of human beings to retrieve data and deliver it as information, to generate knowledge, and to make decisions based on the new knowledge; and (3) a third element that supports specific business processes that make use of the information or the new knowledge for increasing business values. To investigate the usage of BI in firms, we will need to look at the three aspects of BI.

Jourdan et al. (2008) reviewed the BI research published before 2006. One finding of their study is that BI research before 2006 focused mainly on exploratory research: formal theory and literature review, and very little survey research were conducted. The other interesting finding is that prior research only addressed new technologies and issues in BI without attempting to explain the fundamental issues of IS research as it relates to BI, such as generalizability and realism of context.

Although competitive intelligence (CI) was used in Wright et al. (2009)'s study, we believe CI is part of BI. Some other BI specific issues have been studied in recent years: critical success factors (Yeoh and Koronios 2010); intelligence strategy (Johannesson and Palona 2010); and intelligence maturity model (Lahrman et al. 2011). Prior literature also includes a few studies on BI and its contextual factors. For example, Muller et al. (2010) studied BI functions and how service-oriented architecture could help those functions. Seah et al. (2010) conducted a case study on culture and leadership role in BI implementation. Trkman et al. (2010) performed a survey study about the impact of BI on supply chain performance. Elbashir et al. (2011) researched the organizational capabilities that help with BI assimilation. Marjanovic and Roose (2011) carried out a case study to investigate how to integrate BI into business process improvement. Laursen and Thorlund (2010) provided an excellent illustration on what business intelligence is and how it should be carried out at different levels of organization: strategic level (strategic initiatives) and operational level (business process changes). These papers, however, did not address how complementary resources affect BI contribution to a firm's competitive performance and/or general firm performance, and therefore did not address the question of why firms need to be BI based.

Our literature review reveals that research works after 2006 also did not address the concerns raised by Jourdan et al. (2008) about generalizability and realism of context in BI research. From the organizational agility perspective, we propose that BI is a contributing factor to agility. BI can help to increase firms' ability to sense and detect environmental changes. Through agility, BI can help increase firms' competitive performance and becomes a strategic force for improving competitive performance.

**Environmental Turbulence**

In the integrative model of IT business value, Melville et al. (2004) emphasized the impacts of industrial characteristics on the relationship between IT enabled resources and firm performance. Turbulent environment is referred to as hypercompetitive environment (Mithas et al. 2011) and in general is defined as “general conditions of uncertainty” (Rai and Tang 2010, p. 521). El Sawy and Parlou (2008, p. 139) characterized a turbulent environment with “unpredictability arising from unexpected changes in market demand and consumer preferences, new technology developments, and technological breakthroughs.” They found that there are three types of capabilities that influence strategic advantage in such turbulent environments: 1) operational capabilities (ability to execute processes), 2) dynamic capabilities (the planned ability to reconfigure operational capabilities), and 3) improvisational capabilities (the learned ability to spontaneously reconfigure operational capabilities). It has been established in IT business value research that business environments affect the value of IT. Johannesson and Palona (2010) studied the influence of the gap between environmental turbulence level and strategic intelligence strategy on strategic intelligence function's success and found that the gap has negative impact on success. In general, it is agreed that IT creates value under certain conditions (Kohli and Grover 2008). How a turbulent environment moderates BI's value has not been thoroughly researched. In this research, we will investigate the impact of BI and IT infrastructure flexibility on competitive performance in a turbulent business environment.

**Research Model and Hypothesis Development**

Drawing on dynamic capability framework and current literature on BI, IT flexibility, organizational agility, and competitive performance, we developed our research model as shown in Figure 1.

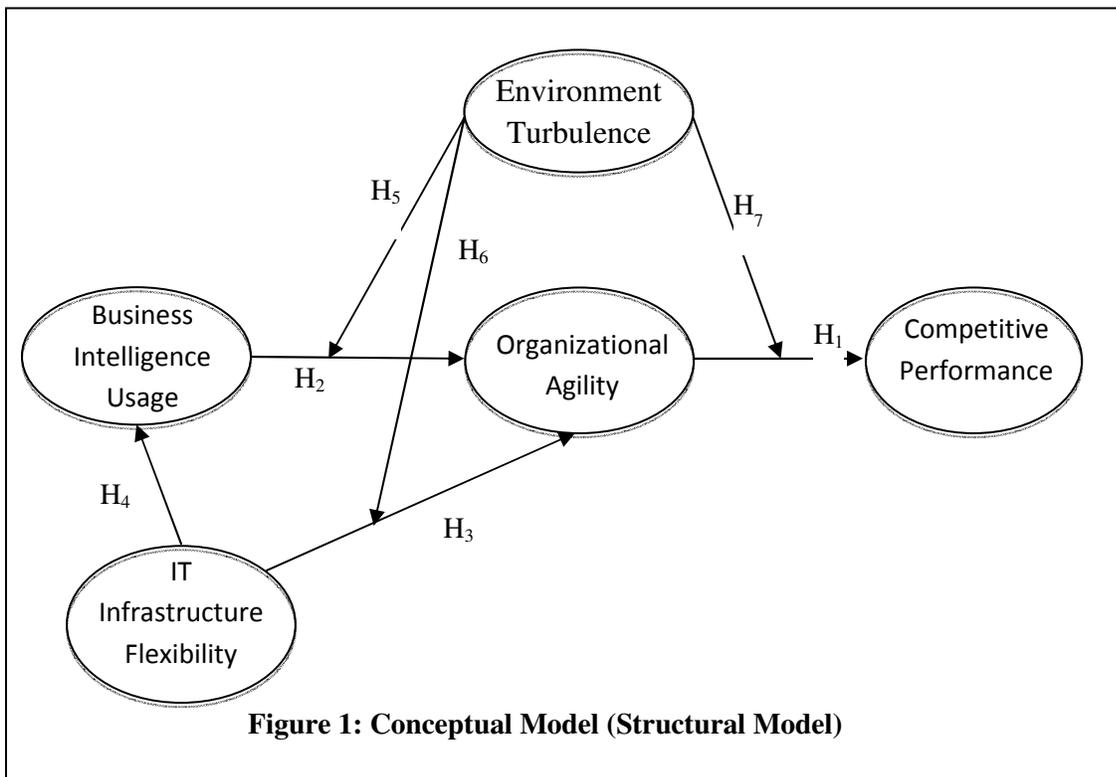


Figure 1: Conceptual Model (Structural Model)

As mentioned in the literature review section, dynamic capability framework (Teece et al. 1997) theoretically argues the direct link between firms' dynamic capabilities and competitive performance. Past research in MIS has also established the link between organizational agility and competitive performance (Sambamurthy et al. 2003; Lee et al. 2008).

Sambamurthy et al. (2003) argued that organizational agility comprises of three interrelated capabilities: customer agility, partnering agility, and operational agility. In general, Sambamurthy et al. (2003)'s categorization implies that organizational agility has three dimensions: customer, partner, and operation. Sambamurthy et al. (2003, p. 245) defined customer agility as "the co-opting of customers in the exploration and exploitation of opportunities for innovation and competitive action moves." Their definition of customer agility is narrowly related to co-creation of new ideas, products, and services. In this study, we use Holsapple and Li (2008)'s dimensions of agility: alertness and responsiveness to define customer agility. We view customer agility in a broader sense as organization's ability to sense and respond to customer changes in demand for products and services in a turbulent environment. Based on Venkatraman and Henderson (1998)'s research, Sambamurthy et al. (2003, p. 245) defined partner agility as "ability to leverage the assets, knowledge, and competencies of suppliers, distributors, contract manufacturers, and logistics providers through alliances, partnerships, and joint ventures." Operational agility is about ability of firms' operation processes to innovate and compete with speed, accuracy, and cost effectiveness. We are interested in how an organization's competitive performances are influenced by an organization's agility. We will collect agility data from the three dimensions of agility. Our first hypothesis is based on the dynamic capability framework and current MIS research on agility and competitive performance:

*H<sub>1</sub>: An organization's agility will positively impact its competitive performance.*

System theory defines systems as things and things have properties (Von Bertalanffy 1968; Ackoff 1971; Checkland 1981). Organizational agility is an emergent property whose sources come from two dimensions: one is sensing/detecting environmental changes and the other is acting/responding to environmental changes. We argue that the usage of BI in firms will help increase organizational agility by improving a firm's ability to sense/detect environmental changes.

The BI's contribution to organizational agility can also be found in current MIS research on the topic. The construct of information management capability (IMC) by Mithas et al. (2011) is an encompassing concept that includes functions provided by BI. They defined IMC as the ability to (1) provide data and information to users with the appropriate levels of accuracy, timeliness, reliability, security, and confidentiality; (2) provide universal connectivity and access with adequate reach and range; and (3) tailor the infrastructure to emerging business needs and direction. BI can play an important role in the first ability. Mithas et al. (2011) found significant positive influences of IMC on three organizational capabilities: performance management capability, customer management capability, and process management capability.

In this research, we study the relationship between BI and organizational agility, which includes customer agility, partner agility, and operation agility (Sambamurthy et al. 2003). Customer agility is an essential part of customer management capability and operational agility is part of Mithas et al. (2011)'s process management capability. Therefore, we have reasons to postulate that BI use can enhance an organization's agility. Furthermore, business intelligence collects, analyzes, and presents interpreted information to organization managers to help them make the right decision at the right time. Business intelligence can help organizational agility by detecting customer event patterns, identifying operational opportunities and bottlenecks, and revealing changes in partners' assets and competencies to managers so that they can sense, act, or make timely decisions. Therefore, business intelligence can help increase an organization's agility. Our second hypothesis is:

*H<sub>2</sub>: The use of business intelligence will positively impact an organization's agility.*

Because contemporary organizations are mostly IT enabled, organizational capabilities are often inseparable from IT (Ferrier et al. 2007; Pavlou and El Sawy 2010). Modern organizations are digitally enabled. Organizational actions are rarely executed without information technology. IT infrastructure

flexibility provides the means for IT to quickly respond to change requests from functional lines of business. From the systems theory perspective, IT infrastructure flexibility can be another contributing source component to organizational agility. IT infrastructure flexibility, together with business functional lines' process agility can improve a firm's ability to respond to or act on changes in competitive environments whether the changes are from customers, partners, or operations. Prior research in MIS also suggests the positive link between IT infrastructure flexibility and organizational agility (Sambamurthy et al. 2003; Tiwana and Konsynski 2010). Therefore, we propose the following hypothesis:

*H<sub>3</sub>: IT infrastructure flexibility will positively impact organizational agility.*

Business intelligence requires access to data from a variety of sources. A flexible IT infrastructure can help business intelligence easily and quickly access or integrate existing and new data sources. Therefore, we believe that a flexible IT infrastructure can increase business intelligence usage because more information can be easily available when needed. Our next hypothesis is:

*H<sub>4</sub>: IT infrastructure flexibility will positively impact BI usage.*

One theme that is common for the constructs discussed is speed. Organizational agility is about the speed to sense and respond to changes. BI is about helping managers make the right decision at the right time quickly and increase organizational agility. IT flexibility is about making the IT infrastructure malleable to quickly adjust to the ongoing changes in business environments. Obviously, the speed requirement varies among industries. An Internet company is probably more sensitive to customer changes than an educational institution. Therefore, a turbulent environment or a quickly changing environment in terms of customers' demands and preferences will require organizations to respond more quickly and cost effectively to increase competitive performances and to stay afloat.

Although El Sawy and Parlou (2008) mentioned that the IT infrastructure capabilities influence both dynamic and improvisational capabilities in turbulent environments, the things that they showed IT infrastructure could help were also things that could be helped by BI (e.g., effectively sensing the environment; acquiring, assimilating, and using knowledge by effectively coding, synthesizing, and sharing knowledge to generate new learning; and making information visible and accessible). Turbulent environments create more opportunities and crises for companies competing in the environments. BI can help organizations quickly sense those opportunities and threats. In turbulent environments, organizations will rely more on BI to sense and more on IT infrastructure flexibility to respond to opportunities and threats. Turbulent environments will amplify the effect of BI and IT infrastructure flexibility on organizational agility and in turn amplify the effect of organizational agility on competitive performance. Therefore, our next three hypotheses are:

*H<sub>5</sub>: Environmental turbulence will strengthen the positive impact of BI usage on organizational agility.*

*H<sub>6</sub>: Environmental turbulence will strengthen the positive impact of IT infrastructure flexibility on organizational agility.*

*H<sub>7</sub>: Environmental turbulence will strengthen the positive impact of organizational agility on competitive performance.*

## **Research Method**

### ***Data Collection***

We will test our research model using survey data. We will randomly select firms from various industries from business directories of executives, such as Dun Bradstreet's directory of executives. The targeted respondents for the survey are managers of IT function. We choose managers of IT function from each firm as our primary respondents because they are the operation managers who supervise the implementation and use of BI and manage the IT infrastructure, which are the two main constructs in our study. Managers of business (line) functions will also be contacted in each firm for BI usage, organizational agility, environmental turbulence, and competitive performance to address common methods bias, which refers to the degree to which correlations are altered (inflated) due to a method's effect (Meade et al. 2007). In addition to addressing the common methods bias, we choose to include managers of business (line) functions in our study because they have more insights on a firm's agility

capability, environmental turbulence, and competitive performance. Several waves of emails will be sent out to the selected executives to increase the response rate.

### **Data Analysis**

Partial least squares (PLS) will be used to assess the measurement model and to test the structural model. PLS is appropriate for this study because it is variance-based and places minimal restrictions on measurement scales, sample size, and residual distribution (Chin et al. 2003).

### **Conclusions**

BI has attracted much attention in the last several years from both business practitioners and academic researchers. After a survey of nearly 3000 executives, managers, and analysts from more than 30 industries and 100 countries, Lavallo et al. (2011) found that the top performers use BI in the widest possible range of decisions while lower performers use intuition for their decisions. A MISQ special issue (guest edited by Chen et al. 2010) on BI research illustrates the growing interests in BI research in academia. As pointed out by Jourdan et al. (2008), BI research works are still in the infancy stage and many works focus on defining concepts and exploring formal theories. Following the call to study effects of specific information systems (Mukhopadhyay et al. 1995; Pavlou and El Sawy 2010), we aim to investigate the effects of BI on a firm's competitive performances in this research and study how different resources, especially IT resources, in a firm interact with each other to affect competitive performances.

### **Potential Contributions**

The theoretical contributions of this research are four folds. First, from the lens of dynamic capabilities framework, we investigate how BI can help to increase firms' competitive performance and through which complementary resources can BI help to enhance competitive performance. Second, we want to clarify the concepts of IT infrastructure flexibility and IT agility in the literature and empirically test the relationship between the two concepts. Third, we extend the existing research on IT values by providing insights on how BI, IT infrastructure flexibility, and IT agility can be integrated into organizational capability to enhance competitive performance. Finally, we synthesize the research on IT infrastructure flexibility research and provide a holistic view on the formation of IT infrastructure flexibility. We also empirically test the formation of IT infrastructure flexibility based on the definition of IT infrastructure, which is defined as a collection of technologies, people, and processes that facilitates large scale connectivity and enables effective inter-operation of an organization's IT systems (Kumar 2004).

This study will also contribute to practice. First, it provides insights on how BI interacts with other organizational resources to enhance competitive performance. BI can create values with the right conditions. As an information system, the value of BI will be affected by IT infrastructure. Second, it reminds 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 that can contribute to competitive performance. Attention should be allocated to various areas of IT infrastructure, such as IT infrastructure flexibility, to fully take advantage of IT to enhance an organization's competitive performance.

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