Journal of the Association for Information Systems

Research Paper ISSN: 1536-9323

The Role of Business Intelligence and Communication Technologies in Organizational Agility: A Configurational Approach

YoungKi Park
George Washington University
ykpark@gwu.edu

Omar A. El Sawy
University of Southern California

Peer C. Fiss
University of Southern California

Abstract:

This study examines the role that business intelligence (BI) and communication technologies play in how firms may achieve organizational sensing agility, decision making agility, and acting agility in different organizational and environmental contexts. Based on the information-processing view of organizations and dynamic capability theory, we suggest a configurational analytic framework that departs from the standard linear paradigm to examine how IT's effect on agility is embedded in a configuration of organizational and environmental elements. In line with this approach, we use fuzzy-set qualitative comparative analysis (fsQCA) to analyze field survey data from diverse industries. Our findings suggest equifinal pathways to organizational agility and the specific boundary conditions of our middle-range theory that determine what role BI and communication technologies play in organizations' achieving organizational agility. We discuss implications for theory and practice and discuss future research avenues.

Keywords: Sensing Agility, Decision Making Agility, Acting Agility, Business Intelligence Technology, Communication Technology, Configurational Paradigm, Fuzzy-set Qualitative Comparative Analysis (fsQCA).

Varun Grover was the accepting senior editor. This paper was submitted April 9, 2016, and went through two revisions.

1 Introduction

Organizational agility—an organization's ability to quickly sense and respond to environmental changes in order to quickly seize market opportunities—is a key aspect of surviving and thriving in high-velocity environments (D'Aveni, Dagnino, & Smith, 2010; Overby, Bharadwaj, & Sambamurthy, 2006; Sambamurthy, Bharadwaj, & Grover, 2003). Prior IS studies have suggested IT as a key way to achieve organizational agility and investigated IT's impact on agility with diverse models and approaches (e.g., Chakravarty, Grewal, & Sambamurthy, 2013; Lee, Sambamurthy, Lim, & Wei, 2015; Lu & Ramamurthy, 2011; Overby et al., 2006; Roberts & Grover, 2012; Sambamurthy et al., 2003; Tallon & Pinsonneault, 2011).

While extant studies strongly suggest that organizations need IT to achieve organizational agility, little research has examined just how they do so at a high level of granularity. The literature has mostly treated IT as a single unarticulated construct measured at the organizational level; thus, we lack understanding about the critical IT components that organizations need to achieve agility and their detailed relationships. In today's pervasively digitized business environment in which information technologies have rapidly evolved to become more fused with business processes and in which enterprises both internally and externally use such technologies in their interactions with customers and partners (El Sawy, 2003; Yoo, 2010; Zammuto, Griffith, Majchrzak, Dougherty, & Faraj, 2007), organizations can collect data at every interaction and interface with business processes, supply chains, and customers (Chen, Chiang, & Storey, 2012; Wixom, Ariyachandra, Douglas, Goul, & Gupta, 2014). However, at the same time, the vast amounts of diverse types of data often create information overload, a situation in which organizations cannot process the big data in a timely manner and, thus, experience difficulty in sensing and responding to rapidly changing customer preferences, new emerging technologies, regulations, and competitors' moves in a timely manner (Jacobs, 2009; The Economist, 2010). In practice, to effectively handle the challenge of information processing in the current big data era, organizations have extensively developed data-centric approaches to business intelligence and communication, such as advances in techniques, technologies, and governance for data collection; data warehousing; analytics to extract intelligence from big data (Chen et al., 2012; Roberts & Grover, 2012; Tallon, Short, & Harkins, 2013; Wixom & Watson, 2001); and sharing information in and between themselves in real time (Malhotra et al., 2007; Sahaym et al., 2007). Such advancement in information technologies and data management can ostensibly help organizations to quickly sense and respond to important business events. However, we lack studies (except for some anecdotal and consulting reports) that explain how and under what conditions such BI and communication technologies enable organizations to achieve agility.

Accordingly, in this paper, we build a middle-range theory of IT-agility relationships that explains the role that BI technologies and communication technologies play in organizations' achieving agility in different organizational and environmental contexts. First, we conceptualize three key dimensions of organizational agility (i.e., sensing, decision making, and acting agility) based on the theoretical framework that views organizations as information processing and interpretation systems (Daft & Lengel, 1986; Daft & Weick, 1984; Galbraith, 1973; Houghton, El Sawy, Gray, Donegan, & Joshi, 2004; Morgan, 1986; Thomas, Clark, & Gioia, 1993) and dynamic capability theoretical articulations (Eisenhardt & Martin, 2000; Helfat & Winter, 2011; Peteraf, Stefano, & Verona, 2013; Teece, Pisano, & Shuen, 1997).

Second, we adopt a configurational theory approach to explain how IT and organizational and environmental elements simultaneously combine to produce agility. Zammuto et al. (2007, p. 755) suggest, "Attending to either IT or organizational aspects alone would not provide a complete picture" and that "by examining the process and outcomes of the *combination* process and how the organization and IT accommodate and support these combinations, new theories of organizational agility can be created" (emphasis added). To set a theoretical perspective for our study, we adopt this suggestion and argue that a configurational approach that focuses on combinations best applies to investigating the complex relationships between the three types of agility (sensing, decision making, acting) and the two types of IT systems (BI, communication technology) under different organizational contexts and environmental conditions. Accordingly, we adopt a corresponding method—fuzzy-set qualitative comparative analysis (fsQCA)—which can effectively handle the exponentially increasing complexity of a configurational perspective (Fiss, 2007; Misangyi et al., 2017; Ragin, 2008).

Third, by following the stream of IS research on the relationship between IT and agility (Chakravarty et al., 2013; Lee et al., 2015; Tallon & Pinsonneault, 2011), we empirically investigate the contingency effects of organizational contexts and environmental conditions on the relationships between IT and agility. We apply fsQCA to field survey data on 106 organizations from diverse industries and find multiple distinct configurations that produce high sensing agility, decision making agility, and acting agility, which suggests multiple equifinal pathways to organizational agility in which BI and communication technologies play different roles depending on the specific context.

Our study offers several contributions to the IT-agility literature[1]. First, we suggest a framework to conceptualize key constructs for IT-agility research by synthesizing the extant theoretical frameworks with a grounding in the information-processing view of organizations. This framework augments the traditional input-output box of the sense-response process by more fully and explicitly explaining the core tasks of interpreting captured events and making decisions for action. Second, we explain the complex dynamics of IT-agility with a holistic configurational approach. Instead of focusing on IT's unique effect on agility while holding all other factors constant, we show how IT and organizational and environmental elements combine into multiple configurations in different ways to achieve each type of agility. Our findings indicate that organizations may significantly depend on IT to produce agility in some configurations but that IT may be irrelevant or even counterproductive in other configurations. Third, we examine the relationship between BI and communication technologies and the three types of agility with specific boundary conditions in detail and suggest a middle-range theory with theoretical propositions that reflect agility's context specificity. Finally, we also offer a methodological contribution to the information systems research area by demonstrating the merits of applying a configuration approach and fsQCA to explicate the complex relationship between IT and agility in the form of configurations.

In combination, our research study offers a novel way of thinking about theory building in the context of the interconnected, non-linear digital world. It departs from the standard linear paradigm by charting a configural, equifinal approach to an important digital phenomenon, which results in different theory structures, propositions, and articulations. Thus, it opens up a novel path and structure for both theorizing and empirical analysis. Broadly, we view our study as part of an emerging neo-configurational perspective (Misangyi et al., 2017) that examines causal complexity through the logic of set theory.

This paper proceeds as follows: in Section 2, we conceptualize the main constructs of the study and explain our theoretical framework. In Section 3, we describe our research methodology, including a sample of data, measurement development, and fsQCA. In Section 4, we present the fsQCA results and interpret in detail multiple configurations of organizational agility. In Section 5, we suggest theoretical propositions for the roles of BI and communication technology in achieving agility. Finally, in Section 6, we discuss the study's theoretical contributions and implications to the literature on IT and agility and discuss future research avenues.

2 Theoretical Background and Research Model

2.1 IT and Organizational Agility

Studies that have examined the strategic management of information technologies to cope with rapidly changing environments have moved the conceptualization of dynamic capabilities conceived in the strategic management literature (e.g., Eisenhardt & Martin, 2000; Teece et al., 1997) in the direction of organizational agility (e.g., Overby et al., 2006; Sambamurthy et al. 2003). Researchers have formally defined dynamic capability as a "firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Teece et al., 1997, p. 516), which ultimately focuses on an organization's capability to effectively and efficiently address and manage environmental changes for superior performance. Thus, continuous environmental change requires organizations to develop and exercise dynamic capabilities that enable them to keep adjusting existing (or creating new) operational capabilities in order to sustain competitive advantage. Prior research has further noted that dynamic capabilities support very specific purposes and activities that typically depend on the context (Helfat & Winter, 2011; Peteraf et al., 2013; Winter, 2003; Pavlou & El Sawy, 2011).

Researchers have also realized that organizational agility is a manifested type of dynamic capability (Teece, Peteraf, & Leih, 2016). Organizational agility focuses on and is manifested by supporting organizational-level strategic tasks of sensing and responding to internal and external business events of environmental changes in a timely manner in order to seize opportunities and handle threats effectively and efficiently (Lee et al., 2015; Overby et al., 2006; Roberts & Grover, 2012; Sambamurthy et al., 2003). As we explain below, organizational agility enables a firm to adjust its existing techniques and routines or

[1] Here, the IT-agility literature means the literature on the relationship between IT and agility.

create new ways of acting in a timely manner to cope effectively with environmental changes regarding their customers, supply chains, technologies, regulations, and competition.

The IS research literature suggests that IT plays a central role in firms' achieving organizational agility, which Table 1 summarizes (ordered by date of publication).

Table 1. Selected IS Studies on Agility

Paper	Research type	Conceptualization: dimensions of agility	IT and agility relationships
Sambamurthy et al. (2003)	Conceptual theory development	Customer agility, partnering agility, and operational agility	IT generates digital options, which in turn enable agility.
Overby et al. (2006)	Conceptual theory development	Sensing agility and responding agility	Knowledge-oriented IT increases sensing agility, and process-oriented IT increases responding agility.
Lu & Ramamurthy (2011)	Empirical theory testing & development	Market capitalizing agility and pperational adjustment agility	IT enables agility. It does not find evidence of an inhibiting role of IT.
Tallon & Pinsonneault (2011)	Empirical theory testing & development	Customer agility, partnering agility, and operational agility	IT-business alignment has a positive impact on agility. It does not find a negative impact of IT on agility.
Nazir & Pinsonneault (2012)	Conceptual theory development	Sensing agility and responding agility	Both external and internal electronic integrations are required to increase organizational agility.
Roberts & Grover (2012)	Empirical theory testing & development	Sensing customer agility and responding customer agility	IT enables both customer sensing and responding capabilities through knowledge creating synergy and processing enhancing synergy. Alignment between sensing and responding agility types matters for competitive activities.
Chakravarty et al. (2013)	Empirical theory testing & development	Entrepreneurial agility and adaptive agility	IT has an enabling and facilitating impact on agility.
Lee et al. (2015)	Empirical theory testing & development	Proactiveness, radicalness, responsiveness, and adaptiveness	IT ambidexterity enables operational ambidexterity, which, in turn, increases organizational agility.

For example, prior research has shown that the ability to effectively manage and use IT resources enables and facilitates organizational agility (Chakravarty et al., 2013; Roberts & Grover, 2012). IT ambidexterity—the ability to simultaneously exploit and explore IT resources (Lee et al., 2015)—IT infrastructure flexibility (Lu & Ramamurthy, 2011), and the strategic alignment between IT and business (Tallon & Pinsonneault, 2011) all appear to play an enabling role in achieving agility. Further, organizational operational capability mediates and environmental dynamism, IS integration, and analytical capabilities moderate IT's impact on agility (Chakravarty et al., 2013; Lee et al., 2015; Roberts & Grover, 2012).

2.2 Conceptualization of Organizational Agility through a Sense-Response Process

IS studies have defined various types of agility in specific ways to best support their research foci and contexts (Table 1). For example, Sambamurthy et al. (2003) define customer agility, partnering agility, and operational agility; Lu and Ramamurthy (2011) define market capitalizing agility and operational adjustment agility; and Lee et al. (2015) conceptualize organizational agility as a higher-order construct that comprises four lower-order constructs (proactiveness, radicalness, responsiveness, and adaptiveness). Although these researchers conceptualized these types of agility from different theoretical perspectives, they all show some ways to effectively sense and respond to business events to capture market opportunities. In fact, some studies conceptualized "sense and response" as the two major components that comprise agility (e.g., Nazir & Pinsonneault, 2012; Overby et al., 2006). Moreover, most studies have not empirically operationalized and investigated sensing and responding agility and their relationships with IT, though some notable exceptions exist, such as Roberts and Grover (2012). More importantly, we believe that this two-step input-output conceptualization of the sense-response process may not fully and effectively reflect the whole process—especially for the core tasks of interpreting the captured events of environmental changes and making strategic decisions on how to respond to them.

In this study, we ground how we conceptualize organizational agility in the information-processing view of organizations (Daft & Lengel, 1986; Daft & Weick, 1984; Galbraith, 1973; Morgan, 1986; Thomas et al., 1993). This perspective and its theoretical constructs articulate and operationalize the detailed strategic tasks of an organizational sense-response process (which includes scanning, filtering, interpreting, deciding, learning about events of environmental changes, and making action plans to respond and adapt to such changes) from the informational capability perspective. Although the original definition of dynamic capabilities does not explicitly articulate the aspects of information capabilities for sensing and decision making, more recent studies include them as a core part of the dynamic capabilities for addressing environmental changes (e.g., Helfat & Winter, 2011; Pavlou & El Sawy, 2011; Peteraf et al., 2013; Teece et. al., 2016). Thus, we find that the information-processing view and dynamic capabilities conceptualizations naturally complement and mutually reinforce each other for building a theoretical framework with which we can effectively conceptualize organizational agility.

The theoretical framework that views organizations as information processing and interpretation systems has several fundamental assumptions (e.g., Daft & Lengel, 1986; Daft & Weick, 1984; Galbraith, 1973; Morgan, 1986). First, it posits that organizations are open social systems in that organizations and environments interact with each other and, thus, mutually depend on each other's changes. Second, organizations have cognitive systems, memories, communication systems that preserve and share knowledge, behaviors, norms, and values over time among managers who constitute the interpretation system. Third, organizational information processing is the core task of top managers, who interpret important business events, make strategic decisions, and create organizational action plans. Fourth, variation in the sense-response process across organizations is not random but systematic depending on organizational and environmental characteristics, which suggests that contingency effects influence agility. Lastly, unlike at the individual level, organizational-level information processing and strategic decision making must involve coordination and information sharing between top managers across multiple departments to sense and respond to rapidly changing environments in a timely manner.

Based on these assumptions, we extend the existing conceptualizations of agility and add decision making as a distinct element. We also treat sensing as input of information of new events, decision making as processing, and acting as output and, thus, more fully and explicitly represent the whole agility-building process. Specifically, we define three strategic tasks of the sense-response process (i.e., scanning (sense events), interpretation/decision making (giving meaning and making a plan to act), and learning/action) for which we conceptualize three types of agility: sensing agility, decision making agility, and acting agility.

Further, with these assumptions, we can select other theoretically relevant constructs for the sense and response process; that is, IT as a central nervous system to manage and share information and knowledge. We take a top-down view with the top management team as the key actor for all these strategic tasks and activities. We consider environmental velocity as a key contextual factor (Bourgeois & Eisenhardt, 1988; Eisenhardt & Martine, 2000; Mendelson & Pillai, 1998; Nadkarni & Narayanan, 2007). We also consider organization size as an important definer of context (Roberts & Grover, 2012; Harris & Katz, 1991).

Building on the dynamic capabilities theoretical framework and the "organizations as information processing and interpretation systems" framework (see above), we suggest and articulate an organizational sense-response framework with appropriate accompanying constructs. Figure 1 shows our framework.

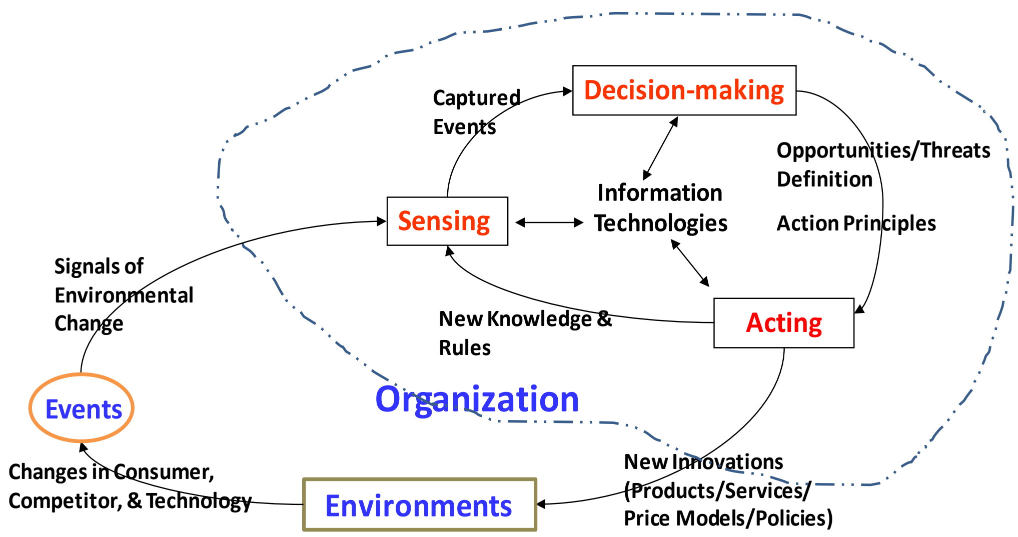


Figure 1. Organizational Sense-response Process Loop

From the organizational perspective, the framework articulates and describes how organizations reactively and proactively sense and respond to environmental changes manifested in strategically important business events and how IT systems support the three strategic tasks of sensing, decision making, and acting. The inter-related complexity between environments, organizations, and information technologies that this process loop depicts shows that one can better explain organizational agility with a configuration of such related elements, not by a single element. Thus, with this process, we can not only conceptualize agility but also explain how all the theoretically relevant elements combine to produce organizational agility. We consider organizational agility as a form of manifested dynamic capability and conceptualize it at a process level in an operationalized way through strategic event management tasks.

In Figure 1, the process that identifies and manages opportunities and threats generated from environmental changes comprises three strategic event-management tasks (i.e., sensing, decision making, and acting), and we emphasize that the top management team (TMT) plays a central role in the whole process:

- The *sensing* task refers to strategically scanning business events that manifest business environment changes that might have significant impact on organizational strategy, competitive action, and future performance (Daft & Weick 1984; Milliken, 1990; Thomas et al., 1993). The sensing task includes such activities as acquiring information about events of environmental change (e.g., customer preference change, competitors' strategic moves, emergence of new technologies, and new regulations) and filtering out relatively unimportant information (El Sawy, 1985). This task initiates decision making and acting tasks (Daft & Weick, 1984; Dutton & Duncan, 1987) that eventually lead to organizational reactive adaptations to environmental changes or proactive enactments of new environmental changes (Smircich & Stubbart, 1985; Weick, Sutcliffe, & Obstfeld, 2005).
- The *decision making* task refers to several inter-related activities that interpret the captured events and define opportunities and threats (Thomas et al., 1993). Organizations gather, aggregate, structure, and evaluate relevant information from diverse internal and external sources to understand the implications of the captured events to their business. Through these activities, they define opportunities and threats. Then, they decide and make an action plan of activities for maximizing the effect of opportunities and minimizing the effect of threats (Haeckel & Nolan, 1993; Houghton et al., 2004; Kester, Griffin, Hultink, & Lauche, 2011; Mendonça, 2007).
- The *acting* task refers to a set of activities defined in the action plan that explains how to reconfigure resources or adjust business processes in a way that initiates new competitive actions in the market (Daft & Weick, 1984; Teece et al., 1997). The acting task includes new competitive actions such as introducing new products/services and new pricing models to the market and changing policies with strategic partners and major customers (D'Aveni, 1994; Ferrier, Smith, & Grimm, 1999; Thomas et al., 1993). Organizations can also change extant business processes with different procedures and resources, or they can redesign organizational structure

(Thomas et al., 1993). These enacted events are new environmental changes to which other market players such as competitors, key customers, and suppliers may respond.

The model has open loops to the environment. Thus, a cycle of these tasks is also an organizational learning process, which creates new knowledge of environmental change and commands organizations to adjust or replace extant knowledge and rules. Organizations can store and manage this new knowledge in IT systems using knowledge databases or rule-bases and use it for the next cycle of the sense-response process.

In the framework we describe here, each type of agility represents distinct aspects of enterprise-wide agility for the core tasks, and organizational agility refers to an organization's ability to execute the constellation of all three tasks in a timely manner in order to seize market opportunities. We would expect that an organization with a high level of sensing, decision making, and acting agility can have faster experimentation cycles and more frequently introduce innovations to the market.

2.3 Information Technology Functionalities as a Central Nervous System for the Organizational Sense-response Process Loop

We explain how IT supports all the tasks for the whole sense-response process and focus on business intelligence (BI) and communication technologies due to their fit to the core tasks. The IS literature defines many different types of information technologies in a way that supports specific business tasks (Goodhue & Thomson, 1995; Sabherwal & Chan, 2001). For example, Zigurs and Buckland (1998) define three IT types (i.e., information processing, communication support, and process structuring technologies) that are relevant to group decision making tasks. Pavlou and El Sawy (2006, 2010) define three types of information technologies in a way that specifically supports new product development tasks. Roberts and Grover (2012) focus on the role of two dimensions (components) of IT infrastructure (i.e., Web-based customer tools and analytical tools) that can support customer sensing agility and the indirect magnifying role of IT infrastructure for customer responding agility. Tallon and Pinsonneault (2011) explain the moderating role of IT infrastructure flexibility on the main relationship between strategic IT alignment and agility. As such, based on the task-technology fit theory, studies on agility choose and focus on specific types of IT systems instead of including all types of information technologies.

We also have such a specific focus on the role of IT in the three core tasks of sense-response process from the view of organizations as information processing and interpretation systems, and we argue that BI and communication technologies can best fit the tasks. Based on the working assumptions of our framework (Daft & Weick, 1984), we argue that the functionalities that BI and communication technologies provide (e.g., those functionalities to capture, process, store, and share data, information, rules, and knowledge) form a central nervous system for the sense-response process. Through sensing and decision making tasks, organizations learn from new events and create new data, rules, and knowledge that BI systems store and managers across different business units and departments share via communication technologies, which, in turn, can effectively support collaborative action tasks. Thus, business intelligence (BI) technologies and communication technologies can best fit to the event management tasks in the sense-response process by sufficiently providing such functionalities that best support all the tasks. This task-technology fit can be further supported by the fact that they are most widely adopted by organizations to support the information processing tasks in the big data era and receive great attention from information systems research studies on agility (Chen et al., 2012; Houghton et al., 2004; Roberts & Grover, 2012; Watson, 2009; Wixom et al., 2014).

More specifically, BI technologies provide a set of functionalities that help one to effectively build, manage, and access enterprise-wide consistent data and extract patterns from complex big data, which supports sense-response tasks (Chen et al., 2012; Wixom & Watson, 2001). Specifically, BI technologies enable organizations to store and manage codified knowledge and rules, which, in turn, enable them to automatically monitor and keep watch for important business events (e.g., digital dashboard with workflow algorithms and rule-base). BI technologies also allow one to access enterprise-wide consistent databases (e.g., data warehouse) and include what-if analyses, data explorations, and visualizations, which may support timely decision making. In practice, in order to cope with rapid and uncertain business changes, organizations have extensively developed data-centric business intelligence systems, including data warehousing, data mining, balanced scorecard, digital dashboard, and online analytical processing (OLAP) solutions (Anderson-Lehman, Watson, Wixom, & Hoffer, 2004; Chandy & Schulte, 2009; Carte, Schwarzkopf, Shaft, & Zmud, 2005; Chen et al., 2012; Cooper, Watson, Wixom, & Goodhue, 2000; Houghton et al., 2004; Roberts & Grover, 2012; Watson, 2009).

Communication technologies provide a set of functionalities that support interactive communication and collaboration, such as real-time information dissemination and sharing with key stakeholders, two-way communication between co-workers, and real-time video/audio conferencing (Wagner & Majchrzak, 2007; Zigurs & Buckland, 1998). Exchanging information in a timely manner in and between organizations possibly enables them to quickly sense and respond to important business events (Malhotra, Gosain, & El Sawy, 2007; Sahaym, Steensma, & Schiling, 2007).

Table 2 summarizes the key functionalities and provides illustrative examples of BI and communication technologies that can effectively support all the tasks. In particular, for acting tasks, high-quality information and its seamless flow via BI and communication technologies in and between organizations can enable managers and different business units to effectively collaborate and execute operational processes, which enhances acting agility (Roberts & Grover, 2012, pp. 238-239; Dove, 2001; Haeckel, 1999). We add some examples in the table in order to help one easily understand BI and communication technologies. Many of the example technologies may provide the same functionalities. In any case, the functionalities are key characteristics that can sufficiently reflect what BI and communication technologies do and support for the tasks and, thus, enable one to investigate their roles in achieving agility. Accordingly, we measure each type of technology based on these key functionalities, not on the examples in Table 2.

Table 2. Information Technologies for Sense-response Tasks

Type	Key functionalities	Examples
Business intelligence (BI) technologies	• Providing access to multiple data sources • Rule-based exception handling • Alerting managers about business events • Accessing enterprise-wide consistent database • Supporting what-if analysis • Presenting data visually • Extracting patterns from data	Digital dashboards, balanced scorecards, data warehouses, data mining, OLAP, Web analytics
Communication technologies	• Disseminating relevant information to stakeholders in real time • Information sharing and interaction within an organization and with key partners • Real-time virtual video/audio conference	Video/audio conferences, collaboration systems (e.g., Yammer, Google Wave, Lotus Notes), mobile apps (e.g., SMS, digital bulletin board), help desks, instant messaging, Web 2.0, blogs, email.

Other types of information technologies may be able to support sense-response tasks as well, such as production and enterprise systems, supply chain management and customer relationship management systems. We understand the importance of such information technologies for supporting manufacturing and service delivery to customers, which may directly relate to acting tasks. However, we do not consider such technologies because our study focuses on organizations' information processing and interpretations. One could conduct another study to investigate the role of such other types of IT systems in firms' agility (e.g., Kharabe, Lyytinen, & Grover, 2013). Thus, in this study, we focus on these BI and communication technologies and their relationships with organizational agility.

2.4 Organizational and Environmental Elements

As we mention above, the information-processing view assumes that variation in the sense-response process across organizations depends on organizational and environmental characteristics, which suggests the importance of considering the contingency effects of environmental and organizational factors on the relationships between IT and agility. We include environmental velocity, TMT energy, and organizational size as key organizational and environmental elements.

2.4.1 Environmental Velocity

Agility as a type of dynamic capability specifically focuses on sensing and responding to environmental changes in order to seize opportunities and handle threats in a timely manner (Sambamurthy et al., 2003). While more environmental changes grow in speed and become unpredictable and discontinuous (Bourgeois & Eisenhardt, 1988; D'Aveni, 1994; Meyer, Gaba, & Colwell, 2005; Wiggins & Ruefli, 2005), studies on organizational dynamic capabilities and agility have not conceptualized environments as a single dimensional construct (Lee et al., 2015; Sambamurthy et al., 2003; Tallon & Pinsonneault, 2011). However, to develop a richer understanding of the relationship between business environments and organizational agility, it is helpful to go beyond one dimension (Davis, Eisenhardt, & Bingham, 2009; Eisenhardt, Furr, & Bingham, 2010; McCarthy, Lawrence, Wixted, & Gordon, 2010). Indeed, many studies call for conceptualizing environments with multiple dimensions instead of treating it as a single dimension (e.g., Davis et al., 2009; Eisenhardt et al., 2010) with, for example, industry clockspeed concepts (Mendelson & Pillai, 1998; Nadkarni & Narayanan, 2007) and industry velocity concepts (Bourgeois & Eisenhardt, 1988; Eisenhardt, 1989; Eisenhardt & Martin, 2000). Some studies (e.g., Bourgeois & Eisenhardt, 1988; McCarthy et al., 2010; Fiss, 2011) have conceptualized environmental change and velocity with two dimensions (speed and direction/unpredictability of a change—the two key dimensions of velocity in physics) and empirically measured and investigated the roles that the multiple environmental dimensions play in the dynamics of organizational configurations. These studies also provide some examples of different environmental types (e.g., McCarthy et al., 2010). Based on those studies, we define environmental change using the two key dimensions of velocity: *the speed of change* and *unpredictability*. The *speed of change* refers to the rate at which new events and opportunities emerge (Davis et al., 2009; Eisenhardt, 1989) and the rate at which new products and services are introduced (Mendelson & Pillai, 1998; Nadkarni & Narayanan, 2007). *Unpredictability*, which relates to the direction of environmental change, refers to the amount of disorder and whether it shows consistent similarity or a pattern (Davis et al., 2009). For example, the current desktop computer manufacturing industry may have fast speed and moderate or low level of uncertainty, while a new digital ecosystem based on digital platform (e.g., sharing economy, such as with Uber, Lyft, Airbnb) can exemplify rapidly and unpredictably changing environments. We investigate how these two dimensions of environmental change have distinct but combinatorial impacts on the role of IT for agility.

2.4.2 Top Management Team (TMT) Energy

Another important organizational factor to consider in the context of this study is the top management's role in managing business events (e.g., Eisenhardt, 1989; Hambrick, Cho, & Chen, 1996; Markus, 1983; Wixom & Watson, 2001). Hambrick (2007) has clarified—based a series of papers on upper echelon theory over twenty years—that focusing on a top management team's characteristics yields stronger explanations of organizational outcomes. The theoretical framework of information processing and interpretation (Daft & Weick, 1984) assumes that top managers are the most exposed to the environment and are the key players in charge of the strategic tasks of the sense-response process. According to TMT theories, TMT plays a critical role in an organization's successfully sensing and responding to environmental change (Eisenhardt, 1989; Hambrick et al., 1996; Houghton et al., 2004). TMT interprets important business events arising in environments and formulate organizational actions that respond to environmental changes and then drive actions (Daft & Weick, 1984; Kaplan, 2008). We conceptualize the role of TMT in this study as *TMT energy*. We define TMT energy as top managers' energy to steadfastly and energetically drive organizational changes to adapt to changing environments. One can reasonably assume that greater TMT energy will influence outcomes. Practitioners have identified the concept of TMT energy as a key influencer of organizational performance consistent with upper echelon theory (cf. Bruch & Vogel, 2011). TMT energy goes beyond simple support and opportunistic top management entrepreneurship and includes continuous proactivity and committed action in changing environments.

2.4.3 Organizational Size

Studies of strategic management and technology have demonstrated the importance that an organization's size (e.g., Fiss, 2011; Harris & Katz, 1991; Mabert, Soni, & Venkataramanan, 2003) plays in its ability to successfully adapt to changing environments. Thus, we include organization size as a key element since extant studies have widely adopted size as a key contingency factor to explain organizational behaviors and capabilities (e.g., Roberts & Grover, 2012; Harris & Katz, 1991) because different organization sizes may mean different levels of available resources, structures, and complexity. As we explain above, organizational level information processing and strategic decision involve coordination and information sharing between top managers across multiple departments. Thus, as an organization's size increases, information processing's complexity also increases due to the difficulties that managers from different departments face in coordinating and sharing information. To capture the effects of organizational size, we consider various proxies of organization size such as the number of employees, sales revenue, gross capital, and industry type. Thus, our construct for organization size contains rich information to better capture the diverse effects of organization size on agility.

2.5 Research Model and Approach

Agility as a type of dynamic capability views the source of competitive advantage not as independent individual elements but as configurations of organizational resources, IT, and competencies (El Sawy, Malhotra, Park, & Pavlou, 2010; Teece et al., 1997; Sambamurthy et al., 2003). Thus, a configurational approach best supports this view of organizational strategic competitiveness by explaining how the IT and organizational and environmental elements combine into bundles to make the outcome of interest. Figure 2 depicts the nomological network of our research. The figure illustrates the configuration paradigm we used to build a context-specific middle-range theory that explains complex simultaneous interactions between all the elements and that suggests specific, not general, prescriptive causal recipes to produce organizational agility depending on specific organizational and environmental contexts.

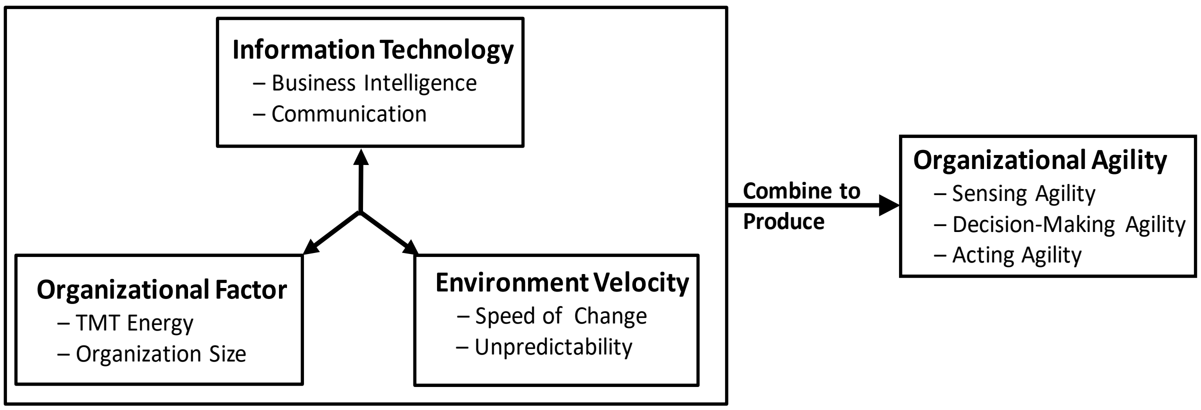


Figure 2. Nomological Network of Configurations Producing Agility

Note that, in the current study, we align the configurational approach and fsQCA methods and use them in a retroductive way that embraces the view that social research advances most when it involves an iterative dialogue between ideas and evidence (Ragin, 1994). With this retroductive theory-building approach—also known as an abductive approach (Locke, Golden-Biddle, & Feldman, 2008; Van Maanen, Sorenson, & Mitchell, 2007)—we select and define theoretical concepts and ideas about IT and agility based on existing theories of agility and the information-processing view of organizations and on context-specific knowledge or past unmet expectations or findings. Then, we devise a theoretical framework that helps us collect empirical data and evidence and that further drives our theory elaboration and building about the IT-agility relationship. Therefore, we create a context-specific middle-range theory that comprises configurational propositions or hypotheses that others can further develop and advance with the retroductive approach or the deductive theory-testing approach. Thus, we build the findings and theoretical inferences that we present in this study with a retroductive theory-building approach, which is distinct from a traditional purely deductive approach that relies on only theoretical logic rather than evidence to create hypotheses and from a traditional purely inductive approach that focuses on directly observing and avoiding theory testing. We believe that, for social science research topics in which concepts are not all clear or knowledge is fragmented and inconsistent, this approach is particularly useful, and the configuration approach with fsQCA methods that we use in this paper particularly suits such topics. For example, Misangyi and Acharya (2014) address the inconsistent arguments and findings of corporate governance studies. They argue that one main reason for the inconsistent findings is the traditional research approach that adopts deductive theory testing with correlation-based analyses. Then, using fsQCA with a retroductive approach, they investigate how key governance mechanisms combine and interact with each other to make the outcome of interest. Based on the findings of configurations, they suggest theoretical propositions that can reconcile the inconsistencies in extant studies. Bensaou and Venkatram (1995) also adopted this approach: they develop a conceptual model on inter-organizational relations and derive a set of constructs and corresponding operational measures. Then, they empirically investigate how the elements naturally combine together and show consistent patterns, and they eventually suggest a configuration-based middle-range theory. One can find more examples that use this approach in the management literature (e.g., Misangyi et al., 2017; Crilly, 2011; Crilly, Zollo, & Hansen, 2012). For more information, in Appendix A, we provide a table that compares our research approach with traditional deductive correlational approach and inductive case study approach.

3 Data and Set-theoretic Analysis

3.1 Data Collection

We collected survey data from senior managers in Korean companies in diverse industries that differed in their level of environmental dynamism. Korea is well known for its advanced information technologies and network infrastructure; for example, it ranks first in high-speed Internet coverage in the world, and its economy relies heavily on the high-tech industry. Further, Korea has a “Pali-Pali culture” marked by a strong preference for fast service that reduces wait time (Braun & Röse, 2007), which makes the context particularly relevant for understanding agility. Our sample data include a broad array of companies associated with major Korean business schools. This sampling frame suits our study given that we explore the dynamics of the sense and response process of companies across a variety of different environments. Further, non-random sampling does not present a problem from a statistical perspective due to the non-parametric nature of our fsQCA analysis, and, in fact, we follow several influential studies of organizational configurations that have for the same reasons employed non-random sampling based on research contexts (e.g., Doty, Glick, & Huber, 1993; Fiss, 2011; Ketchen, Thomas, & Snow, 1993).

A total of 218 managers from 106 firms from diverse industries completed surveys; we received multiple responses from 47 firms. We excluded all incomplete responses from data analysis. The firm-level response rate was 93 percent. The sampling method we used, which relied on personal contacts or interviews before administering the survey questionnaires, may explain this high response rate. For the firms with multiple responses, we calculated average scores across items for each construct so that we averaged out the biases of individual responses. The intra-class correlation coefficient (ICC) was relatively large, with 25.7 percent of the total variance’s being accounted for purely by grouping responses into firms (Luke, 2004, pp. 18-21; Raudenbush & Bryk, 2002, p. 71). Appendix B shows detailed descriptive statistics of our sample data in terms of survey participants and firms.

3.2 Measurement and Validation

Whenever possible, we used existing scales from the literature in order to increase reliability and validity. When we had to develop new measures, we followed scale-development procedures (Bagozzi & Phillips, 1982; Boudreau, Gefen, & Straub, 2001). To develop items for measuring sensing, decision making, and acting agility, we referenced existing scales of market orientation capabilities (Jaworski & Kohli, 1993) and the major features of each type of agility as we explain in Section 2.2. Although we did not directly use all the items for market intelligence generation (sensing), response design (decision), and implementation (action) from Jaworski and Kohli (1993), the items helped us to develop our survey items in a way that fully reflected the main characteristics of each type of agility.

We used three items for measuring the speed and unpredictability of change in customers, competitors, and technologies (Daft, Sormunen, & Parks, 1988; McCarthy et al., 2010). We developed new items for measuring IT based on the major functionalities for BI and communication technologies. We developed two new items to measure TMT energy. We measured all variables with multiple items on a seven-point Likert scale (see Appendix C for final items).

Before administering the full-scale survey, we conducted a pilot survey with industry managers, business school professors, and business PhD students to test the face and content validity of the survey. We corrected such problems as equivocal wording, syntax errors, overuse of jargon, not enough time to finish the questionnaire, and any biased factors in the scale (Babbie, 1973). Then, we translated English to Korean using a translation committee approach (van de Vijver & Leung, 1997), which previous IT studies have proven to be valid and useful (e.g., Lee et al., 2015). A committee of bilinguals that comprised four business professors participated in the translation. After translating the questionnaire to a Korean version, we tested it with managers of Korean companies and corrected all possible problems in the same way we corrected problems in the English version.

Table 3 presents the descriptive statistics and correlations for all constructs. Composite reliabilities were greater than 0.9 for all constructs, which indicates sufficient internal consistency (Nunnally, 1978). All Cronbach alpha values were greater than 0.8, which evidences reliability (Bagozzi & Edwards, 1998; Fornell & Larcker, 1981). The average variance extracted (AVE) values for individual constructs were greater than their correlations with other constructs and greater than 0.8. Further, all standardized-item loadings resulting from a factor analysis were greater than 0.7 and loaded on their corresponding factor (described in Appendix D). Thus, all these validity tests confirmed that our constructs have discriminant and convergent validity (Chin, 1998; Gefen, Straub, & Boudreau, 2000). In addition, we applied Harman's single-factor test and found no evidence of common-method bias due to our using a single method (i.e., survey) to collect data (Podsakoff & Organ, 1986). Eight factors were extracted from the data with Eigenvalue greater than one, corresponding to the latent variables in this study.

Table 3. Correlation and Composite Reliability for Principal Constructs

	Item #	Mean	St.dev	Reliability	Cronbach α	SPD	UNP	SEN	DM	ACT	BI	COMM	TMT
Speed (SPD)	3	4.92	1.10	0.92	0.87	**0.89**							
Unpredictability (UNP)	3	3.97	0.91	0.89	0.81	0.30	**0.85**						
Sensing (SEN)	3	4.73	1.00	0.92	0.88	0.20	0.09	**0.90**					
Decision making (DM)	5	4.26	0.95	0.91	0.88	0.11	0.05	0.21	**0.82**				
Acting (ACT)	7	4.24	0.94	0.92	0.89	0.34	0.08	0.20	0.28	**0.78**			
Business intelligence (BI)	6	3.98	1.03	0.95	0.93	0.31	0.21	0.33	0.19	0.52	**0.86**		
Communication (COMM)	6	4.38	1.00	0.93	0.90	0.22	0.07	0.40	0.14	0.29	0.57	**0.82**	
TMT energy (TMT)	2	5.05	1.10	0.97	0.94	0.16	0.20	0.37	0.26	0.38	0.44	0.41	**0.97**

The diagonal shows the square roots of average variances extracted (AVEs).
Correlations greater than 0.30 were significant at the 0.01 level; those greater than 0.23 were significant at the 0.05 level.

3.3 Set-theoretic Analysis with fsQCA

In line with our configurational approach, we used fuzzy-set qualitative comparative analysis (fsQCA), a set-theoretic method, to explore how the key elements systemically combine into configurations. In doing so, we could elaborate, build, and test configurational theories (e.g., Crilly, 2011; Crilly et al., 2012; El Sawy et al., 2010; Fiss, 2011; Greckhamer, 2011; Misangyi & Achara, 2014; Misangyi et al., 2017; Pajunen, 2008). While we cannot explain this method in depth here, we briefly explain the key concept and steps of fsQCA that pertain to our study[2].

As a research approach, fsQCA provides several unique benefits for effectively describing the complex relationships between multiple elements that stem from its using set theory, Boolean algebra, and counterfactual analysis. fsQCA primarily focuses not on identifying the net effects of individual independent variables on an outcome but on identifying causal "recipes" (Ragin, 2000) associated with an outcome—in our case, on showing how multiple IT and organizational and environmental elements simultaneously combine to produce the outcome of interest. Unlike the traditional interaction term in regression analysis that tends to be limited to three-way interaction effects (cf. Fiss, 2007; Ganzach 1998, Drazin & Van de Ven 1985), fsQCA can handle the complex multi-way relationships in which all elements theoretically relevant to the outcome participate, which reduces concern that unobserved heterogeneity may cause (Grewal, Chandrashekaran, Johnson, & Mallapragada, 2013; Chakravarty et al. 2013). Further, QCA overcomes the main limitations of the traditional cluster analyses that find clusters of homogeneous cases based on empirical data without theoretical foundation and control over the outcome and, thus, cannot explain why and how the clusters are made. QCA allows researchers to theoretically select the outcome of interest and possible causes relevant to the outcome and then determine how the causes combine into multiple bundles that produce the outcome. As such, it enables researchers to examine the role of each element in achieving the outcome. Fiss (2007) and Vis (2012) compare QCA and other analysis methods in more detail.

3.3.1 Calibration

Using fsQCA requires one to calibrate the attributes[3] and outcomes into set-membership scores. Calibration defines the extent to which a given case has membership in the set of, for example, a high level of organizational agility. Ragin's (2008) direct methods of calibration are based on three qualitative anchors: full membership, full non-membership, and the crossover point of maximum ambiguity regarding membership of a case in the set of interest. A researcher should define these three anchors based on empirical and theoretical knowledge of the context and cases (Ragin 2000, 2008). For example, Fiss

[2] One can find detailed, in-depth explanations and guidelines for fsQCA in several papers and books (e.g., Fiss, 2007; Ragin, 2008; Rihoux & Ragin, 2009).
[3] In QCA, element, attribute and causal condition represent the same meaning and, thus, can be used interchangeably (Rihoux & Ragin, 2009).

(2011) defines ROA of 16.3, 12, and 7.8 percent as anchors for full membership, cross-over, and full non-membership, respectively, in the set of high firm performance by referring to external industry reports about firm performance in the U.K and U.S manufacturing industries. Calibration allows a researcher to tie attributes of cases to substantive theoretical concepts and more exactly define a group of cases that have similar memberships (i.e., a clear boundary of contingency effects) (Fiss, 2011; Ragin, 2008). We used Ragin's (2008) direct method of calibration implemented in the fsQCA 2.5 software package, which transforms a variable into a fuzzy set using the metric of log-odds and the distance of the variable value from the crossover point with the values of full membership and full non-membership as the upper and lower bounds (Ragin, 2008). The resulting fuzzy membership score are between 0 and 1: 0 indicates a full non-membership and 1 indicates full membership.

By following the guideline of calibration for survey measurement (e.g., Fiss 2011; Misangyi et al., 2016, p. 9), we defined the three anchors of memberships using a seven-point Likert scale (1 = "strongly disagree", 4 = "neither agree in nor disagree", 7 = "strongly agree"). Specifically, we defined a value of 6 as the full membership anchor for the set of high-agility, 2 as the anchor for full non-membership, and 4 as the crossover point (i.e., a qualitative status of a case as "not in nor out in the set" of agility). Thus, instead of calibrating based on the sample statistics, we used the qualitatively defined scale for calibration, which we believe reflects reality more exactly. We recognize that some elements (e.g., TMT energy and environment speed) had a high average around 5 (Table 3). However, we do not see such values as containing bias or resulting from a mistake in measurement; rather, we see them as reflecting a reality that there are more firms in highly turbulent environments and with high levels of TMT energy. However, to further validate our calibration, we conducted sensitivity analyses with a value of 7 as the threshold for full membership. However, we obtained substantially similar results, which supports the appropriateness of our calibration. Appendix A provides a more detailed explanation.

We applied this same calibration to other variables except for organization size. We define organization size as either large (1) or small/medium (0). Regarding organization size, we follow the definition provided by the Small and Medium Business (SMB) Administration, the Korean Government agency that administers small and medium-sized companies (http://smba.go.kr/eng). This definition considers not only the number of employees and sales revenue but also other factors such as gross capital, industry type, and whether the company is a subsidiary of a larger company. Thus, this definition can more comprehensively measure the effects of firm size on organizational agility and also captures some external effects such as government support for a company, which can change depending on whether a firm is a SMB or large company. Thus, in our measurement, a firm size as either large or SMB is not determined by a single traditional measure of firm size. Rather, the traditional measures of firm size such as sales revenue and the number of employees are more appropriately used together with a firm's other characteristics for defining it as an SMB or large company. In our measurement, the same amount of sales revenue or the same number of employees can represent an SMB in one industry but a large business in another industry, because, for example, the Small and Medium Business Administration of Korea defines a company with fewer than 300 employees or with gross capital less than $8M as a SMB in the manufacturing industry but a company with fewer than 100 employees and less than $10M in gross capital in the wholesale industry as a SMB.

3.3.2 Truth Table Analysis

After calibration, to use fsQCA, one next needs to apply the truth-table algorithm (Ragin, 2008) that identifies combinations of elements that produce the outcome of interest. A truth table includes all logically possible combinations of the elements, and each row corresponds to one combination. In Appendix E, we present truth tables for all types of agility. For example, Table E2 is the truth table of sensing agility, and each row combines the causal conditions for high sensing agility. In the truth table, the "number" column shows the frequency of cases allocated to each combination. We set the minimum acceptable frequency of cases at three and, thus, consider combinations only with at least three empirical instances for subsequent analysis.

The truth table algorithm then calculates a consistency score that explains how reliably a combination results in the outcome, a measure roughly comparable to the significance level in standard econometric analysis. fsQCA contains two kinds of consistency: 1) raw consistency, which is calculated analogously to crisp set consistency but in addition gives credit for "near misses" and penalties for large inconsistencies; and 2) proportional reduction in inconsistency (PRI) consistency, an alternate measure of consistency that additionally eliminates the influence of cases that have simultaneous membership in both the outcome and its complement (i.e., y and ~y). In this study, we rely on both raw consistency and PRI consistency.

That is, for rows (i.e., combinations of conditions) that satisfy the frequency threshold, we set 0.9 as cutoff for raw consistency and 0.75 for PRI consistency, which means that we considered only combinations with a raw consistency of at least 0.9 and a PRI consistency of at least 0.75 as reliably resulting in agility. In the truth table, the agility column shows a value 1 for the combinations with raw consistency higher than 0.9 and PRI consistency higher than 0.75 or otherwise 0. With the truth table assembled, we next apply the truth table algorithm (Ragin, 2008) to reduce the numerous combinations into a smaller set of configurations based on the QM algorithm and counterfactual analysis[4].

As an analysis method, fsQCA can identify multiple equifinal configurations associated with an outcome, which means that a system can reach the same outcome through different paths from different initial conditions (Fiss, 2007, 2011). Across the configurations, IT may play a different role as part of a causal "recipe" for the outcome, which means that the status of other elements in a configuration determines IT's role in an organization's achieving agility. Thus, IT may be essential for producing agility in one configuration but may be irrelevant or even counterproductive in another configuration. Lastly, with fsQCA, we can identify which element or a set of elements are necessary and/or sufficient conditions for the outcome of interest and, thus, provide insight into two core aspects of causality (Ragin 2000, 2008; Rihoux & Ragin, 2009). In Section 4, we present a necessary condition for agility and then multiple configurations that sufficiently produce agility from which we extract patterns to achieve agility.

4 Set-theoretic Configurational Analysis Results

4.1 Identifying Necessary Conditions

Due to its set-analytic nature, fsQCA allows one to identify both necessary conditions and sufficient solutions for agility (Ragin, 2008; Rihoux & Ragin, 2009). Specifically, if the value of set membership of an element is essentially always equal to or higher than value of set membership in the outcome, then that element is a candidate for a necessary condition. Figure 3 is a fuzzy-set membership plot that depicts the membership distribution of cases in terms of TMT energy and sensing, decision making, and acting agility. Most cases appear below the diagonal and much fewer cases just above the diagonal, a pattern consistent with a necessary condition. We confirmed this result via a necessary condition test that fsQCA provides. Our findings indicate that consistency values of TMT energy for decision making and acting agility were 0.94 and 0.92 and, thus, above the typically used threshold of 0.90 and that coverage values (the proportion of the outcome covered by this condition) were 0.73 and 0.71, which indicates that TMT energy was a widely shared antecedent for decision making and acting agility. Further, consistency of TMT energy for sensing agility was 0.88 and coverage was 0.82, which indicates an empirically relevant, valid-necessary condition (Ragin, 2008, p. 53). Based on this evidence, we identified TMT energy as an almost always necessary condition for agility, which means that, with few exceptional cases, an organization needs it to achieve agility. We further conducted sensitivity analysis to evaluate whether this finding was robust to the use of different calibrations. Given that the sample average of TMT energy was quite high (5.05), we increased the value for full membership to 7 (i.e., maximum value) while keeping the values for cross-over and full non-membership as before at 4 and 2. The consistency and coverage values for this alternative calibration of TMT energy regarding the three outcomes were quite similar at 0.86 and 0.86 for sensing, 0.92 and 0.77 for decision making, and 0.91 and 0.75 for acting agility. These results confirm TMT energy as a valid, almost-always necessary condition for each type of agility. This alternative calibration also had essentially no effect on subsequent analyses, and, thus, we found the same configurations with similar consistencies and coverages. In Appendix E, we present the results of the necessary condition test for all elements and the truth tables for all types of agility.

[4] Methodologically, fsQCA relies on Boolean algebra that allows for the logical reduction of all theoretically possible combinations. Further, fsQCA uses counterfactual analysis to overcome the limitations of a lack of empirical instances (Ragin, 2008, p. 162). This counterfactual analysis allows one to distinguish between "easy" and "difficult" counterfactuals where "easy" counterfactuals deal with empirically unobserved combinations that add a condition and "difficult" counterfactuals deal with empirically unobserved combinations that omit a condition. This truth table algorithm results in three kinds of sufficient solutions: a complex one that uses no counterfactuals, an intermediate one that uses only "easy" counterfactuals, and a parsimonious one that uses both "easy" and "difficult" counterfactuals.

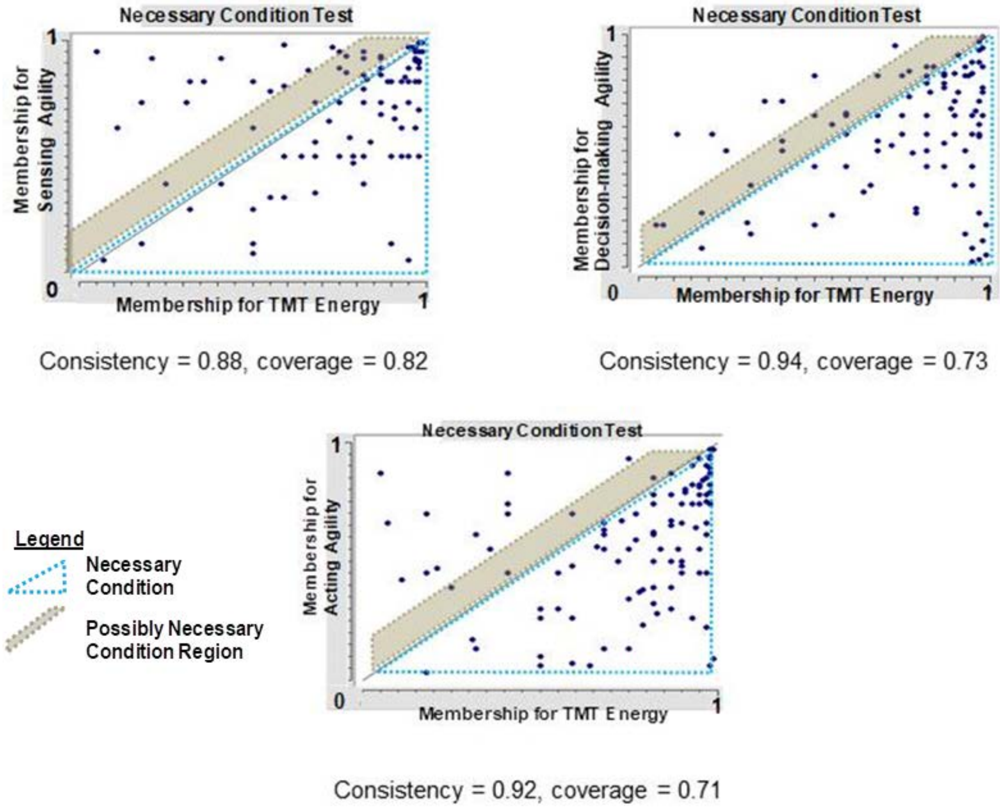


Figure 3. Membership Plot for Checking TMT Energy as a Necessary Condition

4.2 Identifying Sufficient Solutions for Agility

Next, we focused on identifying causal recipes sufficient for agility using truth table analysis (Ragin, 2008). Table 4 presents the fsQCA results in the Boolean expression for intermediate and parsimonious solutions: + means logical OR, * means AND, and ~ means negation. For example, for sensing agility, our findings indicate a parsimonious solution with two recipes (i.e., two combinations of elements producing high sensing agility): BI*OrgSize + TMT*OrgSize → sensing agility, which one can interpret as that large organizations with a high level of BI or large organizations with high TMT energy are likely to produce high sensing agility. Further, the results show an intermediate solution with three recipes for sensing agility. Here, the elements in the parsimonious solution are embedded in the intermediate solution, marked as a bold font, and these elements are core conditions that have a strong causal relationship with the outcome. On the other hand, the elements that appear only in the intermediate solution are peripheral conditions that have a relatively weaker relationship with the outcome and complement core elements for achieving the outcome.

Figure 4 graphically depicts the results of Table 4 using the notation system from Ragin and Fiss (2008)[5]. Each rectangle in this figure (e.g., S1, D1, A1) represents one configuration of conditions and corresponds to one recipe of the intermediate solution. Large circles indicate core elements, and small circles indicate peripheral elements. Full circles indicate the presence of a condition, and crossed-out circles indicate its absence, which suggests that dark circle elements are an enabler for the outcome and that crossed-out elements may inhibit a firm from achieving the outcome. For example, the presence of COMM (dark circle) means that full membership in a high level of communication technology exists (i.e., enabling role), and its absence (X circle) means that full membership in a high level of communication technology does not exist in the configuration that results in agility (i.e., inhibiting role). In addition, blank spaces indicate a "don't-care situation" where the element may be either present or absent.

[5] In configuration tables, researchers commonly number the configurations based on core conditions to indicate first- and second-order equifinality (Fiss, 2011). For instance, according to this convention, in Figure 4, one would label the configurations D1 and D2 D1a and D1b because they have the same set of core conditions and, thus, are first-order equifinal. However, since this distinction is not a key issue here, we number the configurations consecutively for ease of presentation.

Table 4. Configurations of Elements Sufficient for Agility

	Parsimonious solution	Intermediate solution
Sensing agility	**OrgSize*BI + OrgSize*TMT** → sensing agility	**BI*OrgSize*TMT***SPD + **BI***~COMM***OrgSize***SPD*~UNP+ COMM***OrgSize*TMT***SPD*UNP → sensing agility
Decision making agility	**BI*TMT*~UNP** → decision making agility	**BI***COMM*OrgSize***TMT***SPD***~UNP** + **BI***~COMM*~OrgSize***TMT***SPD***~UNP** → decision making agility
Acting agility	**BI*TMT** → acting agility	**BI***OrgSize***TMT***SPD*UNP + **BI***COMM*OrgSize***TMT***SPD + **BI***~COMM*~OrgSize***TMT***SPD*UNP → acting agility

* Bold font elements in intermediate solutions represents parsimonious solutions, which means they are core elements that have a stronger causal relationship with the outcomes.

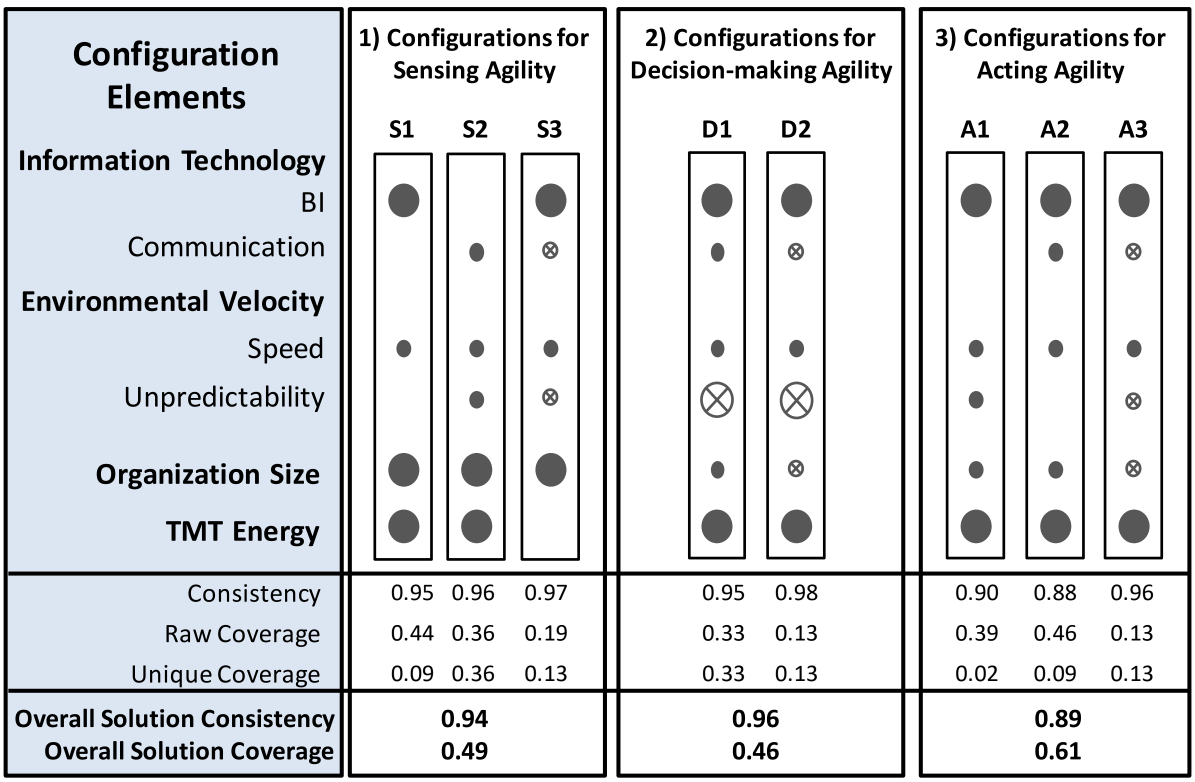


Figure 4. Configurations for Achieving High Agility[6]

By graphically showing configurations, we can more effectively interpret and compare the complex structures of configurations in a way that explains how the elements combine simultaneously and systemically to result in the outcome and the role of each element in the dynamics involved in achieving agility. Thus, unlike the traditional method such as cluster analysis, with fsQCA, we can not only find clusters of high agility but also examine in fine detail the connections between the elements and the role of each element of a configuration in achieving high agility and, thus, build a systemic middle-range theory (Fiss, 2007, 2011). In Sections 4.2.1 to 4.2.3, we further delve into the dynamics of agility by explaining the details of configurations for each type so we can more deeply understand the role of BI and communication technologies play in firms' achieving agility.

[6] Full circles indicate the presence of a condition, and crossed-out circles indicate its absence. Large circles indicate core conditions; small ones, peripheral conditions. Blank spaces indicate "don't care" situations.

4.2.1 Sensing Agility

First, as Figure 4 shows, we found three configurations that organizations can adopt to achieve high sensing agility, which indicates situation of equifinality. BI (in configuration S1) or communication technologies (S2) can support large organizations to achieve sensing agility in fast and unpredictable environments. Interestingly, large organizations in fast, predictable environments (S3) can achieve sensing agility only with BI technologies—they do not need a high level of communication technology. For configurations of sensing agility, BI technologies are core elements that have a strong causal relationship with sensing agility, while communication technologies are a peripheral element that may complement core BI technologies in a firm's achieving high sensing agility. In addition, all the configurations of high sensing agility applied to large organizations, which means that organization size matters for sensing fast environmental changes in a timely manner. Large organizations' significant resources and diverse communication channels may help them to more effectively collect data about changing environments (Cohen & Klepper, 1996) and, thus, possible more easily achieving sensing agility.

Figure 4 shows two types of measures for validating the solutions: consistency and coverage. First, sensing agility's overall solution consistency measures the degree to which all configurations together consistently result in high sensing agility. In this example, overall consistency was 0.94—far above the usually acceptable level of 0.80 (Ragin, 2008). Raw coverage is roughly the extent to which each configuration covers the cases of outcome, more exactly the proportion of cases that have membership in its respective path to the outcome. Thus, it shows an empirical relevance and effectiveness of the solution for the outcome, although a higher coverage does not necessarily mean theoretical importance (Ragin, 2008, p. 44). Thus, organizations can achieve sensing agility with different paths (i.e., equifinality), but individual paths differ in their empirical importance and effectiveness. In these equifinal solutions, configuration S1 has the largest coverage, which means it is empirically most relevant and effective in a firm's achieving sensing agility.

4.2.2 Decision Making Agility

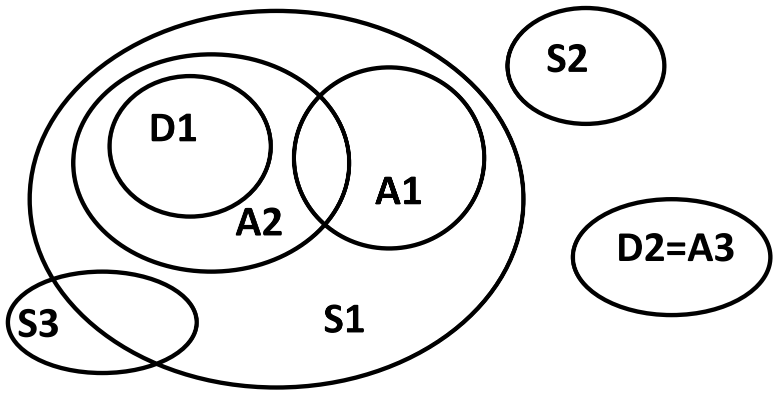
Two configurations are available for organizations to achieve high decision making agility in which BI technologies are a core element and communication technologies are peripheral. In fast and relatively predictable environments, BI and communication technologies together effectively support large organizations to make a timely decision (D1). However, for smaller organizations in fast, predictable environments (D2), only BI technologies are enough to achieve decision making agility, and a high level of communication technology is absent. Further, our results do not suggest any solution for decision making agility in fast and unpredictable environments.

4.2.3 Acting Agility

Organizations can use three configurations to achieve high acting agility. The structures of these configurations are similar to those of sensing agility configurations. BI technologies as core elements and communication technologies as peripheral elements can support organizations to achieve acting agility, and firms that use them together more effectively achieve acting agility (A2) when considering the highest raw coverage for this path that shows a complementary relation between BI and communication technologies in enabling large organizations to act in a timely fashion in fast environments regardless of environmental unpredictability. However, smaller organizations in fast, predictable environments (A3) need BI but not a high level of communication technology to achieve acting agility.

Using Boolean algebra, we can now find common solutions that can achieve more than one type of agility simultaneously by examining the intersections of the all configurations and their set-subset relationships (Ragin, 1987; Frambach, Fiss, & Igenbleek, 2016). By performing this analysis, we found find that configuration D1 is a subset of configuration A2 because they share the same elements except for unpredictability. We can formally express both configurations as follows: D1 = {BI, COMM, SPD, ~UNP, OrgSize, TMT}, A2 = {BI, COMM, SPD, (UNP or ~UNP), OrgSize, TMT}. Thus, D1 is subset of A2 (i.e., A2 ⊃ D1). Similarly, D1 is also a subset of S1 (i.e., S1 ⊃ D1). In other words, D1 is a common recipe that can achieve all three types of agility simultaneously for large organizations. Analyzing the intersection of all configurations indicates that D1 is, in fact, the only recipe sufficient for achieving all three forms of agility. However, several recipes are sufficient for achieving two out of three types of agility. Specifically, A1 is a subset of S1 (i.e., S1 ⊃ A1), meaning a solution for sensing and acting agility. A3 is equal to D2 (i.e., D2=A3), meaning a solution for decision making and acting agility. Single solution S2 and S3 are for sensing agility without intersection with decision making and acting agility. Figure 5 depicts these results.

In verbal terms, our results indicate that large organizations in fast and predictable environments with BI and communication technologies and TMT energy can achieve high sensing agility, decision making agility, and acting agility. In fast and unpredictable environments, large organizations can achieve sensing and acting agility with recipe A1 that combines BI technologies and TMT energy or they can achieve sensing agility with recipe S2 which combines communication technologies and TME energy[7]. We did not identify a configuration for high decision making agility in fast and unpredictable environments for large organizations. On the other hand, smaller organizations in fast and predictable environments can achieve decision making agility and acting agility with recipe D2=A3 (i.e., BI technology, not a high level of communication technology, and TMT energy). Our results to not indicate a consistent recipe for agility for smaller organizations in fast and unpredictable environments.



D1 = {BI, COMM, SPD, ~UNP, OrgSize, TMT}, A1 = {BI, SPD, UNP, OrgSize, TMT},
S2 = {COMM, SPD, UNP, OrgSize, TMT}, S3 = {BI, ~COMM, SPD, ~UNP, OrgSize, TMT},
D2 = A3 = {BI, ~COMM, SPD, ~UNP, ~OrgSize, TMT}
S1 = {BI, SPD, OrgSize, TMT}, A2 = {BI, COMM, SPD, OrgSize, TMT}

Figure 5. Set-Subset Relations of Configurations from Intersection Analysis

In general, across all the configurations for three types of agility, organizations need BI technologies to achieve all three types of agility, while communication technologies take a peripheral and complementary position and play multifaceted roles. In Section 5, we further elaborate the key findings from the contingency perspective and suggest configurational propositions regarding the relationships between IT and organizational agility.

5 Theoretical Configurational Propositions for IT and Organizational Agility

Wth this study, we develop a richer understanding of the role of information technologies in organizational agility. We built a theoretical framework based on the information-processing view of an organization and dynamic capability from which we conceptualized organizational agility and key components of IT and the organization and environment. Then, with a configurational approach and fsQCA, we investigated how the all elements combine in bundles to produce the three types of agility. We found multiple configurations of organizational agility, which may represent institutionalized forms and best practices that many organizations adopt to achieve agility. The equifinal configurations imply that organizations can choose one of multiple paths to a high level of agility with a distinct set of information technologies that better fits their unique context. Thus, in accordance with the contingency perspective (e.g., Lawrence & Lorsch, 1967), the roles of BI and communication technologies do not ubiquitously apply to all organizational contexts and environmental conditions.

This study shows that organizations need to apply each type of IT to a specific context and, therefore, builds a middle-range theory that suggests organizational and environmental boundary conditions that determine what role BI and communication technologies play in firms' achieving agility. In particular,

[7] While the solution indicates that it is theoretically possible for S1 and S2 to intersect, we did not find that they did so empirically since raw and unique coverage for S2 are identical. Accordingly, Figure 5 shows S2 as not intersecting with S1.

based on our theoretical framework, we selected two contingency factors: environmental velocity and organization size. Consistent with the definition of agility, an organizational ability to quickly sense and respond to environmental changes in order to seize market opportunities in a timely manner", the results show that organizational agility always emerged in a high-speed environment as appeared in all the configurations of agility in Figure 4. Unpredictability, the second dimension of environmental velocity, and organization size add more complexity. With these contingency dimensions, we now suggest a contingency framework with which we integrate our findings in a systemic way that may more effectively elaborate ways to achieve organizational agility using BI and communication technologies depending on a specific contingency (Figure 6). Since organizational agility is not a concept of slow environments, our framework shows only high-speed environments for large and smaller organizations.

		Environmental Velocity	
		High Speed & Predictable	**High Speed & Unpredictable**
Organization Size	**Large**	• Many well-defined events • High interdependence & complexity • Well-defined questions, enough rules & knowledge, structured procedures	• Many unclear, unexpected events • High interdependence & complexity • Many new questions, less rules & knowledge, new procedures
	Small	• Many well-defined events • Low interdependence & complexity • Well-defined questions, enough rules & knowledge, structured procedures	• Many unclear, unexpected events • Low interdependence & complexity • Many new questions, less rules & knowledge, new procedures

Figure 6. Conceptual Framework of the Contingency Perspective

5.1 Organizational Size Effect

Research has established organization size as one key contingency factor that can affect an organization's structure, how it allocates resources and authority, and its information processing and decision making processes (Galbraith, 1973; Mintzberg, 1980; Sambamurthy & Zmud 1999). Organizational-level information processing and strategic decision making regarding important business events involves information sharing and collaboration between managers across multiple departments. Thus, as an organization's size increases, the interdependency and complexity in the process also increases, which results in managers' experiencing difficulties in coordinating and sharing information to perform sensing, decision making, and acting tasks in a timely manner. As such, we need to consider that organizations may have different paths to achieve agility depending on their size.

5.2 Environmental Velocity: Speed and Unpredictability Effect

Based on its definition, organizational agility concerns high-speed environments in which new events and opportunities emerge more frequently (Davis et al., 2009; Eisenhardt, 1989) and organizations introduce new products and services at a faster rate (Mendelson & Pillai, 1998; Nadkarni & Narayanan, 2007). Unpredictability is related to multiplicity and disorder in that it concerns the direction of environmental change and is, thus, also relevant to agility.

In predictable environments, organizations deal with mostly well-defined business events and have defined questions to cope with them (Daft & Lengel, 1986). Organizations are likely to have enough data and knowledge to answer the questions and to follow structured rules and procedures to make strategic decisions and execute their strategic plans. In such predictable environments, managers often automatically interpret the meaning of predictable events without spending much time and effort, and sometimes their perception and past experience with the same type of event automatically guides their actions (Ortiz de Guinea & Webster, 2013).

In unpredictable environments, organizations confront unclear, unexpected events for which they do not have enough knowledge and rules to cope. For unclear, unexpected events, diverse interpretations can emerge from managers who have different business foci and interests. In essence, such an environment introduces what research has called ambiguous "wicked problems" (Conklin, 2005) where one spends significant effort in defining the issue with many new questions and creating shared understanding about the problem (Daft & Lengel, 1986). Thus, the sensing activity requires a disproportionate degree of managerial effort compared to the decision making activity. Thus, information processing in fast, unpredictable environments requires an organization to bridge disagreement and diverse interpretations quickly (Daft & Lengel, 1986). Each cell of the framework (Figure 6) summarizes the main characteristics of these contingency effects.

We now turn to developing theoretical propositions regarding the relationships between key antecedent elements and agility (in particular, the role that BI and communication technologies play). In Figure 7, we map the empirical solutions that we obtained from Figure 5 to each cell of contingency. In Sections 5.3 to 5.6, we elaborate the role of BI and communication technologies for agility and suggest theoretical propositions based on the theoretically driven contingency framework and our empirical findings.

		Environmental Velocity	
		High Speed & Predictable	High Speed & Unpredictable
Organization Size	Large	• BI & COMM & TMT → all three types of agility	• BI & TMT → sensing & acting agility • COMM & TMT → sensing agility • No configuration found for decision-making agility
	Small	• BI & ~COMM & TMT → decision-making & acting agility • No configuration found for sensing agility	• No configuration found

Figure 7. Solutions for Achieving High Agility: Contingency Perspective

5.3 BI Technology and Agility

The functionalities that BI technologies such as enterprise-wide consistent integrated databases, data visualization, exception handling, and data mining provide can increase an organization's information-processing capabilities and reduce information-processing needs and, thus, help it to effectively handle information overload that big data causes (Chen et al. 2012; Davenport & Harris 2007; Wixom & Watson 2001). Rule-based exception handling and information about key performance measures that digital dashboards display enable organizations to monitor and capture important business events at the right time (Carte et al., 2005; Cooper et al., 2000; Houghton et al., 2004). In addition to such typical BI functionalities, the recent advancement in BI technology enables organizations to automatically handle data in a way to monitor business events in real time and to proactively and reactively send out information about events to relevant people who are responsible for managing the captured events (Anderson-Lehman et al. 2004; Chandy & Schulte, 2009; Watson & Wixom, 2007). Therefore, BI functionalities can help organizations to enhance sensing agility. Data warehousing provides enterprise-wide integrated, historical, consistent data. Online analytical processing and data mining help managers to find patterns embedded in data, and what-if analyses and data visualization help them to compare several alternative models (Davenport & Harris, 2007; Houghton et al., 2004; Wixom & Watson, 2001). Such BI functionalities enable managers to increase their strategic decision making speed (Chen et al., 2012; Eisenhardt, 1989; Wixom & Watson, 2001). Further, BI technologies help them to create actionable knowledge—to transform data into knowledge and intelligence based on which they can make a set of procedures that automatically respond to routine events in a timely manner.

5.4 Communication Technology and Agility

Real-time information sharing and collaboration supported by communication technologies can help a group of managers from different departments quickly develop common ground and collective sensemaking (Majchrzak, Logan, McCurdy, & Kirschmer, 2006; Majchrzak, Jarvenpaa, & Hollingshead, 2007; Pavlou & El Sawy, 2010) and make a strategic decision in a timely manner (Eisenhardt, 1989). That is, real-time and rich communication functionalities (e.g., video/audio conferencing) help managers increase information use, reduce communication barriers, and increase interactions among team members (Majchrzak, Malhotra, & John, 2005; Malhotra et al., 2007; Thomas et al., 1993; Zigurs & Buckland, 1998). Thus, communication technologies enable managers to share information relevant to the specific context in and across organizational borders and, thus, collectively interpret events and make a decision in a timely manner (Galbraith, 1974; Malhotra et al., 2007; Tushman & Nadler, 1978).

5.5 Fast, Predictable Environments

BI technologies can effectively capture fast well-defined events and allow the right people to access the right information to interpret and make decisions about it in a timely manner. Actionable knowledge and BI procedures (e.g., rule-base, workflow) can automate or support timely action for routine predictable events, which suggests that BI technologies play a core, enabling role in a firm's achieving all the three types of agility. Our empirical findings support this argument.

Unlike BI technologies, communication technologies can deliver diverse types of information that one has not filtered or interpreted yet. Although such diverse types of information can help managers sense unpredictable events in a timely manner, not all the information that communication technologies convey may be relevant for interpreting them. Thus, communication technologies may unnecessarily increase the amount of raw data that one needs to process before using it to make decisions (especially in predictable environments in which organizations can pre-define the information and rules for processing events). However, communication technologies enable organizations to effectively cope with the interdependency and complexity caused by their size. As we explain above, communication technologies allow managers across departments to share information and coordinate and, thus, to quickly develop consensus and agreement in a timely manner. Thus, information processing, enterprise-wide high-quality data, and real-time information sharing that BI and communication technologies provide can support large organizations to effectively overcome the complexity.

On the other hand, smaller organizations that have relatively low complexity may not need to extensively using communication technologies to process predictable routine events. Compared to large organizations, in smaller organizations, a smaller number of managers may participate in the information processing for well-defined events. They also can have face-to-face group meetings more easily than large organizations. Thus, BI technologies can sufficiently support smaller organizations to sense and respond predictable events.

Our empirical solutions support this argument. Communication technologies play a complementary role for large organizations in achieving agility, while small organizations in predictable environments do not need a high level of communication technology. Thus, we suggest:

> **Proposition 1:** In fast, predictable environments, BI technologies are essential for firms to achieve sensing agility, decision making agility, and acting agility. Communication technologies complement BI technologies for a large organization to achieve agility. However, for small organizations, BI technologies are sufficient and the extensive use of communication technologies is not necessary for them to achieve agility.

In fast, unpredictable environments, it becomes more important for organizations to support managers to explore and develop new context-specific knowledge for unexpected events and related problems and to share this knowledge between themselves so that they reach consensus quickly and make a timely strategic decisions and actions. BI technologies enable managers to filter noise data, focus on important business events, and access the right information, which helps to reduce their information-processing needs. However, some functionalities of BI technologies have constraints for unclear, unexpected events. For example, rule-bases of BI technologies typically apply to recurring and well-defined events (Daft & Lengel, 1986). Alert and report functionalities can include information for only predefined business events, processes, and performance measures. Data mining requires data scientists' knowledge and intensive manual working to extract patterns from big data, which takes time. Therefore, BI technologies alone may not sufficiently help an organization sense and respond to rapid, unpredictable events.

Communication technologies complement BI technology. Communication technologies deliver diverse types of information in real time and help managers sense unpredictable events in a timely manner. Communication technologies provide a real-time collaborative task environment in which a group of managers share and discuss their experience and knowledge through rich cues and rapid feedback to define new problems related to unclear events and, thus, develop an agreed-on interpretation quickly (Weick, 1979; Daft & Lengel, 1986). Thus, BI and communication technologies play an essential role in helping managers to sense fast, unpredictable events in a timely manner.

Although managers need IT to sense fast, unpredictable events in a timely manner, the functionalities of BI and communication technologies cannot support predefined rules and guidance for making decisions for unclear, unexpected events. Thus, to make strategic decision making in a timely manner for fast, unpredictable events, the TMT should play a critical role in bridging disagreement and diverse interpretations and helping managers make a decision quickly (Daft & Lengel, 1986), and IT mainly complements the TMT role. For acting agility, the same logic we use to explain fast, predictable events applies because the main difference between predictable and unpredictable events from the information-processing view mostly concerns sensing and decision making tasks as we explain above. Thus, after the TMT creates a strategic action plan in a decision making task, appropriate IT functionalities can support organizations to execute the plan in a timely manner.

We apply the same logic to this context regarding organization size. The functionalities that BI and communication technologies provide can support large organizations to overcome the complexity that their size causes.

Our empirical findings support this argument. BI and communication technologies enable organizations (especially large ones) to effectively achieve sensing agility and acting agility in fast, unpredictable environments. Our empirical findings do not contain an IT-enabled solution for decision making agility in fast, unpredictable environments. Further, we could not empirically find configurations for small organizations, which may imply that creating shared understanding around wicked problems with a small-firm TMT may require less IT-enablement. Thus, we suggest:

Proposition 2: In fast, unpredictable environments, both BI and communication technologies enable organizations (especially large ones) to achieve sensing and acting agility.

5.6 The Role of TMT

Top managers are at the center of information-processing view of organizations. They do the major job for sensing important business events, strategic decision making related to the captured events, and making action plans and realizing them. Thus, top managers are a basic, core building block of organizational agility. As we say above, TMT energy emerged as a necessary condition for organizations to achieve all three types of agility and, logically, also overall organizational agility. Following prior work, the TMT plays an important role in determining the ways an organization interprets important business events that arise in environments and formulates organizational actions that respond to environmental changes (Eisenhardt & Martin, 2000; Hambrick et al., 1996; Kaplan, 2008).

According to the extant studies on TMT and dynamic capability, the TMT initiates a strategic change by capturing and interpreting business events from environments, and, without top management energy, organizations may not successfully reconfigure in enterprise-level their structure, resources, and business processes to adapt to changing environments (Balogun, Bartunek, & Do, 2015; Hambrick et al., 1996; Eisenhardt, 1989; Teece et al., 1997). Further, the IT literature shows that TMT energy is a key success factor that determines the ways organizations adopt and use information technologies (Cooper et al., 2000; Markus, 1983; Wixom & Watson, 2001). The functionalities that BI and communication technologies provide support TMT to foster innovations by encouraging sense-response experimentation, communication, and collaboration (Davenport & Harris, 2007, p 23; Houghton et al., 2004; McAfee & Brynjolfsson, 2007). As such, TMT energy is tightly related with IT's role in organizational agility.

Our empirical fsQCA results show that TMT energy presents as a core element for all types of agility, which supports our argument that TMT energy is a valid-necessary condition for agility. Thus, we suggest:

Proposition 3: TMT energy as a necessary condition fundamentally drives organizations to develop sensing agility, decision making agility, and acting agility. BI and communications technologies need to be designed to effectively support TMT tasks in the sense-response process depending on specific organizational and environmental contexts.

Taken together, these configurational propositions can serve as building blocks for a systemic middle-range theory of IT-embedded organizational agility. Our articulating sensing agility, decision making agility, and acting agility helps explain the dynamics of IT's role in organizational agility in different contextual conditions. As such, we establish better understanding about how to configure information technologies in a way to enable organizational agility under different conditions.

6 Discussion

6.1 Contributions and Implications for Theory and Practice

In today's increasingly turbulent digitized business environments, organizations strive to achieve competitive advantage by investing more in information technologies so that they can be agile in sensing, decision making, and acting in response to market opportunities and threats. In the current emerging big data era in particular, organizations invest increasingly more resources in business intelligence, analytics, and communication technologies to quickly sense and respond to rapidly changing customer preferences, new emerging technologies, and competitors' moves (Chen et al., 2012; Wixom et al., 2014). However, there is also growing concern over the real effect of such a large-scale IT investment on agility. Organizations want to understand the detailed relationships between IT and agility so that they can invest in and configure appropriate types of information technologies.

In this study, we build a middle-range theory of IT's relationship with agility that suggests the boundary conditions that determine the role that BI and communication technologies play in firms' achieving all types of agility. Specifically, this study makes several significant theoretical and methodological contributions to the IT-agility literature. First, we expand the IT-agility literature by suggesting a theoretical framework to conceptualize key constructs for IT-agility research, which we synthesize the extant frameworks grounded on the view of organizations as information processing and interpretation systems and dynamic capabilities. This framework complements the traditional input-output box of the sense-response process by more fully and explicitly explaining the core tasks of interpretation of the captured events and strategic decision making for action.

Second, we explain the complex dynamics of IT-agility with a holistic configurational approach. Instead of focusing on the additive linear net-effects of IT on agility, we explain how IT and organizational and environmental elements combine into multiple configurations. By doing so, we show multiple equifinal pathways to each type of agility and the multifaceted role of IT across the configurations. We empirically explain the systemic, complex nature of IT-agility relationships in which BI and communication technologies may be essential for producing one type of agility in some configurations but may be irrelevant or even counterproductive in other configurations. Thus, we show the different roles of IT in a firm's achieving agility, which resolves somewhat conflicting arguments of extant IT-agility studies about the role of IT in developing organizational agility, pointing to IT as an enabler (Chakravarty et al., 2013; Lee et al. 2015; Lu & Rmamurthy, 2011) versus IT as an inhibitor for agility (Galliers, 2007; Leonardi & Barley, 2008; Rettig, 2007, Tripas & Gavetti, 2000) or IT does not matter (Carr, 2004).Third, we make a methodological contribution by applying a configuration approach and fsQCA in information system research to investigate the complex relationship between IT and agility in the form of configurations. We do not simply introduce the method but show how to adjust it to this research context. For example, using intersection analysis with the resulting configurations from fsQCA, we further delve into common solutions to achieve three types of agility simultaneously. Further, we apply both raw consistency and PRI consistency to find more rigorous patterns in the relationship between IT and agility. These contributions are significant according to the typology of the level of empirical studies' theoretical contributions (Colquitt & Zapata-Phelan, 2007).

Our findings also have implications for practice. Practically, the multiple configurations of high agility and the multifaceted roles of IT in the configurations imply that organizations in different conditions can choose their own unique configurations that can be more effective and affordable in achieving agility for their own contextual condition, instead of following the uniform “herd” industry practice of implementing all types of information technologies. Thus, in practice, managers have various options to choose from to achieve high agility that can take advantage of their organization's capabilities and, thus, reduce the risk of failure.

At the same time, as we show in the fsQCA results, organizations can use few configurations to achieve high agility, and the effectiveness of each solution for the outcome is different from one another. This finding implies that there are a limited set of options that organizations can choose, which can reduce cognitive overload on managers when they need to make such a choice over multiple paths to agility.

6.2 Limitations and Future Research

This study has several limitations that suggest further study. First, our empirical fsQCA results and solutions might show only part of the full potential role of IT in achieving agility. Accordingly, separate studies need to further test and complement the propositions. For example, we could not find an IT-enabled solution for high decision making agility for organizations in rapid and unpredictable environments. This result may mean organizations experience difficulties in making timely decisions for rapid and unpredictable business events, but it does not exclude the possibility that an organization can achieve high decision making agility using information technologies. Further, for small organizations, we found a limited number of recipes that applied only to fast, predictable environments. Future research may focus on finding an IT-enabled solution for fast, unpredictable environments (and especially for small and medium-sized businesses and in other research contexts) so that can make our middle-range theory more generalizable.

Second, we explain how to achieve three types of agility and the role that BI and communication technologies play in achieving organizational agility in different organizational and environmental contexts. However, in the current study, we did not empirically test if the configurations of agility achieve high firm performance or not. Depending on organizational and environmental contexts, distinct configurations can require different levels of the three types of agility (Nazir & Pinsonneault, 2012; Overby et al., 2006) to achieve high firm performance. Future studies can empirically show how to configure such agility with information technologies and test if such configurations result in high firm performance. Third, as we note above, we adopted the view of organizations as information processing and interpretation systems. Thus, we focused on the role that BI and communication technologies play in agility. However, other types of information systems may have a significant relationship with agility as well. For example, organizations can make large-scale investments in enterprise systems such as enterprise resource planning (ERP) systems and supply chain management (SCM) systems, which can change their structures and business processes. Accordingly, enterprise systems can result in significant changes in the dynamics of agility. Enterprise systems can provide data for sensing events in real-time and automate some business processes and, thus, possibly enhance acting agility. However, at the same time, large-scale IT-business alignment that organizations achieve from implementing enterprise systems can bring rigidity and organizational inertia that eventually inhibit organizations from moving fast (Tallon & Pinsonneault, 2011). IT infrastructure is another important IT aspect that may significantly influence organizational agility. For example, Roberts and Grover (2012) empirically investigate of the role that IT infrastructure plays in firms' developing customer-sensing agility and responding agility with mediating and moderating factors, showing more holistic aspects of IT-agility relationships. Thus, it is worth investigating further how other types of IT systems relate to organizational agility.

Fourth, we provide guidance for future research on how to adopt the configurational approach with the QCA method for building richer theories in the interconnected, non-linear digital world. Zammuto et. al. (2007) have called for the need for the IS field to rediscover socio-technical systems theory that views the social and technological systems of organizations in concert given that IT has become "inextricably intertwined with social relations". Majchrzak and Markus (2013) have further proposed a "technology affordances and constraints theory" (TACT) that, in addition to considering affordances, considers technology constraints that hold back an individual or organization from accomplishing a particular purpose when using a technology or an information system. The configurational approach with QCA would allow researchers to rethink the structuring and form of those theories and, hopefully, further enrich and augment them. Thus, more generally, the approach would enable researchers to develop novel theories in the information systems area that capture the complexity of the interconnected digital world and that go beyond linear traditional relationships (Straub & Burton-Jones, 2007).

This study enriches our understanding of IT's relationship with agility and provides new avenues for future research. We hope that it will stimulate other researchers to adopt a configurational theory-building approach with accompanying set-theoretic analysis to advance our understanding of the complexity of the dynamics and intricacies of the structure of organizational agility and the influence of information technologies on how it is enabled or inhibited. As a final note, we again emphasize the importance of the multifaceted role of IT in a firm's achieving agility as either enabling or inhibiting and either core or peripheral across multiple configurations. IT itself is not sufficient for producing the outcome but is an element of a systemic configurational solution in which IT together with organizational and environmental elements can produce agility.

Acknowledgments

We thank Varun Grover (the senior editor) and the two anonymous reviewers of *Journal of the Association for Information Systems*. We also thank Hee-Seok Lee at KAIST, Taeho Hong at the Pusan National University, Youn Sung Kim at the Inha University, and Hau Yong Sauk at the Yeungnam University for their help for data collection. This paper is partly based on the first author's dissertation. The first author thanks Ann Majchrzak, Dan O'Leary, and Merril Silverstein at the University of Southern California for their comments to improve this paper.

References

Anderson-Lehman, R., Watson, H. J., Wixom, B. H., & Hoffer, J. A. (2004). Continental airlines flies high with real-time business intelligence. *MIS Quarterly Executive*, *3*(4), 163-176.

Babbie, E. R. (1973). *Survey research methods*. Belmont, CA: Wadsworth Pub Co.

Bagozzi, R. P., & Edwards, J. R. (1998). A general approach for representing constructs in organizational research. *Organizational Research Methods 103*, 411-423.

Bagozzi, R. P., & Phillips, L. W. (1982). Representing and testing organizational theories. *Administrative Science Quarterly*, *27*, 459-489.

Balogun, J., Bartunek, J. M., & Do, B. (2015). Senior managers' sensemaking and responses to strategic change. *Organization Science*, 26(4), 960-979.

Bensaou, M., & Venkatraman, N. (1995). Configurations of interorganizational relationships: A comparison between U.S. and Japanese automakers. *Management Science, 41*(9), 1471-1492.

Boudreau, M. C., Gefen, D., & Straub, D. W. (2001). Validation in IS research: A state-of-the-art assessment. *MIS Quarterly, 25*(1), 1-26.

Bourgeois, L. J., & Eisenhardt, K. M. (1988). Strategic decision processes in high velocity environments: Four cases in the microcomputer industry. *Management Science, 34*(7), 816-835.

Braun, B., & Röse, K. (2007). Localization issues: A glimpse at the Korean user (from the western perspective). In *Proceedings of the 2nd International Conference on Usability and Internationalization* (pp. 324-333).

Bruch, H., & Vogel, B. (2011). *Fully charged: How great leaders boost their organization's energy and ignite high performance*. MA: Harvard Business School Press.

Carr, N. G. (2003). IT doesn't matter. *Harvard Business Review*, *81*(5), 41-49.

Carte, T. A., Schwarzkopf, A. B., Shaft, T. M., & Zmud, R. W. (2005). Advanced business intelligence at Cardinal Health. *MIS Quarterly Executive*, *4*(4), 413-424.

Chakravarty, A., Grewal, R, & Sambamurthy, V. (2013). Information technology competencies, organizational agility, and firm performance: Enabling and facilitating roles. *Information Systems Research*, *24*(4), 398-417.

Chandy, K. M., & Schulte, W. R. (2009). *Event processing: Designing IT systems for agile companies*. New York: McGraw-Hill.

Chen, H., Chiang, R. H., & Storey, V. C. (2012). Business intelligence and analytics: From big data to big impact. *MIS Quarterly*, *36*(4), 1165-1188.

Chin, W. W. (1998). The partial least squares approach to structural equation modeling. In G. A. Marcoulides (Ed.), *Modern methods for business research* (pp. 295-336). Mahwah, NJ: Lawrence Erlbaum Associates.

Cohen, W. M., & Klepper, S. (1996). Firm size and the nature of innovation within industries: The case of process and product R&D. *The Review of Economics and Statistics*, *78*(2), 232-243.

Colquitt, J. A., & Zapata-Phelan, C. P. (2007). Trends in theory building and theory testing: A five-decade study of the Academy of Management Journal. *Academy of Management Journal*, *50*(6), 1281-1303.

Conklin, J. (2005). *Dialogue mapping: Building shared understanding of wicked problems*. New York, NY: John Wiley and Sons.

Cooper, B. L., Watson, H. J., Wixom, B. H., & Goodhue, D. L. (2000). Data warehousing supports corporate strategy at first American corporation. *MIS Quarterly, 24*(4), 547-567.

Crilly, D. (2011). Predicting stakeholder orientation in the multinational enterprise: A mid-range theory. *Journal of International Business Studies*, *42*, 694-717.

Crilly, D., Zollo, M., & Hansen, M. T. (2012). Faking it or muddling through? Understanding decoupling in response to stakeholder pressures. *Academy of Management Journal*, *55*(6), 1429-1448.

D'Aveni, R. A. (1994). *Hypercompetition: Managing the dynamics of strategic maneuvering*. New York, NY: The Free Press.

D'Aveni, R. A., Dagnino, G. B., & Smith K. G. (2010). The age of temporary advantage. *Strategic Management Journal, 31*(13), 1371-1385.

Daft, R. L., & Lengel, R. H. (1986). Organizational information requirements, media richness and structural design. *Management Science 32*(5), 554-571.

Daft, R. L., Sormunen, J., & Parks, D. (1988). Chief executive scanning, environmental characteristics, and company performance: An empirical study. *Strategic Management Journal*, *9*, 123-139.

Daft, R. L., & Weick, K. E. (1984). Toward a model of organizations as interpretive systems. *Academy of Management Review, 9*, 284-295.

Davenport, T., & Harris, J. (2007). *Competing on analytics: The new science of winning*. Boston, MA: Harvard Business School Publishing.

Davis, J. P., Eisenhardt, K. M., & Bingham, C. B. (2009). optimal structure, market dynamism, and the strategy of simple rules. *Administrative Science Quarterly*, *54*, 413-452.

Doty, D. H., Glick, W. H., & Huber, G. P. (1993). Fit, equifinality, and organizational effectiveness: A test of two configurational theories. *Academy of Management Journal, 36*(6), 1196-1250.

Dove, R. (2001). *Response ability: The language, structure, and culture of the agile enterprise*. New York: John Wiley & Sons.

Drazin, R., & Van de Ven, A. H. (1985). Alternative forms of fit in contingency theory. *Administrative Science Quarterly*, *30*, 514-539.

Dutton, J. E., & Duncan, R. B. (1987). The creation of momentum for change through the process of strategic issue diagnosis. *Strategic Management Journal, 8*, 279-295.

Eisenhardt, K. M. (1989). Making fast strategic decisions in high-velocity environments. *Academy of Management Journal 32*, 543-576.

Eisenhardt, K. M., & Martin, J. (2000). Dynamic capabilities: What are they? *Strategic Management Journal*, *21*, 1105-1121.

Eisenhardt, K. M., Furr, N. R., & Bingham, C. B. (2010). Microfoundations of performance: Balancing efficiency and flexibility in dynamic environments. *Organization Science, 21*(6), 1263-1273.

El Sawy, O. A. (1985). Personal information systems for strategic scanning in turbulent environments: Can the CEO go go-line? *MIS Quarterly, 9*(1), 53-60.

El Sawy, O. A. (2003). The IS core IX: The 3 faces of IS identity: Connection, immersion, and fusion. *Communication of the Association for Information Systems*, *12*(1), 588-598.

El Sawy, O. A., Malhotra, A., Park, Y., & Pavlou, P. A. (2010). Seeking the configurations of digital ecodynamics: It takes three to tango. *Information Systems Research, 21*(4), 835-848.

Ferrier, W. J., Smith, K. G., & Grimm, C. M. (1999). The role of competitive action in market share erosion and industry dethronement: A study of industry leaders and challengers. *Academy of Management Journal, 42*(4), 372-388.

Fiss, P. (2007). A set-theoretic approach to organizational configurations. *Academy of Management Review*, *32*(4), 1180-1198.

Fiss, P. (2011). Building better causal theories: A fuzzy set approach to typologies in organization research. *Academy of Management Journal, 54*, 393-420.

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research, 18*, 39-50.

Frambach, R. T., Fiss, P. C., & Ingenbleek, P. T. M. (2016). How important is customer orientation for firm performance? A fuzzy set analysis of orientations, strategies, and environments. *Journal of Business Research*, *69,* 1428-1436.

Galbraith, J. (1974). Organization design: An information processing view. *Interfaces*, *4*(3), 28-36.

Galbraith, J. (1973). *Designing complex organizations*. Reading, MA: Addison-Wesley.

Galliers, R. (2007). Strategizing for agility: Confronting information systems inflexibility in dynamic environments. In K. C. DeSouza (Ed.). A*gile information systems: Conceptualization construction and management* (pp. 1-15). Burlington, MA: Butterworth-Heinemann.

Ganzach, Y. (1998). Nonlinearity, multicollinearity and the probability of type II error in detecting interaction. *Journal of Management, 24*, 615-622.

Gefen, D., Straub, D. W., & Boudreau, M. C. (2000). Structural equation modeling and regression: Guidelines for research practice. *Communications of the Association for Information Systems, 4*(7), 1-77.

Goodhue, D., & Thompson, R. L. (1995). Task-technology fit and individual performance. *MIS Quarterly, 19*(2), 213-236.

Greckhamer, T. (2011). Cross-cultural differences in compensation level and inequality across occupations: A set-theoretic analysis. *Organization Studies, 32*, 85-115.

Grewal, R., Chandrashekaran, M., Johnson, J. L., & Mallapragada, G. (2013). Moderating role of the environment for the effect of market orientation on firm outcomes: Accounting for unobserved heterogeneity. *Journal of the Academy of Marketing Science, 41*(2), 206-233.

Haeckel, S., & Nolan, R. (1993). Managing by wire. *Harvard Business Review*, *71*(5), 122-132.

Haeckel, S.H. (1999). *Adaptive enterprise: Creating and leading sense-and-respond organizations*. Boston, MA: Harvard Business School Press.

Hambrick, D. C., Cho, T. S., & Chen, M. (1996). The influence of top management team heterogeneity on firms' competitive moves. *Administrative Science Quarterly, 41*(4), 659-684.

Hamrick, D.C. (2007). Upper echelons theory: An update. *The Academy of Management Review, 32*(2), 334-343.

Harris, S. E., & Katz, J. L. (1991). Firm size and the information technology investment intensity of life insurers. *MIS Quarterly, 15*(3), 333-352.

Helfat, C. E., & Winter, S. G. (2011). Untangling dynamic and operational capabilities: Strategy for the (N)ever-changing world. *Strategic Management Journal*, *32*, 1243-1250.

Houghton, R., El Sawy, O. A., Gray, P., Donegan, C., & Joshi, A. (2004). Vigilant information systems for managing enterprises in dynamic supply chains: Real-time dashboards at Western Digital. *MIS Quarterly Executive*, *3*(1), 19-35.

Jacobs, A. (2009). The pathologies of big data. *Communications of the ACM, 52*(8), 36-44.

Jaworski, B. J., & Kohli, A. K. (1993). Market orientation: antecedents and consequences. *Journal of Marketing*, *57*(3), 52-70.

Kaplan, S. (2008). Cognition, capabilities, and incentives: Assessing firm response to the fiber-optic evolution. *Academy of Management Journal, 51*(4), 672-695.

Kester, L., Griffin, A., Hultink, E. J., & Lauche, K. (2011). Exploring portfolio decision-making processes. *Journal of Product Innovation Management*, *28*(5), 641-661

Ketchen, D. J., Thomas, J. B., & Snow, C. C. (1993). Organizational configurations and performance: A comparison of theoretical approaches. *Academy of Management Journal, 36*(6), 1278-1313.

Kharabe, A., Lyytinen, K., & Grover, V. (2013). Do organizational competencies influence how enterprise systems foster organizational agility? In *Proceedings of the 34th International Conference on Information Systems.*

Lawrence, P. R., & Lorsch, J. W. (1967). *Organization and environment: Managing differentiation and integration.* Boston, MA: Harvard University Press.

Lee, O. D., Sambamurthy, V., Lim, K. H., & Wei, K. K. (2015). How does IT ambidexterity impact organizational agility. *Information Systems Research, 26*(2), 398-417.

Leonardi, P. M., & Barley, S. R. (2008). Materiality and change: Challenges to building better theory about technology and organizing. *Information and Organization, 18*(3), 159-176.

Locke, K., Golden-Biddle, K., & Feldman, M. S. (2008). Making doubt generative: Rethinking the role of doubt in the research process. *Organization Science*, *19*(6), 907-918.

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

Luke, D. (2004). *Multilevel modeling*. Thousand Oaks, CA: Sage.

Mabert, V. A., Soni, A., & Venkataramanan, M. A. (2003). The impact of organization size on enterprise resource planning (ERP) implementations in the US manufacturing sector. *Omega*, *31*, 235-246.

Majchrzak, A., & Markus, M. L. (2013). Technology affordances and constraints theory (of MIS). In E. H. Kessler (Ed.), *Encyclopedia of management theory*. Thousand Oaks, CA: Sage.

Majchrzak, A., Jarvenpaa, S. L., & Hollingshead, A. B. (2007). Coordinating expertise among emergent groups responding to disasters. *Organization Science, 18*(1), 147-161.

Majchrzak, A., Logan, D., McCurdy, R., & Kirchmer, M. (2006). Four keys to managing emergence. *MIT Sloan Management Review*, *47*(2), 14-18.

Majchrzak, A., Malhotra, A., & John, R. (2005). Perceived individual collaboration know-how development through information technology-enabled contextualization: Evidence from distributed teams. *Information Systems Research*, *16*(1), 9-27.

Malhotra, A., Gosain, S., & El Sawy, O. A. (2007). Leveraging standard electronic business interfaces to enable adaptive supply chain partnerships. *Information Systems Research, 18*(3), 1-20.

Markus, M. L. (1983). Power, politics, and MIS implementation. *Communications of the ACM, 26*(6), 430-444.

McAfee, A., & Brynjolfsson, E. (2007). Dog eat dog. *Wall Street Journal*. Retrieved from https://www.wsj.com/articles/SB117735476945179344

McCarthy, I. P., Lawrence, T. B., Wixted, B., & Gordon, B. R. (2010). A multidimensional conceptualization of environmental velocity. *Academy of Management Review*, *35*(4), 604-626.

Mendelson, H., & Pillai, R. (1998). Clockspeed and informational response: Evidence from the information technology industry. *Information Systems Research, 9*(4), 415-433.

Mendonça, D. (2007). Decision support for improvisation in response to extreme events: Learning from the response to the 2001 world trade center attack. *Decision Support Systems, 43*(3), 952-967.

Meyer, A. D., Gaba, V., & Colwell, K. A. (2005). Organizing far from equilibrium: nonlinear change in organizational fields. *Organization Science, 16*(5), 456-473.

Milliken, F. J. (1990). Perceiving and interpreting environmental change: an examination of college administrators' interpretation of changing demographics. *Academy of Management Journal, 33*, 42-63.

Mintzberg, H. (1980). A synthesis of the research on organization design. *Management Science*, *26*(3), 322-341.

Misangyi, V. F., & Acharya, A. G. (2014). Substituting or complements? A configurational examination of corporate governance mechanisms. *Academy of Management Journal*, *57*(6), 1681-17055.

Misangyi, V. F., Greckhamer, T., Furnari, S., Fiss, P. C., Crilly, D., & Aguilera, R. (2017). Embracing causal complexity: The emergence of a neo-configurational perspective. *Journal of Management, 43*(1), 255-282.

Morgan, G. (1986). *Images of organization*. Beverly Hills, CA: Sage.

Nadkarni, S., & Narayanan, V. K. (2007). Strategic schemas, strategic flexibility, and firm performance: The moderating role of industry clockspeed. *Strategic Management Journal, 28*(3), 243-270.

Nazir, S., & Pinsonneault, A. (2012). IT and firm agility: An electronic integration perspective. *Journal of the Association for Information Systems*, *13*(3), 150-171.

Nunnally, J. C. (1978). *Psychometric theory*. New York, NY: McGraw-Hill.

Ortiz de Guinea, A., & Webster, J. (2013). An investigation of information systems use patterns: Technological events as triggers, the effect of time, and consequences for performance. *MIS Quarterly*, *37*(4), 1165-1188.

Overby, E., Bharadwaj, A., & Sambamurthy, V. (2006). Enterprise agility and the enabling role of information technology. *European Journal of Information Systems, 15*(2), 120-131.

Pajunen, K. (2008). Institutions and inflows of foreign direct investment: A fuzzy-set analysis. *Journal of International Business Studies, 39*, 652-669.

Podsakoff, P. M., & Organ, D. W. (1986). Self-reports in organizational research: Problems and prospects. *Journal of Management, 12*(4), 531-544.

Pavlou, P. A., & El Sawy, O. A. (2006). From IT leveraging competence to competitive advantage in turbulent environments: The case of new product development. *Information Systems Research, 17*(3), 198-227.

Pavlou, P. A, & El Sawy, O. A. (2010). The “third hand”: IT-enabled competitive advantage in turbulence through improvisational capabilities. *Information Systems Research, 21*(3), 443-471.

Pavlou. P. A., & El Sawy, O.A. (2011). Understanding the elusive black box of dynamic capabilities. *Decision Sciences, 42*(1), 239-273.

Peteraf, M., Stefano, G., & Verona, G. (2013). The elephant in the room of dynamic capabilities: Bringing two diverging conversations together. *Strategic Management Journal*, *34*, 1389-1410.

Ragin, C. C. (1994). *Constructing social research: The unity and diversity of Method Pine Forge Press*. Thousand Oaks, CA: Sage.

Ragin, C. C. (1987). *The comparative method: Moving beyond qualitative and quantitative strategies*. Oakland: University of California Press.

Ragin, C.C. (2000). Fuzzy *set social science*. Chicago, IL: University of Chicago Press.

Ragin, C. C. (2008). *Redesigning social inquiry: Fuzzy set and beyond*. Chicago, IL: University of Chicago Press.

Ragin, C. C., & Fiss, P. (2008). Net effects versus configurations: An empirical demonstration. In C. C. Ragin (Ed.), *Redesigning social inquiry: Fuzzy set and beyond* (pp. 190-219). Chicago, IL: University of Chicago Press.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods.* Thousand Oaks, CA: Sage.

Rettig, C. (2007). The trouble with enterprise software. *Sloan Management Review, 49*(1), 21-27.

Rihoux, B., & Ragin, C. C. (2009). Configurational comparative methods: Qualitative comparative analysis (QCA) and related techniques. Thousand Oaks, CA: Sage.

Roberts, N., & Grover, V. (2012). Leveraging information technology infrastructure to facilitate a firm’s customer agility and competitive activity: An empirical investigation. *Journal of Management Information Systems*, *28*(4), 231-269.

Sabherwal, R., & Chan, Y. (2001). Alignment between business and IS strategies: A study of prospectors, analyzers, and defenders. *Information Systems Research, 12*(1), 303-327.

Sambamurthy, V., Bharadwaj, A., & Grover, V. (2003). Shaping agility through digital options: Reconceptualizing the role of IT in contemporary firms. *MIS Quarterly, 27*(2), 237-263.

Sambamurthy, V., & Zmud, R. W. (1999). Arrangement for information technology governance: A theory of multiple contingencies. *MIS Quarterly, 23*(2), 261-290.

Sahaym, A., Steensma, H. K., & Schilling, M.A. (2007). The influence of information technology on the use of loosely coupled organizational forms: An industry-level analysis. *Organization Science, 18*(5), 865-880.

Smircich, L., & Stubbart, C. (1985). Strategic management in an enacted world. *Academy of Management Review*, *10*(4), 724-736.

Straub, D. W., & Burton-Jones, A. (2007). Veni, vidi, vici: Breaking the TAM logjam. *Journal of the Association for Information Systems*, *8*(4), 223-229.

Tallon, P. P., & Pinsonneault, A. (2011). Competing perspectives on the link between strategic information technology alignment and organizational agility: Insights from a mediating model. *MIS Quarterly, 35*(2), 463-486.

Tallon, P. P., Short, J. E., & Harkins, M. W. (2013). The evolution of information governance at Intel. *MIS Quarterly Executive*, *12*(4), 189-198.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management capabilities. *Strategic Management Journal, 20*, 1133-1156.

Teece, D. J., Peteraf, M, & Leih, S. (2016). Dynamic capabilities and organizational agility: Risk, uncertainty, and strategy in the innovation economy. *California Management Review*, *58*(4), 13-35.

The Economist. (2010). *Data, data everywhere.* Retrieved from http://www.economist.com/node/15557443

Thomas, J. B., Clark, S. M., & Gioia, D. A. (1993). Strategic sensemaking and organizational performance: Linkages among scanning, interpretation, action, and outcomes. *Academy of Management Journal*, *36*(2), 239-270.

Tripas, M., & Gavetti, G. (2000). Capabilities, cognition, and inertia: Evidence from digital imaging. *Strategic Management Journal, 21*(10-11), 1147-1161.

Tushman, M. L., & Nadler, D. A. (1978). Information processing as an integrating concept in organizational design. *Academy of Management Review, 3*, 613-624.

van de Vijver, F. J. R., & Leung, K. (1997). Methods and data-analysis for cross-cultural research. Newbury Park, CA: Sage.

Van Maanen, J., Sorensen, J. B., & Mitchell, T. R. (2007). The interplay between theory and method. *Academy of Management Review*, *32*(4), 1145-1154.

Vis, B. (2012). The comparative advantages of fsQCA and regression analysis for moderately large-N analyses. *Sociological Methods & Research*, *41*, 168-198.

Wagner, C., & Majchrzak, A. (2007). Enabling customer-centricity using wikis and the wiki way. *Journal of Management Information Systems*, *23*(3), 17-43.

Watson, H. J. (2009). Tutorial: Business intelligence - past, present, and future. *Communications of the Association for Information Systems*, *25*, 487-510.

Watson, H. J., & Wixom, B. H. (2007). Enterprise agility and mature BI capabilities. *Business Intelligence Journal*, *12*(3), 13-28.

Weick. K. E. (1979). *The social psychology of organizing*. Reading, MA: Addision-Wesley.

Weick, K. E., Sutcliffe, K., & Obstfeld, D. (2005). Organizing and the process of sensemaking. *Organization Science, 16*(4), 409-421.

Wiggins, R. R., & Ruefli, T. W. (2005). Schumpeter's ghost: Is hyper competition making the best of times shorter? *Strategic Management Journal*, *26*(10), 887-911.

Winter, S. G. (2003). Understanding dynamic capabilities. *Strategic Management Journal, 24*, 991-995.

Wixom, B. H., & Watson, H. J. (2001). An empirical investigation of the factors affecting data warehousing success. *MIS Quarterly, 25*(1), 17-41.

Wixom, B. H., Ariyachandra, T., Douglas, D., Goul, M., & Gupta, B. (2014). The current state of business intelligence in academia: The arrival of big data. *Communications of the Association for Information Systems*, *34*, 1-13.

Yoo, Y. (2010). Computing in everyday life: A call for research on experiential computing. *MIS Quarterly, 34*(2), 213-231.

Zammuto, R. F., Griffith, T. L., Majchrzak, A., Dougherty, D. J., & Faraj, S. (2007). Information technology and the changing fabric of organization. *Organization Science, 18*(5), 749-762.

Zigurs, I., & Buckland, B. K. (1998). A theory of task/technology fit and group support systems effectiveness. *MIS Quarterly, 22*(3), 313-334.

Appendix A: Comparison of Research Approaches

Table A1) compares our research approach (QCA with a retroductive approach) with the traditional deductive correlational approach and the inductive case study approach.

Table A1. Research Approaches

	Quantitative correlational approach	Qualitative case study approach	Configurational (QCA) approach
Mode of inquiry	Variable-based, net-effects focus → good at describing mechanical sequential relationships	Case-based → good at describing a rich, detailed characteristics of cases	Case-based, combinatorial recipes focus → good at describing systemic, holistic features of a complex phenomenon
Nature of causality	Linear, additive, and symmetric (possibly non-linear with transformation)	Complex, conjunctural, asymmetric	Complex, conjunctural, asymmetric
Reasoning in general	Deductive	Inductive	Retroductive (inductive & deductive) or deductive
Primary goal, outcomes	Theory testing and refining → effective in finding strong parsimonious patterns, useful for testing how of extant relationships and validating a universe grand theory	Theory building → effective in exploring new phenomena, and finding new concepts and understanding why of emergent relationships	Theory building and testing → effective in exploring the diversity of phenomena with multiple equifinal configurations and useful for explaining why and how of emergent and extant relationships and for suggesting a normative and prescriptive theory
Number of appropriate cases	50+	1~10	Small (8 ~ 12), medium (13 ~ 50), large (50+)
Resulting theory	Grand theory (generalizable)	Emergent substantive theory	Primarily middle-range theory
Structure of modeled relationship	Fixed single structure based on linear, univocal net-effect; measured based on correlation	Flexible multiple structures allowing for exceptional outcomes	Flexible multiple structures allowing for exceptional outcomes, diverse systemic effects; measured based on set-membership, set-subset relation, and Boolean algebra

Appendix B: Characteristics of the Survey Sample

Table B1. Sample Characteristics

Firm sales revenue	Number of firms	%
Less than $ 100 million	38	35.8%
100 million - 1 billion	28	26.4%
Over 1 billion	40	37.7%

Firm: number of employees	Number of firms	%
Less than 100	26	24.54%
100 - 1000	34	32.1%
1000 - 10000	29	27.4%
Over 10000	17	16.0%

Individual respondents - average working experience = 13.3 years

Experience for current firm (years)	Number of respondents	%
Less than 5	10	4.6%
5 - 7 years	23	10.6%
8- 10 years	42	19.3%
11 - 15 years	76	34.9%
Over 15 years	67	30.7%

Respondent working area	Number of respondents	%
Business strategic planning	51	23.4%
Sales & marketing	53	24.3%
Finance/accounting	10	4.6%
Production/procurement	22	10.1%
Information technology	15	6.9%
R&D	27	12.4%
General management	40	18.3%

Response rate	
Num. of companies contacted	114
Num. of companies participated in the survey	106
Num. of respondents started the survey	242
Num. of respondents completed the survey	218
Response rate (firm level), 47 firms with multiple responses	93%
Response rate (individual level)	90%

Industry	Subindustry	Num. of firms	Num. of respondents	% (firm)
Construction		12	26	11.3%
Finance		7	15	6.6%
Service	IT/SI	18	31	17.0%
	Non-IT/SI	9	21	8.5%
Manufact.	General consumer goods	5	11	4.7%
	Steel/stone/wood products	8	14	7.5%
	Machinery	8	12	7.5%
	Electrical equipment	14	27	13.2%
	Transportation equipment	7	12	6.6%
Transportation		4	10	3.8%
Retail/utility		6	16	5.7%
Telecom/network		8	23	7.5%

Manager level	Number of respondents	%
Chief officer, executive manager	147	68%
Senior manager	71	32%

Appendix C: Measurement Items

Constructs	Measures
Organizational agility (1 = strongly disagree, 4 = neutral, 7 = strongly agree): "a timely manner" or "without delay" means that a task is done in the allowed time in order not to negatively affect other related tasks.	
	Our organization:
Sensing agility (SEN) (reverse coding)	• Is slow to detect changes in our customers' preferences on products. • Is slow to detect changes in our competitors' moves (e.g., new promotions, products, and prices). • Is slow to detect changes in technologies.
Decision making agility (DM)	• Analyzes important events about customer/competitor/technology without delay. • Finds opportunities and threats from changes in customer/competitor/technology in a timely manner. • Makes an action plan to meet customers' needs without delay. • Makes an action plan to react to competitors' strategic moves without delay. • Makes an action plan on how to use new technology without delay.
Acting agility (ACT)	• Can reconfigure our resources in a timely manner. • Can modify/restructure processes in a timely manner. • Can adopt new technologies in a timely manner. • Can introduce new products in a timely manner. • Can change price quickly. • Can change strategic partnerships in a timely manner. • Can address our customers' changing needs and complaints without delay.
Information technology (1 = almost never, 7 = always, 4 = about half the time).	
	Information systems in our organization:
Business intelligence (BI) technologies	• Support the acquiring of information from diverse sources about changes in customers, competitors, and technologies. • Filter out unimportant events related to customers, competitive actions, and technology change based on predefined rules. • Help appropriate managers to know important events about customers, competitors, and technologies in a timely manner. • Support access to relevant data in a timely manner. • Provide enterprise-wide, integrated, consistent data. • Support what-if analysis, which shows how the outcomes can change when the situations change.
Communication (COMM) technologies	• Support the dissemination of relevant information to the people who need it. • Support information sharing in the company. • Support exchanging relevant information with key partner companies and customers. • Support virtual conferences with real-time video and audio. • Support effective collaboration between employees. • Support effective collaboration with key partner companies and customers.
TMT energy (TMT)	(1 = strongly disagree, 4 = neutral, 7 = strongly agree) • Our top management team is energetic. • Our top management team drives dynamic change.
Environmental change: (SPD: 1 = very slow, 7 = very fast, 4 = moderate), (UNP: 1 = very unpredictable, 7 = very predictable, 4 = moderate)	
Speed (SPD)	• The speed of change in our customers' product preferences is… • The speed of change in competitors' moves is… • The speed of change in the technology in our industry is…
Unpredictability (UNP) (reverse coding)	• The direction of change in our customers' product preferences is… • The direction of change in competitors' moves is… • The direction of change in the technology in our industry is…

Appendix D: Indicator and Cross Loadings

	SPD	UNP	SEN	DM	ACT	BI	CC	TMT
SPD1	**0.916**	0.107	0.066	-0.068	0.031	-0.139	-0.104	0.109
SPD2	**0.894**	-0.057	0.044	0.106	-0.101	0.042	0.108	-0.050
SPD3	**0.856**	-0.055	-0.116	-0.038	0.073	0.104	-0.002	-0.065
UNP1	0.014	**0.900**	0.038	-0.074	0.008	-0.072	-0.011	0.033
UNP2	0.028	**0.879**	0.112	0.007	-0.004	0.029	-0.071	-0.071
UNP3	-0.049	**0.769**	-0.173	0.079	-0.005	0.051	0.093	0.042
SEN1	-0.053	-0.046	**0.903**	-0.020	0.053	-0.078	0.029	0.068
SEN2	0.055	-0.052	**0.910**	0.014	-0.020	0.074	-0.042	-0.009
SEN3	-0.003	0.102	**0.871**	0.006	-0.035	0.004	0.013	-0.061
DM1	0.109	-0.075	0.076	**0.770**	0.011	-0.067	0.108	-0.011
DM2	0.042	-0.058	0.169	**0.821**	0.134	-0.251	-0.036	-0.127
DM3	0.026	0.055	-0.009	**0.838**	0.030	-0.112	0.005	0.013
DM4	-0.097	0.046	-0.006	**0.852**	-0.142	0.226	-0.023	0.126
DM5	-0.070	0.025	-0.221	**0.835**	-0.027	0.190	-0.046	-0.007
ACT1	-0.179	-0.087	-0.008	-0.045	**0.780**	0.113	-0.198	0.289
ACT2	-0.120	-0.109	-0.136	0.076	**0.821**	-0.019	0.014	0.325
ACT3	0.040	0.021	0.083	-0.025	**0.843**	-0.005	0.136	-0.074
ACT4	-0.003	0.127	0.217	0.020	**0.833**	-0.005	0.091	-0.184
ACT5	0.104	0.028	-0.064	0.079	**0.739**	-0.051	0.092	-0.244
ACT6	0.250	0.030	-0.152	0.036	**0.732**	0.081	0.002	-0.236
ACT7	-0.075	-0.014	0.036	-0.149	**0.714**	-0.120	-0.164	0.107
BI1	0.015	0.049	0.012	-0.035	-0.087	**0.891**	0.127	0.022
BI2	-0.039	-0.060	0.051	-0.176	0.067	**0.850**	-0.112	0.028
BI3	0.146	0.028	0.081	0.011	-0.075	**0.877**	-0.062	-0.253
BI4	0.063	0.014	0.103	-0.011	-0.097	**0.910**	0.076	-0.068
BI5	-0.076	-0.059	-0.049	0.041	0.067	**0.820**	0.045	0.319
BI6	-0.127	0.023	-0.219	0.181	0.148	**0.814**	-0.084	-0.027
COMM1	0.034	0.048	0.047	0.001	0.039	-0.129	**0.838**	0.072
COMM2	0.058	-0.003	0.059	-0.088	0.008	-0.064	**0.800**	0.138
COMM3	-0.179	0.067	-0.023	-0.029	0.025	-0.093	**0.835**	-0.017
COMM4	0.073	-0.059	-0.048	-0.019	0.035	-0.075	**0.750**	-0.089
COMM5	0.051	-0.046	-0.014	0.027	-0.031	0.204	**0.865**	0.028
COMM6	-0.028	-0.011	-0.022	0.101	-0.070	0.138	**0.847**	-0.134
TMT1	0.003	-0.005	0.059	0.029	-0.019	-0.004	-0.020	**0.972**
TMT2	-0.003	0.005	-0.059	-0.029	0.019	0.004	0.020	**0.972**

Figure D1. Indicator and Cross Loadings

Appendix E: fsQCA: Necessary Condition Test and Truth Tables

Table E1 shows the results of necessary condition tests for all conditions. Since the average of TMT energy was high (5.05), we conducted a sensitive analysis with different anchors for calibration by increasing the anchor for full membership to 7 (maximum value). Our sample statistics show that the average TMT energy was 5.05 with standard deviation 1.1, that 51 percent (i.e., 54 cases out of 106 cases) had TMT energy with less than or equal to 5, and that 20 percent had less than 4. Thus, a meaningful number of cases were still below the average and the cross-over point.

As we explain in Section 4.1., the results show that TMT energy had high consistency and coverage and, thus, that it is a valid and almost always necessary condition for all three types of agility, meaning that, except for a few cases, high TMT energy is necessary for organizations to achieve agility. Further, given the high sample average of TMT energy, we conducted sensitivity analyses to evaluate whether our finding was robust to the use of different calibration (TMT energy1) that reflects sample statistics. The necessary condition test still shows its validity as a necessary condition for all types of agility, and the fsQCA with this TMT energy1 element produced the same configurations with almost same consistencies and coverages.

Environmental speed seems also necessary for agility, but we put it as a contingency condition in which organizations more want to build agility rather than treat it as an element that they must equip to achieve agility. Also, in slow environments, organizations still can achieve agility, and, thus, high speed is not a necessary condition for achieving agility. However, organizations in high-speed environments need more to equip TMT energy to achieve agility.

Table E1. Necessary Condition Tests

	Sensing agility		Decision making agility		Acting agility	
	Consistency	**Coverage**	**Consistency**	**Coverage**	**Consistency**	**Coverage**
TMT energy	0.88	0.82	0.94	0.73	0.92	0.71
TMT energy1	0.86	0.86	0.92	0.77	0.91	0.75
Org. Size	0.68	0.71	0.70	0.61	0.67	0.59
Speed	0.86	0.82	0.87	0.69	0.90	0.71
Unpredictability	0.64	0.89	0.67	0.79	0.68	0.79
BI	0.67	0.92	0.72	0.82	0.78	0.87
Communication	0.77	0.88	0.78	0.76	0.82	0.78

* We performed a sensitivity analysis with different calibration with TMT energy1 for which we used the interval scale values 2, 4, and 7 for full non-membership, cross-over, and full membership, accordingly.

Tables E2, E3, and E4 are the truth tables for sensing agility, decision making agility, and acting agility, accordingly. In this study, we set the minimum acceptable frequency of cases at three, which the tables show in "number" columns. Thus, we considered combinations only with at least three empirical instances for subsequent analysis. For limited space, we do not show rows with less than three cases in these tables. The truth table algorithm then calculates a consistency score that explains how reliably a combination results in the outcome, a measure roughly comparable to the significance level alpha in standard econometric analysis. fsQCA contains two kinds of consistency: 1) raw consistency, which is calculated analogously to crisp set consistency but in addition gives credit for "near misses" and penalties for large inconsistencies; and 2) proportional reduction in inconsistency (PRI) consistency, an alternate measure of consistency that additionally eliminates the influence of cases that have simultaneous membership in both the outcome and its complement (i.e., y and ~y). In this study, we relied on both raw and PRI consistency. That is, for rows (i.e., combinations of conditions) that satisfy the frequency threshold, we set the lowest acceptable raw consistency cutoff at 0.9, meaning that we considered only combinations with a raw consistency of at least 0.9 and a PRI consistency of about 0.75 as very reliably resulting in agility. PRI consistency applies only to fuzzy set (not crisp set), and it is a more rigorous consistency measure; its value is usually lower than that of raw consistency. We currently lack a widely agreed-on cutoff value for PRI consistency. For the current study, we set the cutoff at 0.75 for two reasons. First, the data indicated a break point in PRI consistency between the rows with PRI consistency above 0.75 and the rows with PRI consistency below 0.75. For example, in Table E2, the minimum PRI consistency for the rows of the presence of sensing agility was 0.89 (4th row), while the maximum PRI consistency for the rows of the absence of sensing agility was 0.71 (7th row): these values show a significant difference and, thus, a preferred break point (Ragin 2008). Second, a PRI consistency of 0.75 corresponds to the minimum value that Ragin (2008) suggests for raw consistency. Thus, in our truth table analysis, we set rows with raw consistency higher than 0.9 and PRI consistency higher than 0.75 to 1 (meaning the row consistently produces agility) or otherwise 0. With the truth table assembled, we next applied the truth table algorithm to reduce the numerous combinations into a smaller set of configurations based on the QM algorithm and counterfactual analysis.

Table E2. Truth Table for Sensing Agility

Size	TMT	BI	Communication	Speed	Unpredictability	Number	Sensing agility	Raw consistency	PRI consistency
1	1	1	1	1	1	15	1	0.98	0.97
1	1	1	1	1	0	9	1	0.98	0.96
1	1	1	0	1	1	3	1	0.97	0.92
1	0	1	0	1	0	3	1	0.97	0.89
1	1	0	1	1	1	5	1	0.96	0.90
0	1	1	0	1	0	3	0	0.92	0.68
1	0	0	1	1	0	3	0	0.90	0.71
0	1	0	0	1	0	3	0	0.89	0.63

Table E3. Truth Table for Decision Making Agility

Size	TMT	BI	Communication	Speed	Unpredictability	Number	Decision making agility	Raw consistency	PRI consistency
0	1	1	0	1	0	3	1	0.98	0.85
1	1	1	1	1	0	9	1	0.95	0.87
1	0	1	0	1	0	3	0	0.94	0.59
1	1	1	0	1	1	3	0	0.93	0.74
0	1	0	0	1	0	3	0	0.90	0.48
1	1	0	1	1	1	5	0	0.90	0.67
1	1	1	1	1	1	15	0	0.88	0.73
1	0	0	1	1	0	3	0	0.87	0.34

Table E4. Truth Table for Acting Agility

Size	TMT	BI	Communication	Speed	Unpredictability	Number	Acting agility	Raw consistency	PRI consistency
1	1	1	0	1	1	3	1	0.96	0.80
0	1	1	0	1	0	3	1	0.96	0.83
1	0	1	0	1	0	3	0	0.93	0.43
0	1	0	0	1	0	3	0	0.93	0.72
1	1	1	1	1	0	9	1	0.92	0.78
1	1	0	1	1	1	5	0	0.92	0.63
1	1	1	1	1	1	15	1	0.91	0.78
1	0	0	1	1	0	3	0	0.88	0.37

About the Authors

YoungKi Park is an Assistant Professor of Information Systems at the George Washington University. He received his PhD in IS from the University of Southern California and his MS in MIS from KAIST in Korea. He has 10 years of IT consulting experience in business intelligence and enterprise systems in multiple industries. His research focuses on IT Strategy in digitized business environments and specializes in the set-theoretic configurational approach, qualitative comparative analysis (QCA). He has organized QCA workshops at international IS conferences to propagate QCA to IS community. His work has been appeared in *Information Systems Research, Journal of the Association for Information Systems, Research in Sociology of Organizations, Information and Software Technology*.

Omar A. El Sawy is the Kenneth King Stonier Chair in Business Administration & Professor of Information Systems in the Data Sciences and Operations Department at the Marshall School of Business, University of Southern California. His current interests are in digital business strategy in dynamic environments and business models for digital platforms. He is currently Senior Editor of *MIS Quarterly*. He holds a PhD from Stanford Business School, an MBA from the American University in Cairo, and a BSEE from Cairo University. He served as Director of Research for USC Marshall's Institute for Communications Technology Management (CTM) from 2001-2007. He is a seven-time winner of the Society for Information Management's Annual Paper Award—most recently in 2015. He has been an AIS Fellow since 2008.

Peer C. Fiss is a Professor in the Department of Management and Organization at the Marshall School of Business, University of Southern California. He received his PhD from Northwestern University. His research interests include framing and social categorization as well as configurational theory and set-theoretic methods such as fuzzy set Qualitative Comparative Analysis (fsQCA). His work has been published in journals such as the *Academy of Management Journal, Academy of Management Review, Administrative Science Quarterly, American Sociological Review, Organization Science,* and *Strategic Management Journal.* His recent book with Charles Ragin, entitled *Intersectional Inequality: Race, Class, Test Scores, and Poverty* (University of Chicago Press), uses a set-analytic approach to examine the different ways in which advantages versus disadvantages combine to affect social inequality.