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Configurational Recipes for IT-AMC Competitive Dynamics

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Abstract

As business competition is getting faster and more complex, taking timely and sufficient competitive actions by holistically utilizing key organizational resources and capabilities is critical for a firm's survival. By extending the awareness, motivation, and capability (AMC) framework of competitive dynamics with information technology (IT), we investigated context-specific configurational mechanisms that explicate the simultaneous interactions among a firm's IT and AMC factors for creating competitive actions. Using fuzzy-set qualitative comparative analysis (fsQCA), a set-theoretic method, we empirically analyze field survey data from 189 manufacturing firms. Our analysis uncovered multiple equifinal configurations, revealing nuanced, interdependent relationships among IT infrastructure and applications, awareness, motivation, and operational excellence and innovation capabilities. These relationships are key to generating a high frequency of competitive actions across diverse organizational and environmental contingencies. Based on the findings, we developed theoretical propositions of configurational causal recipes—namely, automation, autonomy, innovation, and integration—that explain which IT-AMC factors matter, how they interrelate, and the ways in which IT factors complement or substitute AMC factors to drive competitive actions within specific contexts of environmental speed, uncertainty, and firm size. Through interviews with top managers of diverse manufacturing companies, we validate the suggested configurational recipes in contemporary business environments. Additionally, we discuss the potential of refining or specializing the recipes to account for the role of emerging digital technologies. Finally, we conclude with the theoretical and practical implications of our findings.

Keywords: Competitive Actions, IT Assets, IT Infrastructure, IT Applications, AMC, Awareness, Motivation, Operational Excellence Capability, Operational Innovation Capability, Configuration, fsQCA, Causal Recipes

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1 Introduction

Business competition is faster and more complex in dynamic environments exhibiting rapidly changing customer needs, globalization, and disruptive technologies (Bharadwaj et al., 2013; Ferrier et al., 2010). *Competitive dynamics*, which refer to a firm's actions and reactions in response to its market opportunities and competition, are critical for achieving and sustaining competitive advantage (Chen & Miller, 2012; Ferrier et al., 2010). In the competitive dynamics literature, "competitive actions" is a key construct that explains how firms generate business value and achieve competitive advantage over their competitors (Ferrier, 2001; Sambamurthy et al., 2003). Generating competitive actions is a complex phenomenon of interfirm rivalry

(Chen & Miller, 2012; Derfus et al., 2008), where multiple factors such as organizational resources and capabilities, technology innovation, and top management characteristics are tightly interrelated (Chen & Miller, 2015; Ferrier, 2001; Vannoy & Salam, 2010). Pervasive digitalization has added further complexity to competitive dynamics by creating new organizing logics and structures in which information and digital technologies are fused with business processes for creating innovations that eventually influence a firm's competitive actions (Bharadwaj et al., 2013; Chi et al., 2010; Mikalef & Pateli, 2017; Park et al., 2017). As a result, to sustain competitive advantage, it is imperative for firms to understand the complex interdependent relationships between IT and organizational resources and capabilities.

In the competitive dynamics literature, a theoretical framework that sets *awareness* (A), *motivation* (M), *and capability* (C) as the key behavioral drivers of a firm's competitive actions has provided a comprehensive theoretical background for studying competitive dynamics. This framework has been widely adopted and has contributed significantly to advancing competitive dynamics theory (e.g., Chen et al., 2007; Chen & Miller, 2012; Derfus et al., 2008; Grimm et al., 2006). Notwithstanding its usefulness and importance in the competitive dynamics research, our comprehensive literature review reveals a lack of research in the IS literature that adopts the AMC framework to investigate competitive dynamics in pervasively digitized businesses, with the exception of a few studies.[1] While the traditional assumption of the AMC framework is that all A, M, C are needed for generating competitive actions (e.g., Chen et al., 2007), in their interactions with IT, not all A, M, C may be essential and necessary to generate competitive actions, as IT can complement or substitute for organizational resources and capabilities as another essential resource of contemporary firms (Bharadwaj et al., 2013; El Sawy et al., 2010; Majchrzak & Markus, 2013; Melville et al., 2004; Nevo & Wade, 2010; Sarker et al., 2019). For example, IT can partially automate the process for generating competitive actions in stable environments in which business events may be predictable and occur less frequently. In such contexts, firms may rely on IT to make decisions regarding the planning and scheduling of well-structured, routine tasks in new product development and manufacturing processes, thus potentially substituting for motivation and operational capabilities.

Against this backdrop, we explicitly identify specific, important research gaps that we aim to bridge in this study. First, extant studies have mostly segregated IT from other organizational resources and focused on the enabling role of IT from the dominant variance theory perspective, as expressed in "the more IT, the better the outcome" (e.g., Abbott, 1988; Chen & Hirschheim, 2004; Chi et al., 2010; Pavlou & El Sawy, 2010). This perspective oversimplifies the role of IT as a black box in firms' competitive actions; in reality, IT's role can be explained through the multifaceted ways in which IT is used as core or peripheral and how IT interacts with organizational elements in either complementary or substitutive ways.

Second, extant IS studies have explained a linear and sequential relationship from IT to organizational resources and capabilities to performance. In reality, the relationships among a firm's IT, organizational capabilities such as AMC, and competitive actions can be much more complicated than the correlation-based linear model approach can explain: A holistic systems theory-based configurational approach may be a better fit (Abbott, 1988; Chen & Hirschheim, 2004; El Sawy et al., 2010; Meyer et al., 2005; Nevo & Wade, 2010). The competitive dynamics literature has recognized the potentially important role of IT in generating competitive actions, especially through its interactions with AMC factors, which can be better explained with a configurational approach (Chen & Miller, 2012, 2015; El Sawy et al., 2010; Ferrier et al., 2010; Liu et al., 2016; Pavlou & El Sawy, 2006; Sirmon et al., 2007). Extant IS studies have not explicitly explained how IT and AMC together create a firm's competitive actions. Overall, there is a lack of understanding of the *holistic interdependent relationships* between IT and AMC in driving a firm's competitive actions.

Furthermore, although a firm's characteristics (e.g., firm size and industrial setting) and environmental conditions (e.g., environmental speed and uncertainty) have been shown to have a significant impact on competitive dynamics (Derfus et al., 2008; Nadkarni & Barr, 2008), there is limited knowledge about the contingency or nuanced effects of such various internal and external contexts on the interdependent relationships between IT and AMC in generating competitive actions. To fill the knowledge gaps, this study aims to answer the overarching research questions: *How do IT and AMC*

[1] Please refer to Table A1 (Appendix A) for a summary of the comprehensive literature review. Most extant IS studies on competitive dynamics do not adopt the AMC framework, with two exceptions (Chi et al., 2010; Vannoy & Salam, 2010). However, although these two studies adopt the AMC framework as a background theoretical perspective to explain the relationships between key variables, they do not conceptualize, measure, and test AMC factors and their relationships with IT constructs. In Chi et al. (2010), the role of IT and AMC factors is not the focus of the studies, and the dynamic relationships between AMC factors and IT constructs in generating competitive actions are not conceptualized or empirically investigated. Vannoy and Salam (2010) is a case study that uses qualitative data from a single company and suggests a process map that shows a flow of sensing and responding tasks. However, it lacks a development of constructs and their causal relationships as well as empirical rigor with large data.

factors combine into configurations to interdependently and holistically lead to a firm's competitive actions? What roles do they play in the competitive action configurations under different organizational and environmental conditions?

To answer the questions, we extend the AMC framework by incorporating the role of IT assets (Burton-Jones et al., 2021), specifically IT infrastructure and IT applications (Aral & Weill, 2007). To investigate the interdependent relationships between IT assets and AMC factors, we employ a configurational theory approach that is best suited to investigating conjunctural causality[2] among these factors (El Sawy et al., 2010; Misangyi et al., 2017; Mithas et al., 2022). In doing so, we develop configurational causal recipes, consisting of a factorial logic to explain which factors matter and why, and a combinatorial logic to explain how the IT-AMC factors relate as complements or substitutes to generate competitive actions (Fiss, 2011; Park et al., 2020; Pflügner et al., 2024; Ragin, 2008). Accordingly, we apply a fuzzy-set qualitative comparative analysis (fsQCA), a set-theoretic method to build a configurational theory, to a dataset of 189 manufacturing firms and empirically uncover multiple equifinal configurations of IT-AMC factors that generate frequent competitive actions. We theoretically interpret the results and suggest four distinct configurational causal recipes for IT-AMC competitive dynamics, i.e., *automation, autonomy, innovation, and integration recipes*. Interestingly, each recipe is valid under a specific business context of environmental speed, uncertainty, and firm size. For all recipes, IT infrastructure and awareness are necessary conditions for achieving competitive actions, and awareness and operational excellence capability are core conditions; IT applications, motivation, and operational innovation capability are supportive conditions, but they interact differently with the other factors in a complementary or substitutive way across different contexts.

As new digital technologies emerge (Adomavicius et al., 2008), competitive dynamics may also change. Thus, we conducted a complementary applicability check through qualitative interviews with top managers of diverse manufacturing companies (Rosemann & Vessey, 2008). We validated that the suggested configurational recipes are applicable to contemporary firms that adopt emerging digital technologies (Lukyanenko et al., 2019; Maier et al., 2021). We also found that our configurational recipes can be further refined and specialized in a way to reflect the new affordances of emergent digital technologies such as intelligent automation with AI, decentralized automation with blockchain, virtual integration with cloud computing, and predictive integration with big data analytics. The extended IT-AMC framework, empirical findings, and causal recipes of this study make significant contributions by shedding new light on IT-enabled competitive dynamics mechanisms and allowing researchers to open up novel research avenues on digital competitive dynamics.

2 Theoretical Foundation and Research Model

2.1 IT-AMC Competitive Dynamics

In the competitive dynamics literature, *competitive action* is defined as an externally directed, specific, and observable market action or reaction initiated by a firm to capture market opportunities and improve or defend its market position (Chen & Miller, 2012; Ferrier, 2001; Grimm et al., 2006). New product introduction, price changes, advertising, and market expansion are typical examples of competitive actions (Chen & Miller, 2012). By taking a higher volume of such actions,[3] firms can gain a better market position and superior performance (Derfus et al., 2008; Ferrier, 2001).

Our systematic perusal of extant competitive dynamics studies reveals a well-established theoretical framework that sets *awareness* (A), *motivation* (M), *and capability* (C) as the key behavioral drivers of a firm's competitive actions (e.g., Chen et al., 2007; Chen & Miller, 2012; Derfus et al., 2008; Grimm et al., 2006). Simply put, the AMC framework explains that firms need to be aware of new market opportunities and competitors' moves, be motivated to initiate new competitive actions, and have the capabilities to do so. AMC factors are organizational capabilities at different levels, such that A and M are dynamic managerial capabilities while C is an operational capability (Helfat et al., 2007). They bridge a firm's internal and external activities. As such, the AMC framework provides a comprehensive theoretical background for studying competitive dynamics and has thus been widely adopted by extant studies.

[2] Conjunctural causality means that a configuration of variables leads to an outcome rather than a single variable (Mithas et al., 2022). Specifically, "this view contrasts sharply with other views of causality based on the linear net-effect of independent individual variables, symmetrical relations, and temporal "before and after" changes." (Mithas et al., 2022, p. vii).

[3] Prior literature has also examined the complexity and heterogeneity of competitive actions (Chi et al., 2010). Although we acknowledge that complexity and heterogeneity are also important dimensions of competitive actions, our focus is more on the volume of competitive actions. The volume of actions is the most widely used measure in the competitive dynamics literature; complexity and heterogeneity are derived from the volume of competitive actions.

Extant AMC studies posit that all AMC factors are needed for generating competitive actions (e.g., Chen et al., 2007). However, in some cases, not all AMC factors may be essential and necessary. For example, Andrevski and Miller (2022) argued that only awareness and capability are necessary for simple actions. Lee et al. (2024) suggested that firms can respond to rival firms' actions without having awareness if the actions are largely expected. We argue that such differing roles of AMC factors can be salient especially in their interactions with IT, particularly as IT has multifaceted relationships with organizational resources and capabilities—complementing or substituting for them in creating a firm's competitive advantage, depending on firm and environmental contexts (El Sawy et al., 2010; Majchrzak & Markus, 2013; Nevo & Wade, 2010; Park et al., 2020). The potential role of IT in generating competitive actions by interacting with AMC factors has been proposed in the competitive dynamics literature (e.g., Chen & Miller, 2012; Ferrier et al., 2010). For example, Chen and Miller (2012) highlighted the potential influence of information systems on a firm's competitive actions driven by its interactions with AMC factors. Taking the information processing view, they argued that information systems can bridge an organization's awareness factors at various levels (e.g., individual experience, sharing within a group, and top management team heterogeneity) and thus "influence the breadth, accuracy, and relevance of the factors considered in taking (or refraining from taking) actions" (p. 167). Ferrier et al. (2010) also highlighted the importance of IT from a configurational perspective in competitive dynamics, noting that IT cannot be separated from business actions, and argued that IT should be properly blended with other resources and capabilities for business activities, like AMC factors, in defining a firm's processes and outcomes. In line with this, Ba et al. (2010) proposed balancing IT with human-oriented resources and capabilities to make them reciprocally augment each other in customer service contexts. While these studies posit the potential interdependent relationships between IT and AMC factors and highlight the importance of melding them for a firm's competitive actions, our comprehensive literature review reveals that extant IS studies on competitive dynamics have not adopted the AMC framework, and the interdependent relationships between IT and AMC factors have rarely been conceptualized or empirically investigated (Table A1 in Appendix A).

To investigate how IT and AMC factors should be managed, deployed, and configured together for digitized competitive dynamics, we conceptualize the key organizational IT factor as IT assets. IT assets refer to tangible technology assets that directly interact with business processes and users, and also connect and transfer data and information throughout a firm (Wade & Hulland, 2004). Hence, how to deploy IT assets along with other organizational resources and capabilities for particular strategic purposes is a significant concern for both business and IT managers (Aral & Weill, 2007; Ross et al., 1996). As the specific components of IT assets, we focus on IT infrastructure and IT applications (Aral & Weill, 2007; Benitez et al., 2018; Weill & Vitale, 2002).

IT infrastructure provides a flexible foundation for current IT services and future business initiatives that provide enterprise-wide standardized IT services, such as data management, integration, and communication (Aral & Weill, 2007; Weill & Vitale, 2002). IT applications, in contrast, enable firms to meet specific IT-service and information-processing needs across internal business units and across external business boundaries such as transactional, informational, and strategic tasks of business units and processes (Aral & Weill, 2007; Jia et al., 2020; Tian & Xu, 2015).

A firm's IT assets are likely to be unique and inimitable, especially when they are configured with AMC factors, since they can create synergies that are contingent on specific firm contexts and environmental conditions (Liu et al., 2016; Ndofor et al., 2011; Nevo & Wade, 2010; Sirmon et al., 2007). Such synergies generated from the unique and contextual configurations of IT with organizational resources and capabilities have been proposed as the primary source of firms' competitive advantage (El Sawy et al., 2010; Nevo & Wade, 2010; Park & Mithas, 2020). However, how the different components of IT assets and AMC factors create competitive actions through their configurative combinations, i.e., conjunctural causality, has yet to be explained.

2.2 Extended IT-AMC Theoretical Framework

Firms may not realize superior performance by merely possessing resources, but should manage, deploy, and configure the resources to create synergies that generate competitive advantage (Sirmon et al., 2007, 2011). The outcomes of deployed IT resources are dependent upon their configuration with other resources rather than the net independent effect of individual resources (El Sawy et al., 2010; Liu et al., 2016; Sirmon et al., 2007). Drawing upon such holistic and contextual configurations as the salient driver for digitized competitive dynamics (Burton-Jones et al., 2015; Levallet et al., 2021; Ndofor et al., 2011; Nevo & Wade, 2010), we propose an extended IT-AMC theoretical framework, as illustrated in Figure 1.

Specifically, we conceptualize the holistic interdependent, configurational relationships among all IT-AMC factors, i.e., *IT-AMC configurational mechanisms*, which are nuanced and produce competitive actions in different organizational and environmental contexts. The configurational approach assumes that all these elements are interdependent in some ways to produce the outcomes of interest (Burton-Jones et al., 2015; Fiss, 2011; Park et al., 2020; Pflügner et al., 2024), thus being well aligned with the fundamental assumption of the AMC framework (Chen & Miller, 2015).

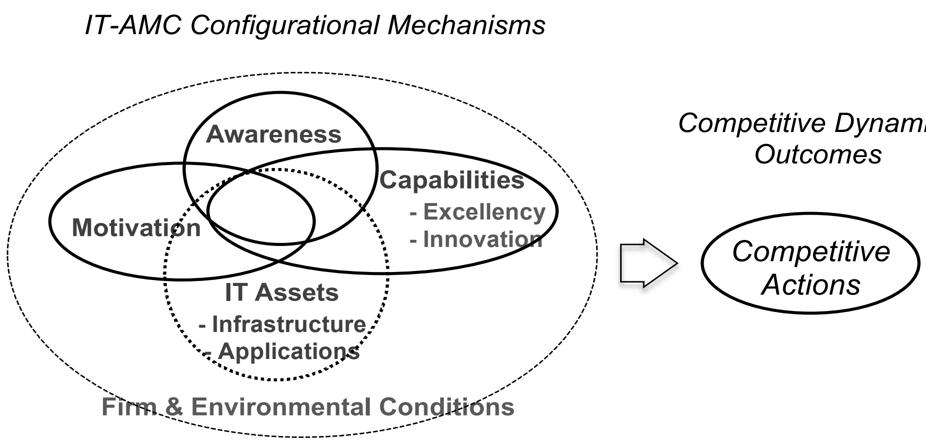

Figure 1. IT-AMC Theoretical Framework

IT infrastructure: As a key component of IT assets, IT infrastructure is an enterprise-wide IT foundation consisting of multiple standardized and interconnected IT resources, such as communication networks, databases, and operating systems, which allow a firm to collect, store, and share business data and information (Benitez et al., 2018; Ray et al., 2005; Roberts & Grover, 2012; Weill & Vitale, 2002).

IT applications: As another key component of IT assets, IT applications are the key IT systems that enable firms to meet various information processing needs and support specific business processes (Aral & Weill, 2007; Queiroz et al., 2018; Sambhara et al., 2022; Weill & Vitale, 2002). Examples of IT applications include enterprise resource planning, customer relationship management, and supply chain management systems (Sambhara et al., 2022). Such IT applications, which are built on IT infrastructure, can support internal and external business processes and collaborations with an integrated database, thus enabling process integration between business divisions of a firm and with partner firms. Thus, we posit that IT infrastructure and applications are related to the AMC factors in generating competitive actions.

Awareness: A firm's awareness refers to the generation and dissemination of market intelligence to be responsive to market change and rivals' competitive actions. Studies involving the AMC framework have emphasized the central role of the top management team (TMT) in a firm's generation of competitive moves. The TMT determines a firm's major rivals and gathers and interprets market information to increase awareness of market opportunities and rivals' competitive moves (Chen et al., 2007; Hambrick et al., 1996; Rai & Tang, 2010).

Motivation: Motivation refers to a firm's intention to take competitive actions in response to its market opportunities and competition (Chen et al., 2021). A firm's motivation explains why the firm initiates or does not initiate certain actions or reactions to market changes or a rival's moves. As a goal-directed driver, a firm-level motivation is also related to its TMT. According to the competitive dynamics and TMT literature, top managers determine a firm's motivation to initiate competitive actions through its strategic decision-making process (Chen & Miller, 2012; Hambrick et al., 1996).

Capabilities: A firm requires operational capabilities to execute actions (Chen & Miller, 2012; Rai & Tang, 2010). Well-honed capabilities in key areas should allow firms to take more frequent and complex actions that make it difficult for rivals to respond quickly (Chi et al., 2010; Ndofor et al., 2011). We elaborate on the conventional operational capability construct by conceptualizing the distinctive aspects of organizational excellence and innovation.

Operational excellence capability refers to a firm's capability to improve existing modes of operation to enhance its speed, reliability, and cost without fundamentally changing how the task is accomplished (Chattopadhyay et al., 2001). In contrast, **operational innovation capability** refers to a firm's capability to invent and deploy new operations by rethinking how to do the work, thus fundamentally changing or reinventing business processes to create new ways of performing tasks (Weerawardena, 2003). The two types of capabilities have been considered essential for both efficient and flexible responses. They together provide *ambidexterity*—a firm's capability to pursue the two competing objectives simultaneously (O'Reilly & Tushman, 2013).

We considered the effects of these two capabilities separately to investigate the nuanced roles of these two distinct types of operational capabilities, extending the AMC literature that has largely focused on a single dimension of capabilities. Furthermore, this conceptualization enabled us to investigate the more delicate roles of IT infrastructure and IT applications in conjunction with the two capability types in creating competitive actions.

Contingency factors: Lastly, we investigated context-specific patterns that show the different roles of IT-AMC factors and their interdependencies changing across contingencies. Specifically, we examined the effect of *firm size*, as it is related to the availability of a firm's resources and capabilities (Ndofor et al., 2011) and the structure of its decision-making process (Fiss, 2011; Park et al., 2017), which are important for a firm's competitive moves.

We also accounted for environmental contingency. Prior studies have suggested that environmental change is not a single dimension but multiple dimensions (Dess & Beard, 1984; Eisenhardt, 1989; Keats & Hitt, 1988). Hence, we conceptualize environmental contingency based on the environmental velocity literature, which defines an environmental change in terms of *environmental speed* and *environmental uncertainty* (Eisenhardt, 1989; McCarthy et al., 2010; Mendelson & Pillai, 1998; Park et al., 2017). Specifically, environmental speed refers to the rate of change of new opportunities and events occurring in an industry, whereas environmental uncertainty refers to the direction of change and whether it is predictable and consistent (Davis et al., 2009; McCarthy et al., 2010). These external environmental conditions are known to affect a firm's sensing and response capabilities for emerging opportunities and threats and are thus tightly related to the competitive action (Park et al., 2017).

With the extended IT-AMC framework, this study specifically focuses on identifying equifinal configurations, from which we developed causal recipes for generating competitive actions, which vary across different organizational and environmental contingencies. Each causal recipe describes a factorial logic of which IT-AMC factors matter and why, and a combinatorial logic of how the factors relate to one another to produce competitive actions in a complementary or substitutive way (Fiss, 2011; Park et al., 2020; Pflügner et al., 2024; Ragin, 2008).

3 Research Methods

We collected data with a large-scale, matched-pair field survey, using secondary archival data for firm characteristics. Then, we applied a configurational method, fsQCA, to find multiple IT-AMC configurations that produce high-competitive actions. Lastly, we performed qualitative interviews with top managers of diverse manufacturing firms to validate whether our findings of fsQCA still hold in current business environments and explore how emerging digital technologies matter in contemporary competitive dynamics. This approach of complementing QCA results with qualitative, detailed explanation for individual cases is considered a desired process of abductive theory building, which this study adopts (Ragin & Amoroso, 2011).

3.1 Data Collection and Sample

Data for the study were gathered at the firm level from the People's Republic of China in late 2005 and early 2006. Particularly, firms located in major, highly industrialized regions in China were targeted using the industry directories of each region.[4] We included firms from various manufacturing industries for our survey. A triangulation approach was used to complement a large-scale, matched-pair field survey with secondary archival data. For this, we developed two questionnaires for each of the sample firms: (1) a questionnaire measuring a firm's IT infrastructure and IT applications for IT executives (e.g., CIO and CTO), and (2) another questionnaire measuring the AMC factors, competitive moves, and environmental conditions for business executives (e.g., CEO and COO). In addition, we gathered secondary data on organizational characteristics (i.e., total assets, annual sales, number of employees, and firm age) and industry characteristics (i.e., total industry revenues and number of firms) from archival sources and company reports. Such a carefully differentiated multisource approach to data collection is recommended to obtain meaningful data for the phenomenon under investigation while reducing the threat of common method variance (Podsakoff & Organ, 1986).

After initial contact with the business and IT executives of over 1,000 target firms through mail and telephone, we conducted interviews by telephone and in face-to-face meetings to help the respondents better understand the survey questions, thus increasing the completion rate. Two separate interviews were conducted with the business and IT executives. After removing incomplete and inappropriate data, we obtained 189 matched-pair cases from diverse manufacturing industries, varying in firm size, age, sales, and percentage of digital workers, as summarized in Table 1. The respondent demographics are also summarized in Table 2.

[4] Although the data were collected in 2005/2006, they remain relevant to the objective of this study, which is to investigate the interactions between IT assets and organizational resources and capabilities in competitive dynamics. IT infrastructure and IT applications are concepts which have been continually used in academic research and have remained practically valid since the early 2000s. More importantly, in this study, we define and operationalize IT infrastructure and IT applications as general concepts, focusing on their unique roles in businesses rather than on specific technologies. Accordingly, we can theoretically interpret the fsQCA results and suggest configurational causal recipes as fundamental mechanisms that continue to be relevant in current business environments, particularly in terms of configuring IT assets and AMC under different contexts. Additionally, through in-depth interviews with top managers of multination manufacturing companies that operate their businesses not only in the United States and South Korea but also in other countries, including China, we validate the findings from this dataset in contemporary business environments. This also provides further insight into how these configurational causal recipes might be refined or specialized to incorporate the role of emerging digital technologies.

Table 1. Sample Demographics (Manufacturing Industries)

Industries	N (%)	Avg. # of employees	Avg. firm age (years)	Avg. total assets (million USD)	Avg. total sales (million USD)	Avg. % of digital workers
Machinery	57 (30.16%)	2,311	14.54	367.84	751.96	43.32%
Electronics	32 (16.93%)	1,423	10.78	151.06	117.59	50.22%
Chemical Products	23 (12.17%)	1,967	16.35	281.84	223.82	40.65%
Medicine & Bio Products	22 (11.64%)	1,744	17.36	249.23	281.40	50.82%
Textile & Apparel	18 (9.52%)	2,501	15.33	228.07	211.21	35.17%
Food Manufacturing	15 (7.94%)	3,977	13.31	275.01	269.45	31.77%
Metal & Non-Metal	12 (6.35%)	2,681	10.69	1,149.74	1,014.24	25.46%
Others	10 (5.29%)	1,595	10.40	267.23	173.96	37.80%
Average (N = 189)		2,196	13.96	336.36	425.04	41.98%

Table 2. Survey Respondent Demographics

	Respondents to business questionnaire		Respondents to technology questionnaire	
Positions	President / vice president / CEO COO / general manager of operations / functional director (e.g., sales, mfg.) / other business managerial positions	34 (18.0%) 136 (72.0%) 18 (9.5%) 1 (0.5%)	CIO / CTO IT director IT manager / Head of IT dept., Other tech manager positions	29 (15.3%) 122 (64.6%) 30 (15.9%) 8 (4.2%)
Educations	College degree Master's degree/MBA PhD degree Other degrees/certificates	143 (75.7%) 36 (19.0%) 4 (2.1%) 6 (3.2%)	College degree Master's degree/MBA PhD degree Other degrees/certificates	158 (83.6%) 21 (11.1%) 1 (0.5%) 9 (4.8%)
Tenure	1 to 5 years 6 to 10 years 11 to 15 years Over 15 years	61 (32.3%) 92 (48.7%) 31 (16.4%) 5 (2.6%)	1 to 5 years 6 to 10 years 11 to 15 years Over 15 years	103 (54.5%) 76 (40.2%) 5 (2.6%) 5 (2.6%)
Total work experience	1 to 5 years 6 to 10 years 11 to 15 years 16 to 20 years Over 20 years	5 (2.7%) 28 (14.8%) 56 (29.6%) 59 (31.2%) 41 (21.7%)	1 to 5 years 6 to 10 years 11 to 15 years 16 to 20 years Over 20 years	32 (16.9%) 118 (62.4%) 26 (13.8%) 8 (4.2%) 5 (2.6%)

3.2 Measurement Development

First, for our measurement development, we adopted extant measures from the literature where possible, with some modifications to suit the context of our research. In cases where no appropriate extant measures were available, we developed new measures based on the construct definitions. Second, using a translation committee approach, four bilingual scholars who were fluent in both English and Chinese and knowledgeable about the subject matter translated the original English instruments into Chinese. This committee approach is useful for establishing both psychological and linguistic equivalence via the sensemaking process among committee members (Lee et al., 2015; Park et al., 2017). Lastly, we validated the measure using a pilot test to verify whether the questions captured the desired information. All measurement items were based on a seven-point Likert scale, where 1 = *very weak* or *strongly disagree*, and 7 = *very strong* or *strongly agree*. Table 3 shows the operational definitions of our variables with their key references (our final measurement items are presented in Appendix B). The descriptive statistics for these variables are summarized in Table 4.

3.3 Construct Validity

We conducted a confirmatory factor analysis (CFA) using the original survey items. In our results, all values were greater than 0.84 for composite reliability and greater than 0.5 for average variance extracted (AVE), indicating a sufficient level of internal consistency (Nunnally, 1978) and reliability (Bagozzi & Edwards, 1998; Fornell & Larcker, 1981). All item loading scores were greater than 0.7 and statistically significant at the 0.01 level, supporting the reliability of the items used for each latent construct (Hair et al., 2011). The square roots of AVE for all constructs were greater than their correlations with other constructs, and each item's loading on its own construct was greater than its cross-loadings on other constructs, confirming discriminant validity (Hair et al., 2011). More details are presented in Appendix C. Lastly, although we used multiple data sources, we checked for common method bias in our measurement model by using the variance inflation factor (VIF) score of each construct. According to Kock (2015), VIF scores for latent constructs should be lower than 3.3 to rule out the possibility of common method bias. The VIF scores in our research constructs ranged from 1.00 to 2.34, confirming no significant risk of common method bias.

Table 3. Operational Definitions of Research Variables

Variables	Operational definitions	Key references
Competitive actions	The relative frequency of a firm's new competitive actions compared to its competitors, such as entering new markets, introducing new products, services or solutions, and designs, and reconfiguring customer relationships	Chen & Miller (2012); Sambamurthy et al. (2003)
IT infrastructure	The extent to which a firm shares and standardizes enterprise IT resources such as hardware, software, and communication networks	Benitez et al. (2018); Ray et al. (2005)
IT application	The extent to which a firm has standardized IS applications to conduct the various business transactions and functional requirements across business units within the firm and across suppliers and customers	Jia et al. (2020); Weill et al. (2002)
Awareness	The TMT's ability to sense, analyze, and identify the current and future market opportunities, threats, and competition with an analysis of the strengths and weaknesses of its main competitors' strategic moves	Brown et al. (2001); Kilduff et al. (2010); Wu et al. (2003)
Motivation	The TMT's ability to initiate strategic business moves to seize future business opportunities by committing funding or other managerial support for risk initiatives	Engelen et al. (2015); Richard et al. (2004)
Operational excellence capability	Operational units' ability to improve the cycle time and efficiency and reduce the cost of existing operations (e.g., product/service development and production, supply chain management, and customer delivery)	Chattopadhyay et al. (2001)
Operational innovation capability	Operational units' ability to implement new, innovative, and radical business operations that are difficult for other firms to replicate	Weerawardena (2003)
Environmental speed	The rate of change in business environments (e.g., new opportunities and events) in terms of technology, market competition, and customer needs/preferences	Park et al. (2017); Wade & Hulland (2004)
Environmental uncertainty	The unpredictability of the direction of change in business environments in terms of technology, market competition, and customer needs/preferences	Davis et al. (2009); Park et al. (2017)
Firm size	The log-transformation of a firm's total assets	Zhu (2004)

Table 4. Descriptive Statistics

Variables	Mean	Standard deviation	Min	Max	Percentile		
					25	50	75
Competitive actions (CA)	4.83	0.98	1.60	7.00	4.20	4.80	5.40
Awareness (A)	5.14	0.79	3.00	7.00	4.75	5.00	5.50
Motivation (M)	4.55	1.05	2.33	7.00	3.67	4.33	5.33
Operational excellence capability (C_E)	4.71	0.79	2.67	7.00	4.33	4.67	5.33
Operational innovation capability (C_I)	4.38	0.95	2.33	7.00	4.00	4.33	5.00
IT infrastructure (ITI)	5.16	0.92	1.25	7.00	4.75	5.25	5.75
IT applications (ITA)	4.69	1.03	1.50	7.00	4.00	4.50	5.50
Environmental speed (ES)	4.28	1.17	1.67	7.00	3.33	4.33	5.33
Environmental uncertainty (EU)	3.89	0.92	1.33	6.00	3.33	3.67	4.67
Firm size (FS)*	8.83	0.68	7.14	10.95	8.31	8.92	9.32

Note: * Log-transformation of total assets in USD

Table 5. Summary of Calibration Anchors

Variable	Calibration anchors		
	Full membership	Crossover	Full non-membership
Competitive actions (CA)	6	4	2
Awareness (A)	6	4	2
Motivation (M)	6	4	2
Operational excellence capability (C_E)	6	4	2
Operational innovation capability (C_I)	6	4	2
IT infrastructure (ITI)	6	4	2
IT application (ITA)	6	4	2
Environmental speed (ES)	6	4	2
Environmental uncertainty (EU)	6	4	2
Firm size (FS)	9.28	8.90	8.18

3.4 Data Analysis

To empirically investigate IT-AMC configurational mechanisms, we employed fsQCA, which enabled us to investigate how the factors combine simultaneously into multiple configurations to generate competitive actions (i.e., equifinal, conjunctural causality) rather than identifying the net effects of individual independent variables on the outcome.[5] It also enabled us to identify which element or sets of elements are necessary and sufficient conditions for the outcome (Fiss, 2011; Levallet et al., 2021; Mikalef & Pateli, 2017; Park et al., 2020; Ragin, 2008).

The key steps of fsQCA are (1) articulating the research topic, including key constructs; (2) calibrating set membership; (3) building configurations with truth-table analysis; and (4) construing causal recipes from theoretical interpretations of the results (Park et al., 2020). As we have explained the research topic and key constructs earlier, we now explain the other three steps of fsQCA as they pertain to our study.

Calibration is a process that transforms the value of each variable for a case into a set membership score that ranges from 0 to 1, where 0 indicates full non-membership, 1 indicates full membership, and 0.5 indicates a crossover point, meaning neither in nor out of a set. For example, calibration defines the extent to which a case is a member of the high-awareness set. We used a direct method of calibration that uses three qualitative anchors: the thresholds for full membership, full non-membership, and the crossover point. We decided on these three thresholds based on the design of the survey questionnaire and the nature of the data (Fiss, 2007; Ragin, 2008). By following the guidelines for calibration of the survey measurement (e.g., Fiss, 2011; Park et al., 2017), we defined the three anchors to calibrate a 7-point Likert scale (1 = *very weak* or *strongly disagree*, 7 = *very strong* or *strongly agree*) to a set-membership score. Specifically, to calibrate all Likert scale variables, we defined a value of 4 as the crossover point because that value indicates the qualitative status of a case as "neither in nor out of the set." Then, we decided on values 6 and 2 as anchors for full membership and full non-membership, respectively. For firm size, we used values corresponding to the 75th, 50th, and 25th percentiles as the three anchors, in accordance with extant studies (e.g., Campbell et al., 2016; Fiss, 2011; Park et al., 2017).[6] In Table 5, we summarize the calibration anchors for individual variables.

Truth-table analysis: The next step is to apply the truth-table algorithm (Ragin, 2008), which identifies sufficient solutions of multiple configurations that consistently produce the outcome of interest. To briefly explain, following calibration, cases are allocated into a truth table that includes all logically possible combinations of the elements. In Table D1 (Appendix D), we present a truth table for high-competitive actions, in which each row corresponds to one combination of all elements. In the table, the "number" column shows the frequency of cases allocated to each combination. By following the suggestion by extant QCA research (e.g., Greckhamer et al., 2013), we set the minimum acceptable frequency of

[5] Unlike the interaction term in regression analysis that can handle, at best, three-way interaction effects (cf. Ganzach, 1998), fsQCA can handle the simultaneous interdependent relationships of all elements and how they lead to the outcome (Fiss, 2007).

[6] Note that there is no one absolutely correct rule to define anchors for calibration. Rather, the use of information that best reflects extant theoretical knowledge, data, contexts, and external benchmarks provided by industry institutions or governments is recommended. For example, Fiss (2011) defined three anchors for firm performance based on data distribution statistics and industry reports in the US and Europe, and Campbell et al. (2016) used an external benchmark and data statistics for calibration. In the same way, we consider both the meaning of the survey item scale (Table 3) and the data distribution statistics (Table 4) for calibration. Furthermore, to check the robustness of our findings, we conducted a sensitivity analysis with [7, 4, 1] as three anchors and found the same configurations with few differences in consistency and coverage values. The truth table for this sensitivity analysis is presented in Table D3 (Appendix D).

cases at three, thus considering combinations with at least three empirical instances for subsequent analysis. With this frequency cutoff, a total of 72% of our data was included in the next step.

In the next step, for the rows that satisfy the frequency threshold, we set 0.9 as the cutoff for raw consistency and 0.75 for the proportional reduction in inconsistency (PRI) for combinations that reliably result in the outcome (Park et al., 2017; Ragin, 2008).[7] Then, the QM algorithm reduced the number of combinations to make a complex solution using Boolean algebra. Subsequently, counterfactual analysis was applied to treat logical remainders, which resulted in an intermediate solution with only "easy" counterfactuals, and a parsimonious one with both "easy" and "included difficult" counterfactuals (Fiss, 2011; Ragin, 2008). To find appropriate assumptions for easy counterfactual analysis, we conducted a comprehensive literature review on AMC and IT studies. The AMC literature explained that A, M, and C are needed to produce competitive actions (Andrevski & Miller, 2022; Chen & Miller, 2012; Chen et al., 2021), and the IT literature explained that IT can play multifaceted roles in achieving the desired outcome (e.g., Majchrzak & Markus, 2013; Park et al., 2020). Thus, we defined the presence of all AMC factors as assumptions for easy counterfactual analysis.

4 Configurational Analysis Results

The fsQCA results are presented in Table 6 in the form of Boolean expressions, where + means logical OR, & means AND, and ~ means negation. The results reveal multiple configurations, and each configuration in the intermediate solution includes both core elements, which have a stronger causal relationship with the outcome, and peripheral elements, which have a weaker relationship with the outcome compared to a core element (Fiss, 2011). For example, the configuration "**A**&M&**C_E**&ITI&ITA&~FS&ES" means that small and medium-sized enterprises (SMEs) with high levels of awareness, motivation, operational excellence capability, IT infrastructure, and IT applications can take highly frequent competitive actions in high-speed environments, with awareness and operational excellence capability being core and other elements being peripheral. Regarding not-high-competitive actions, there was no combination in the truth table that satisfied raw and PRI consistency cutoffs (0.9 and 0.75) as presented in Table D2 (Appendix D), meaning no configuration solution consistently resulted in low-competitive actions.

Figure 2 graphically depicts the results presented in Table 6 using the notation system from Fiss (2011). Each rectangle (e.g., CA1, CA2) represents a configuration. Large circles indicate core elements, small circles indicate peripheral elements, full circles (●) indicate the presence of a condition, and crossed-out (⊗) circles indicate its absence. For example, the presence of motivation means that a firm has full membership in the group of firms with high motivation, whereas its absence means not-high membership in that group. In addition, a blank space indicates a "don't care situation," where the element may be either present or absent.

Table 6. Configurations Sufficient for High and Not-High-Competitive Actions

Outcome	Parsimonious solution	Intermediate solution
High-competitive actions	**A, C_E**	**A**&M&**C_E**&C_I&ITI&ITA&ES + **A**&**C_E**&ITI&ITA&~ES&~EU + **A**&**C_E**&C_I&ITI&ITA&FS&~EU + **A**&M&**C_E**&C_I&ITI&ITA&~FS + **A**&M&**C_E**&C_I&~ITA&~FS&ES&EU + **A**&M&**C_E**&ITI&ITA&~FS&ES + **A**&M&**C_E**&C_I&ITI&~FS&ES
Not-high-competitive actions	No consistent solution was found that satisfies consistency cutoffs.	
Note: & = logical AND operation, + = OR, and ~ = negation. **Bold** font elements in intermediate solutions represent parsimonious solutions, meaning **core** elements with a stronger causal relationship with the outcomes.		

[7] Consistency indicates how reliably a condition, or a combination of conditions, results in the outcome, similar to the significance level in regression analysis. Raw consistency rewards "near misses" and penalizes large inconsistencies, whereas PRI consistency is an alternate measure that further eliminates the influence of cases that belong to both the outcome and its complement (i.e., *y* and ~*y*) (Fiss, 2011).

Causal Conditions	High Competitive Actions CA1	CA2	CA3	CA4	CA5	CA6	CA7
Awareness	●	●	●	●	●	●	●
Motivation	•			•	•	•	•
Operational Excellence Capability	●	●	●	●	●	●	●
Operational Innovation Capability	•		•	•	•		•
IT Infrastructure	•	•	•	•		•	•
IT Application	•	•	•	•	⊗	•	
Firm Size			•	⊗	⊗	⊗	⊗
Environment Speed	•	⊗			•	•	•
Environment Uncertainty		⊗	⊗		•		
Consistency	0.98	0.92	0.97	0.96	0.98	0.96	0.97
Raw Coverage	0.52	0.40	0.33	0.36	0.17	0.30	0.34
Unique Coverage	0.07	0.05	0.01	0.01	0.01	0.01	0.01
Solution Consistency	0.94						
Solution Coverage	0.72						

Figure 2. Configurations of High-Competitive Actions

There are seven configurations for high-competitive actions with consistencies greater than 0.92, meaning that they produce the outcome very consistently. Also, the overall solution coverage is 0.72, which is high enough to cover cases having high-competitive actions.[8]

Regarding the configuration structures, the results show a situation of first-order (across-type) equifinality with second-order (within-type) equifinality, meaning one general solution with awareness and operational excellence capability as core elements and other elements as peripheral to achieve the outcome, within which there are seven permutated pathways to the outcome (Fiss, 2011, p. 407). Different raw coverages indicate that the seven equifinal pathways to the outcome differ in empirical relevance and importance (Ragin, 2008).

Overall, CA1 and CA2 are more general and can be applied to both large firms and SMEs since they involve the "don't care situation" for firm size, meaning that they cover both large firms and SMEs. CA1 shows that firms in high-speed environments should have all AMC and IT factors to produce high-competitive actions, whereas CA2 represents firms with strong IT infrastructure and IT applications in relatively stable environments that can have high-competitive actions without high motivation and operational innovation capability. CA3 is a large firm configuration, whereas CA4-CA7 are SME configurations.

To better understand the relationship between configurations, we conducted an intersectional analysis with raw and unique coverages and visualized the results in the ecology of configurations (Figure 3). This step elucidated the explanatory power of multiple configurations and their explanatory overlap (Park et al., 2017, 2020). The set-subset relationships between configurations reveal the impact of firm size and environmental conditions. Since CA1 and CA2 apply to firms of all sizes, they appear on both sides of the figure. CA3 shows large firms with awareness and operational excellence supported by a strong IT infrastructure and IT applications, but without high motivation in not uncertain environments. By considering its intersection with CA1, however, large firms in fast environments also need high motivation to achieve the outcome. On the other hand, SMEs generally can have high-competitive actions with all AMC and IT infrastructure and IT applications, as shown in CA4. CA6 and CA7 indicate a substitutive relationship between operational innovation capability and IT applications, meaning SMEs with A, M, and operational excellence capability can achieve high-

[8] The overall solution consistency indicates the degree to which all configurations together consistently result in high performance. Raw coverage roughly indicates the extent to which a configuration covers the cases of the outcome, and unique coverage indicates how uniquely (and without an overlap with other configurations) a particular configuration captures cases having the outcome (Ragin, 2008). Thus, coverage is a validation measure, similar to the coefficient of determination (R^2) in a regression analysis; it shows the empirical relativity of each configuration to the outcome, with greater coverage implying more relevant or important configurations (Ragin, 2008). Solution coverage is the total coverage by all configurations.

competitive actions with either IT applications or operational innovation capability. CA5 shows that SMEs in fast and uncertain environments can achieve the outcome with only AMC, without a strong IT infrastructure and IT applications. This is somewhat surprising, but smaller firms may manage to do this due to their simple structure compared to large firms. Also, the coverage of CA5 is very small, meaning only a small portion of SMEs have this structure, implying it is less practically relevant.

Necessary condition test: We conducted necessary condition tests for all elements and their negations, which show whether individual elements or their negations (e.g., IT infrastructure, ~IT infrastructure, A, ~A, M, ~M) are necessary conditions for competitive actions. To validate the necessary conditions of individual elements, we calculated their consistency scores and checked if the consistency was above 0.9, a recommended score for an element to be a valid necessary condition (Ragin, 2008). In a necessary condition test, consistency shows how consistently an element becomes a necessary condition for the outcome, whereas coverage shows the level of empirical relevance of an element as a necessary condition (Ragin, 2008, p. 53). We also inspected a fuzzy-set membership plot to see if the value of set membership of an element is equal to or higher than the value of set membership in the outcome, meaning that the element is a necessary condition. The results of the necessary condition test are presented in Table 7.

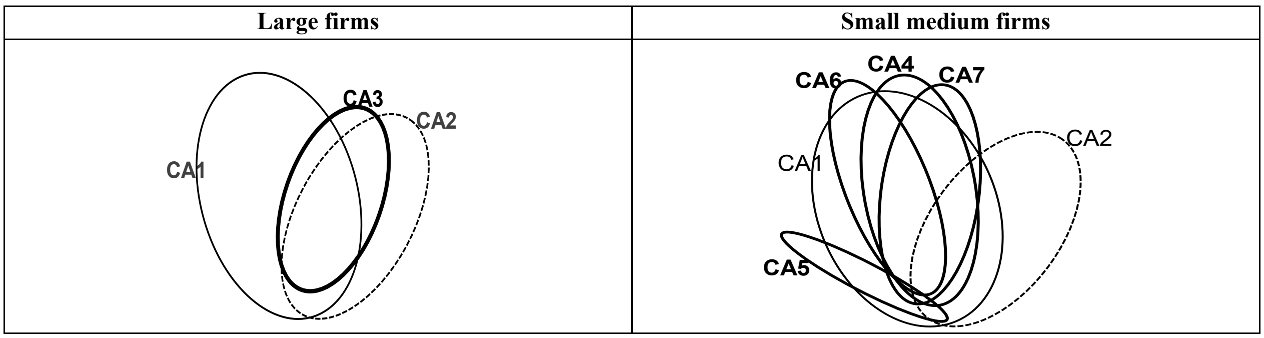

Figure 3. Set-Subset Relations of Configurations for Large and Small/Medium Firms

Table 7. Necessary Condition Test Results

Causal condition	Consistency	Coverage
Awareness (A)	0.96*	0.85
~Awareness (~A)	0.25	0.88
Motivation (M)	0.81	0.92
~Motivation (~M)	0.44	0.83
Operational excellency capability (C_E)	0.88	0.89
~Operational excellency capability (~C_E)	0.39	0.91
Operational innovation capability (C_i)	0.79	0.93
~Operational innovation capability (~C_i)	0.47	0.84
IT infrastructure (ITI)	0.92*	0.82
~IT infrastructure (~ITI)	0.27	0.92
IT applications (ITA)	0.82	0.86
IT applications (~ITA)	0.41	0.90
Firm size (FS)	0.57	0.78
~Firm size (~FS)	0.55	0.79
Environment speed (ES)	0.72	0.91
Environment speed (~ES)	0.50	0.81
Environment uncertainty (EU)	0.59	0.90
Environment uncertainty (~EU)	0.64	0.85

Note: *Relevance of necessity (RoN) values of awareness and IT infrastructure for the outcome are 0.63, 0.60, respectively. For awareness and IT infrastructure, consistency is greater than 0.9, meaning they are necessary conditions for the outcome (Ragin, 2008). Consistency in a necessary condition test indicates how consistently a condition becomes a necessary condition for the outcome, whereas coverage indicates its empirical relevance as a necessary condition. If the coverage of a necessary condition is very small (e.g., 0.01), then the condition is meaningless or trivial. Also, RoN is used to capture a trivial necessary condition that always has a high fixed/constant value (Schneider & Wagemann, 2012, pp. 232-237). In our results, both awareness and IT infrastructure have meaningfully high RoN values when they have high consistency values. Furthermore, XY membership plots also show that both are evenly distributed between 0 and 1, rather than skewed toward a high value.

Awareness and IT infrastructure have very high consistency (i.e., 0.96 and 0.92, respectively), and their coverages (0.85 and 0.82, respectively) are high enough to indicate that both are empirically relevant necessary conditions for competitive actions (Ragin, 2008). Our analysis with fuzzy-set membership plots also confirms this finding. Furthermore, a test for the negation of elements (e.g., ~A, ~M) showed that none of them is a necessary condition. Thus, we conclude that awareness and IT infrastructure are almost always necessary conditions for generating high-competitive actions. [9]

5 Configurational Recipes for IT-AMC Competitive Dynamics

Multiple equifinal configurations in the results represent multiple pathways for generating competitive actions that a firm can choose to implement in a way that fits its specific strategies and internal and external conditions (Havakhor et al., 2019; Sabherwal et al., 2019; Xue et al., 2012). To theorize the pathways, i.e., causal recipes, from the configurational solutions emerging from the fsQCA results, we conducted three additional steps: (1) identifying potential configurational solutions for different contexts, (2) optimizing the solutions for each context, and (3) inducing the factorial and combinatorial logics from the optional solution(s) for each context.

First, based on the two main contingencies (i.e., firm size and environments) and our theoretical background, we propose a contingency framework that allows us to integrate and compare our key findings in a systematic way to effectively explicate the complex, nuanced relationships between IT and AMC, as depicted in Figure 4.

There are various yet limited configurational solutions to configure IT infrastructure and IT applications along with organizational AMC capabilities, which vary as the level of environmental dynamism grows in terms of the speed and uncertainty of market changes and according to firm size; such variation is consistent with both the IT strategic alignment and organizational contingency perspectives (e.g., Havakhor et al., 2019; Hu et al., 2023; Nadkarni & Barr, 2008; Sabherwal et al., 2019; Xue et al., 2012). Additionally, there may be multiple configurations for a specific context. For example, there are CA2 and CA3 for large firms in not-fast and less-uncertain environments, and CA1, CA4, CA6, and CA7 for SMEs in fast and less-uncertain environments. Some configurational solutions are more general in that they can be applied to different contexts—for example, CA4 for SMEs in all environmental conditions. So, how can we decide which configuration is the better path for a firm to achieve high-competitive actions?

Figure 4. Configurational Solutions for High-Competitive Actions: A Contingency Framework

	Not-high speed and not-high uncertainty	High speed and not-high uncertainty	High speed and high uncertainty
Large firms	**Configuration CA2** Configuration CA3	**Configuration CA3** Configuration CA1	**Configuration CA1**
Small firms	**Configuration CA2** Configuration CA4	**Configuration CA6&CA7** Configuration CA1&CA4	**Configuration CA6&CA7** Configuration CA1&CA4 Configuration CA5
	• ***Awareness*** *and* ***operational excellence capability*** *are* ***core*** *elements for all configurations.* • ***Awareness*** *for firms of all sizes and* ***IT infrastructure*** *for large firms are* ***necessary*** *conditions for achieving high-competitive actions.*		

Note: The bold configurations were selected for building theoretical propositions of configurational recipes based on resource effectiveness and solution parsimoniousness. Since the outcome of this study, i.e., frequent competitive actions relative to competitors, is more aligned with the speed of environmental changes, our framework is organized along the level of environmental speed. In the fsQCA results, there was no specific configuration for slow and uncertain environments. We discuss this limitation and its implications for future research in the Discussion.

[9] IT infrastructure is a "don't care" condition for CA5, which is a configuration for SMEs. To address this, we conducted additional necessary condition tests for large firms and SMEs separately. We split data into large firms and SMEs based on their firm size membership score, such that a large firm's membership score for firm size was greater than 0.5. We found that for large firms, awareness and IT infrastructure are necessary conditions (with 0.97, 0.95 consistency). But for SMEs, only awareness is a necessary condition (0.95 consistency), and IT infrastructure is not qualified as a necessary condition (0.88 consistency). This finding implies that IT infrastructure matters more for large firms seeking to take competitive action, possibly due to the more complex structure for decision-making processes that requires enterprise-wide collaboration between multiple business divisions to initiate a new action, for which IT infrastructure can effectively facilitate seamless information flow and sharing (Galbraith, 1974; Park et al., 2017).

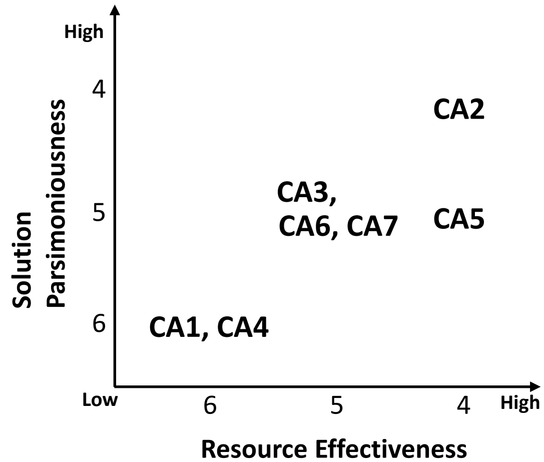

Figure 5. Resource Effectiveness and Solution Parsimoniousness

Second, to answer the question, we identified the optimal configurational solution(s) for each unique context from the resource effectiveness and solution parsimoniousness perspectives. Prior literature has emphasized the importance of effectively configuring a firm's limited resources to sustain competitive advantage by taking competitive actions (Ndofor et al., 2011). Accordingly, all firms should choose the most effective and efficient configuration that can be decided in terms of resource effectiveness and solution parsimoniousness of configurations. *Resource effectiveness* is a relative requirement of the different resources to build a configuration. It can be measured by the number of resource elements that are present in a configuration (i.e., the number of IT assets and AMC factors required to build a configuration, not firm size and environmental factors). For example, CA2 involves four elements as required resources, whereas CA4 involves six; thus, the lower the better. In contrast, *solution parsimoniousness* is the extent to which a configuration is easily built and maintained. It can be measured by the number of all-present and all-absent elements in a configuration, for example, five in CA5. Thus, the more parsimonious the solution, the easier it will be to implement and maintain.

In sum, the more resource effective and more parsimonious the configuration, the better the solution for a firm among alternatives. For example, for large firms in a slow and certain environment, CA2 and CA3 are available, but CA2 is a superior solution to CA3 in terms of resource effectiveness and solution parsimoniousness.

In Figure 5, all configurations are mapped, depicting the relative positions of individual configurations in terms of resource effectiveness and solution parsimoniousness in terms of the number of elements. This helps determine the better solution for a firm seeking to achieve high-competitive actions. For example, for SMEs in fast, either uncertain or certain environments, CA6/CA7 are better than CA1/CA4. Therefore, the blue-highlighted parts in Figure 4 are considered better solutions and thus used for building theoretical propositions of our configurational recipes.[10]

Next, based on this conceptual framework with the selected configurations, we built a context-specific middle-range theory in the form of configurational causal recipes that prescribe the ways to configure IT and A, M, C to achieve high-competitive actions under different contingencies. Specifically, the causal recipes are induced from the configurational solutions' factorial logics explaining which factors matter and why, and combinatorial logics explaining how the IT-AMC factors relate as complements or substitutes to generate competitive actions (Fiss, 2011; Pflügner et al., 2024; Park et al., 2020; Ragin, 2008), as discussed in detail in the following sections. We develop five propositions: Proposition 1 explains the common logics that apply to all causal recipes that prescribe ways to configure IT-AMC, thus applying to Propositions 2-5. Then, Proposition 2 suggests configurational recipes for firms of all sizes in slow and certain environments, Proposition 3 suggests configurational recipes for large

[10] However, CA5 is a configuration for SMEs in fast and uncertain environments, in which IT infrastructure does not matter much and a high level of IT applications is absent, a case exhibiting the result of necessary condition test. In reality, it is highly possible that SMEs will not rely on IT systems for their awareness of market changes and to decide on and initiate competitive actions. It is always possible that multiple configurations can be found empirically, but not all empirically found configurations will be theoretically relevant (Park et al., 2020). As such, although this non-IT-related AMC configuration is practically relevant, it is less relevant for our theory development for a causal recipe to configure IT assets with AMC for competitive actions. Thus, we do not suggest a causal recipe for a non-IT–AMC configuration based on CA5.

firms in fast and certain environments, Proposition 4 suggests configurational recipes for SMEs in fast environments that are either certain or uncertain, and Proposition 5 suggests configurational recipes for large firms in fast and uncertain environments. Through our proposition development, we incorporate the different types of interdependencies (Pflügner et al., 2024) among IT, AMC, and environmental factors. Specifically, the contingency interdependency is applied to theorize the different factorial logics of the IT and AMC factors under specific conditions of firm size and environmental velocity, whereas the complementary and substitution interdependencies are applied to theorize the combinatorial logics among the IT and AMC factors (Park et al., 2020).

5.1 Common Causal Recipe for Limited Equifinal Configurations

Prior to theorizing specific IT-AMC causal recipes based on each of our configurational outcomes for different environmental contexts, we identify common logics that apply to all causal recipes, especially regarding the role of causal factors such as necessary conditions for desired outcomes and core vs. peripheral elements. First, our empirical finding shows that IT infrastructure is a necessary condition, which is especially consistent for large firms, for connecting and configuring AMC to effectively generate competitive actions (Liu et al., 2016; Sirmon et al., 2011; Queiroz et al., 2018). In alignment with the information processing view of organizations (Galbraith, 1974), IT infrastructure helps firms to effectively use IT applications to acquire the right information about their competitors' moves and market changes in a timely manner (Chi et al., 2010; Sambamurthy et al., 2003), particularly for large firms (Park et al., 2017, 2020). Only with a strong IT infrastructure can firms effectively use IT applications to disseminate market intelligence across business units so that they can collaboratively develop a shared understanding and agreement on market needs and challenges (Pavlou & El Sawy, 2006; Vannoy & Salam, 2010), helping them integrate and contextualize diverse information from internal and external sources to determine new opportunities and threats (Park et al., 2017). For example, IT infrastructure provides a way of improving organizational memory by serving as a repository of information and knowledge (Sambamurthy et al., 2003), thus improving the quality of information shared for organizational resource configuration across business units through different management levels (Liu et al., 2016; Queiroz et al., 2018). This is especially true for large firms, mostly due to structural complexity and the ensuing coordination requirements. Compared to large firms, for SMEs with relatively small, simple structures, the collaboration and decision-making process is much simpler and can be done effectively without intensive IT use. As shown in our findings, SMEs can selectively choose either to intensively use IT infrastructure and application (CA4, CA6) or not to rely on IT (CA5 and CA7) in generating competitive actions. Hence, we identify IT infrastructure as a necessary condition only for large firms' competitive actions.

Our configurational results also show that awareness is not only a necessary condition but also a core element, a causally strong factor for frequently generating a firm's competitive actions (Fiss, 2011). This finding indicates that firms' high level of awareness of their competitors' moves and market changes is essential for generating competitive actions and that without this awareness, firms may have difficulty initiating new competitive actions in a timely manner (Andrevski & Miller, 2022). This finding generally aligns with prior AMC studies arguing that firms' awareness of new market opportunities and competitors' moves comprise the preliminary process of competitive dynamics (e.g., Andrevski & Miller, 2022; Chen & Miller, 2012; Grimm et al., 2006). In particular, Chen (1996) pointed out that "awareness is considered a prerequisite for any move" (p. 110). In addition, operational excellence capability is also a core element. A firm with operational excellence capability can execute actions quickly and resource effectively without fundamentally changing extant operations (Chattopadhyay et al., 2001; Chen & Miller, 2012; Rai & Tang, 2010). Competitive actions made with operational excellence can be complex and difficult for rivals to respond to quickly (Chi et al., 2010; Ndofor et al., 2011). Based on these findings, we present the first proposition regarding common logics that apply to all causal recipes:

Proposition 1: For all configurational causal recipes, awareness and operational excellence capability are core elements, and IT infrastructure for large firms and awareness for firms of all sizes are necessary conditions for achieving high competitive actions.

5.2 Automation Causal Recipe

As shown in Figures 4 and 5, in slow or moderately changing and less uncertain environments, CA2 is the most effective configuration to achieve high-competitive actions for both large firms and SMEs. This configuration highlights the importance of both IT infrastructure and IT applications, whereas motivation and operational capability for process innovations matter less. We conceptualize this configurational solution as the *automation causal recipe* since IT infrastructure and IT applications can automate and substitute for both organizational decision-making and operational innovation processes in initiating competitive actions. In a stable environment, the demands of a TMT's strategic decisions and disruptive operational changes are relatively low. Firms tend to provide relatively homogeneous products and services through more routinized processes (Derfus et al., 2008; Havakhor et al., 2019; Xue et al., 2012) and tend to pursue relatively enduring or structured business strategies (Tushman & Anderson, 1986). Moreover, since decision criteria for routinized operations are highly structured and well understood, decision-making rules can be embedded into IT systems. Hence, because organizational tasks are relatively simple, repetitive, and monotonous in a stable environment, IT infrastructure and IT applications can substitute for firms' operational process innovation by reconfiguring and automating organizational tasks (Wu et al., 2020). In other words, IT systems automatically initiate information processing and fulfill new operational requirements in a timely manner for slow and expected changes (Jia et al., 2020; Sambhara et al., 2022; Tian & Xu, 2015).[11]

In contrast, the importance of operational excellence grows for market competition in stable environments since firms strive to reduce costs, eliminate waste, and improve their operational efficiency to increase their competitive position (Havakhor et al., 2019; Xue et al., 2012). In addition, changes in customer preference and technologies are minimal, and the direction of changes can be forecasted (Hu et al., 2023). IT applications standardize functional and operational processes, enhancing information quality and minimizing human errors (Sambhara et al., 2022). The standardization enables each business unit of a firm to follow the same protocols and be better controlled (Jia et al., 2020). Hence, IT infrastructure and IT applications become more tightly interconnected with and complement firms' awareness and operational excellence. As digitized organizational processes expand the volume, variety, and velocity of data that are captured from both inside and outside, these data resources can become instrumental in supporting a firm's analytics to understand and improve its existing business operations (Constantiou et al., 2023). In so doing, firms' high-level IT infrastructure and IT applications can synergistically complement their awareness and operational excellence capability. Thus, we formulate a proposition for the IT automation causal recipe:

Proposition 2: For firms of all sizes under relatively slow and less uncertain environments, IT infrastructure and IT applications can substitute for motivation and operational innovation by automating decision-making and the reconfiguration of routinized tasks for initiating actions while complementing awareness and operational excellence in the generation of high competitive actions.

5.3 Autonomy Causal Recipe

In less uncertain but rapidly changing environments, CA3 is the most effective configuration for large firms, in which awareness and operational excellence, complemented by IT assets, remain essential for generating competitive actions. Moreover, operational innovation capability is required, while firms' motivation is less relevant. In this environment, firms need operational innovations to address fast-changing markets, whereas the TMT's decision-making role may not be critical for predictable markets because it can be autonomously performed by IT systems.

We term this type of configurational solution the *autonomy causal recipe* since IT systems can act as a decision agent replacing decision makers, but operations are not replaced by IT. Strategic decision-making for action generation using IT but without involving the TMT has been discussed from the autonomy-enhancing IS practices perspective, which explains that "IS practices enable employees to make their own decisions, access information, and perform a multitude of tasks without direct mediation of their superiors" (Tafti et al., 2022, p. 1156).[12]

In a fast environment, however, a firm needs more frequent changes in operations to address rapidly changing market needs, e.g., for frequent versions of products or services with shorter life cycles (Tallon & Pinsonneault, 2011). Operational innovation capability can be increased when firms have a higher level of information processing capacity. For large firms, IT infrastructure and IT applications enhance a firm's information processing and communications among business units and other firms, complementing a firm's innovation capability (Ravichandran et al., 2017). IT infrastructure and IT applications enable firms to store and process large volumes of data to find meaningful patterns for innovation (Ravichandran et al., 2017) and support coordination and collaboration among business units (Chi et al., 2010), which are required for operational innovation. Thus, IT can complement rather than substitute for the operational innovation process in this context. The capability to pursue the competing objectives of operational innovation and operational excellence in fast-changing environments has been discussed as *operational ambidexterity* (Lee et al., 2015). According to Lee et al. (2015), IT assets facilitate firms' execution of not only routinized (e.g., operational excellence) but also non-routinized and challenging tasks (e.g., operational innovation) for generating

[11] Our additional qualitative interview with a top manager of a global pharmaceutical company revealed a story of how firms in stable environments can automate with IT its decisions for structured, routine tasks such as planning and scheduling as well as some parts of new product development and manufacturing processes. Details are provided in Section 6.

[12] Our interview with a top manager of a large global renewable energy company showed a real-world story of how a large firm in a certain but fast-changing environment enabled autonomous decision-making by IT systems for the well-structured business process of demand-supply management. Details are provided in Section 6.

competitive actions. Based on this theorization, we present the following proposition for the autonomy causal recipe:

Proposition 3: For large firms under fast and less uncertain environments, IT infrastructure and IT applications substitute for motivation by autonomously executing decisions for initiating actions while complementing awareness and operational excellence capability together with operational innovation capability to generate high competitive actions.

5.4 Innovation Causal Recipe

For SMEs under fast-changing and either uncertain or certain environments, CA6 and CA7 are the more effective configurations. In these configurations, operational ambidexterity becomes optional, whereas IT applications have an alternative relationship with operational innovation capability. The corresponding configurational solutions can be interpreted such that SMEs have a strategic choice between operation-oriented and IT-oriented approaches for competitive action generation. The operation-oriented approach focuses on operational ambidexterity to deal with fast-changing market needs rather than relying on IT. As such, SMEs can pursue both operational excellence and innovation, i.e., operational ambidexterity (Lee et al., 2015), to deal with fast-changing market demands without sufficient functional support from IT applications.

In contrast, the IT-oriented approach focuses on IT applications to deal with such fast environmental changes, while operational innovations become less important and implemented. This strategic choice reflects a TMT's decision-making in dealing with the limited resources of SMEs (especially compared to large firms) for deploying both operational innovation and IT applications at the same time. We conceptualize this IT-oriented configurational solution as the *innovation causal recipe* since IT applications built on IT infrastructure can substitute for operational innovation capability. SMEs can rely on IT applications instead of frequently renovating their operational processes to deal with rapidly changing markets since IT infrastructure and applications can provide a significant level of flexibility, especially using either the predetermined service configurations at the system level or the flexible modular integration at the architecture level (Tiwana & Konsynski, 2010).[13] Fast development of new IT applications can be an alternative way to meet the need of inventing new operations (Lee et al., 2006). Thus, we formulate the following proposition for the innovation causal recipe:

Proposition 4: For SMEs under fast environments, regardless of uncertainty, IT infrastructure and IT applications substitute for operational innovation capability while complementing awareness and operational excellence capability together with motivation to generate high competitive actions.

5.5 Integration Causal Recipe

Lastly, for large firms in fast and uncertain environments, CA1 is an effective configuration. According to Nadkarni and Barr (2008), "high velocity industries are characterized by rapid and unpredictable changes in product and process technologies and competitor's strategic actions that make it difficult for top managers of incumbent firms to develop a clear and comprehensive understanding of their environment" (p. 1399). In such turbulent environments, large firms utilize all IT assets and AMC synergistically to generate competitive actions. In this configuration, TMTs' strategic decision-making is important to cope with high market uncertainty, while operational ambidexterity is vital to enhance the efficiencies of current operations and invent new operations for addressing changes in environments.

We conceptualize this type of configurational solution as the *integration causal recipe* since IT infrastructure and IT applications tightly interact with all AMC so that they can effectively handle the structural complexity of large firms in generating frequent competitive actions. Specifically, IT infrastructure provides a shared and standardized platform for seamless communication and data networking among business units (Sambhara et al., 2022; Tian & Xu, 2015; Weill et al., 2002), which, in turn, streamlines business processes and facilitates collaboration among different functions at various levels in large firms, from top management to business operations (Barki & Pinsonneault, 2005; Park et al., 2017). Figuratively, the role of IT infrastructure is similar to the nervous system in the human body (Barki & Pinsonneault, 2005), a complex network of nerves carrying messages from the brain to multiple parts of the body, making them responsive in a harmonious way to perform a specific action. Likewise, IT applications are important for integrating various business transactions and functional requirements across business units within the firm and across suppliers and customers (Aral & Weill, 2007; Jia et al., 2020; Liu et al., 2016; Tian & Xu, 2015). IT applications support coordination and collaboration among business units (Chi et al., 2010), which leads to the integration of different streams of experience and knowledge. Furthermore, IT applications enable firms to integrate operational processes (Barki & Pinsonneault, 2005; Jia et al., 2020)

[13] Our interview with a top manager of a mid-sized satellite company revealed a real-world story of how an SME in a fast-changing environment realized the timely execution of new initiatives (e.g., new quality assurance and control requirements) by rapidly implementing new IT applications. Details are given in Section 6.

such that processes can be tightly linked to each other and can become more responsive (Tian & Xu, 2015). Thus, large firms can utilize IT assets in turbulent environments for integrating and coordinating the various entities and their respective resources and capabilities to generate competitive actions (Xue et al., 2012). The relationship among the IT-AMC factors in this causal recipe can be characterized as "strong complementing" since all are required to be strongly complementary and tightly interdependent with each other. Based on the conceptual development, we present the last proposition for the integration causal recipe:

Proposition 5: For large firms under fast and uncertain environments, IT infrastructure and IT applications integrate all AMC factors in a way that complements awareness and operational excellence capability to generate high competitive actions.

6 Qualitative Validation and Theoretical Extension

We also conducted a complementary applicability check (Rosemann & Vessey, 2008) to validate our findings from fsQCA and gained additional insights. We interviewed top managers of multinational manufacturing companies for two reasons. First, since the IT-AMC configurational causal recipes for competitive actions were based on industry survey data that had a time gap, the new interview data were used to gain additional validation of our findings and derive further insights into how IT infrastructure and applications impact contemporary competitive dynamics (e.g., Lukyanenko et al., 2019; Maier et al., 2021). Second, as technologies continue to evolve (Adomavicius et al., 2008), it is important to understand how recent advances in digital technologies such as cloud services, big data analytics, blockchain, and AI might affect our proposed causal recipes and thus further extend our theoretical development on digital competitive dynamics (Burton-Jones et al., 2021).

We interviewed top managers of diverse multinational manufacturing companies in the US and South Korea,[14] in which organizational IT assets are highly modernized and intensively used by businesses. To do so, we followed the steps proposed in the literature (e.g., Lukyanenko et al., 2019; Rosemann & Vessey, 2008). First, we recruited top managers from 10 large and SME companies that operate globally, who had sufficient work experience with a good strategic understanding of IT-AMC competitive dynamics (see the demographics of our interviewees summarized in Table E1, Appendix E). Our interviewees are considered appropriate for meeting the specific purposes of this study.

Second, we conducted semi-structured open-ended interviews. The interviews were conducted from January to February 2023, with each taking approximately one hour. As guided in the literature (e.g., Rosemann & Vessey, 2008), the interview procedures included: (1) providing an explanation of our research background and the objectives of the interview; (2) collecting the interviewee's demographic information about the interviewee; (3) presenting the IT-AMC configurational causal recipes for competitive action generation, and confirming their applicability regarding *importance, accessibility, and suitability* to the specific context of the interviewee's company (i.e., firm size, environmental speed, and uncertainty);[15] (4) asking the interviewees to explain how their companies use emerging digital technologies for their competitive actions so that we could better understand how our suggested configurational recipes could be further refined or specialized. During the interview, we also asked them to describe the overall landscape of competitive dynamics for their business, with specific examples of how they generate competitive actions along the lines of the configurations or otherwise, including the role played by recent advances in digital technologies, particularly cloud, big data analytics, blockchain, AI and other emergent technologies. Lastly, the interview results were coded in a report form, reviewed by all authors, and summarized for reporting.

6.1 Qualitative Validation of the IT-AMC Causal Recipes

All interviewees agreed that IT infrastructure and IT applications are important for producing fast and frequent competitive actions for contemporary firms in general. Furthermore, they agreed with the relevance of our configurational recipes for the competitive dynamics of their firms. First, an interviewee (the head of business strategy of a large global pharmaceutical company) confirmed the validity of the automation causal recipe for his company. The interviewee characterized his company's environment as somewhat slow and less uncertain in terms of product features,

[14] We interviewed top managers from multinational companies that operate their businesses not only in the United States and South Korea but also in other countries, including China. In these countries, organizational IT assets are highly modernized, and the roles of IT infrastructure and IT applications are critical for business processes in various industrial settings. Thus, the interview data are appropriate for validating that our findings can be applied to the current business environments.

[15] After presenting our findings, we posed questions to interviewees to get their feedback in terms of (1) whether our research findings focus on today's key management issues and address real-world problems, i.e., "important"; (2) whether our findings are understandable. i.e., "accessible"; and (3) whether the findings provide meaningful guidance or recommendations to the interviewee's company, i.e., "suitable" (Lukyanenko et al., 2019; Rosemann & Vessey, 2008).

technologies involved, customer needs, competitors' moves, and required marketing approaches. However, he stated that significant business risks still exist, mainly relating to the time to market of new products among competitors. Although the business environment is somewhat slow and predictable, his company still needs to make a significant investment in its IT infrastructure and IT applications for data processing and integration, especially regarding external public data sources, for new product development. Moreover, the interviewee highlighted the importance of automated organizational decision-making for new initiatives like new product development and their operational implementation using transactional and performance data, e.g., using a planning IT system for automatic planning for product manufacturing and marketing, and using digitized processes to meet compliance requirements for continuous auditing of the new operations. He stated:

> *Our decisions for the planning and scheduling are quite structured. Hence, we frequently automate the routinized planning processes using IT. We also are required to automate some parts of new product development and manufacturing processes that are affected by industry regulations.*

Hence, in this case, IT can substitute for organizational decision-making and operational innovation at least partly, if not fully. In contrast, the TMT's insight into awareness of long-term and global changes is still critical to detect new opportunities and their optimal time to market, and IT infrastructure and applications are vital to complement the TMT's awareness by providing effective data integration, processing, and mining. The interviewee also highlighted the importance of IT in the ongoing improvement of the existing operations—for instance, through monitoring and processing transactional data, which can be seen as IT's complementary (not substitutive) role for, e.g., operational excellence capability.

Second, an interviewee (the VP for digital operations of a large global renewable energy company) confirmed the validity of our autonomy causal recipe for large firms in certain but fast-changing business environments. The interviewee characterized her company's business environment as less uncertain since the core technologies used for business are stagnant and the customer demands in energy consumption are predictable. Also, the company has a limited number of major competitors, although the competition uncertainty is significantly influenced by government regulations and geopolitical issues. Hence, the overall uncertainty level of this interviewee's company is considered to be moderate. However, the speed of changes was characterized as fast due to the increasing market demands, the hasty market transition triggered by the changes in government regulations, and the rapid development of substitutes like hydrogen energy. Such speedy market changes forced her company to dynamically shape its business model and operations, i.e., providing energy packages to end consumers (B2B2C) instead of selling solar modules to installers only (B2B). Regarding this dynamic transition, the interviewee pointed out the significant role of IT in optimizing the visibility of required data from both internal and external sources (e.g., for energy retail demand-supply changes) and the visibility of performance outcomes (e.g., expected energy inventories and revenues). She stated:

> *As we are maximizing data visibility through comprehensive data collected from the whole value chain, including suppliers and customers, top management's involvement has been reduced, especially in the structured business decisions for service management like demand-supply management.*

In particular, this interview case represents an "autonomy-enhancing IS practice," in which IT compensates for the TMT's decision-making for service management and changes. She also confirmed that IT assets are necessary to complement the company's organizational transitions and that they involve new service development with new operations and organizational structure (i.e., operational innovation) as well as continuous improvement of existing operations (i.e., operational excellence) in that they complement organizational efforts to collect and monitor business transactions and competitors' service implementation and performance (i.e., awareness).

Third, an interviewee (the VP of satellite operation and image service unit of a mid-sized satellite manufacturing and service provider) confirmed the validity of our innovation causal recipe for SMEs in fast-changing business environments. The interviewee defined the business environment of his company as moderately uncertain since customer demand is getting diversified from public sectors (e.g., security, government, and defense) to private sectors (e.g., image processing and communication services). Although the number of its major competitors is somewhat limited due to technological complexity, the speed of market changes is fast due to the recent advancements in technological applications (e.g., reusable rockets and satellite data communications). In this organizational and environmental context, the interviewee highlighted the importance of the TMT's decisions for technology and business strategy due to the high risks embedded in the firm's domain technologies. In addition, the continuous improvement of product and process quality (i.e., operational excellence) was also highlighted due to the specific market position of the company—as a relatively small company compared to other large competitors, it has fewer significant slack resources. In line with this, IT infrastructure and IT applications were discussed as critical for internal collaboration and coordination, data sharing, and communication between engineers and marketing (e.g., using project tracking software like Jira and work coordination tools like MS Teams). In addition, the interviewee highlighted the importance of his company's practice of implementing new IT applications for the fast execution of new initiatives as follows:

> *When we were required to implement new quality assurance (QA) and quality control (QC) to address our customers' concerns, we could timely solve the problem by quickly developing new QA and QC applications. Likewise, when our company needs to initiate a new action, we frequently start with developing new IT applications.*

This example can be seen as an IT-oriented initiative. However, he also agreed that some of the new operational practices are initiated even without a deeper involvement of IT, mainly due to the high level of operational uniqueness of the initiatives and the lack of IT resources within the company, given that it is an SME. This point was further confirmed by another interviewee (the director of global business development of a small automotive product manufacturing company). While this additional interviewee also confirmed the importance of IT applications for the TMT's decision and operational excellence for his company's market competition, which is characterized as fast and uncertain due to the low technical barriers of the market, he admitted that sometimes non-IT-based operational changes are more effective and efficient at dealing with their fast-changing market conditions, compared with new IT development or adoption, which would require significant time and costs, especially in the case of SMEs. Thus, in accordance with our configurational findings, SMEs can selectively choose either an *IT-oriented innovation recipe* or an *operation-oriented ambidexterity* approach for competitive action generation.

Lastly, the validity of our integration causal recipe for large companies in highly uncertain and fast business environments was confirmed by multiple interviewees, including the division director for product design of a large global electronics company, the director for the big data analytics service of a large global electronics company, and the regional CFO and operational director of a global semiconductor company. They reported high market uncertainties due to growing global competition and unpredictable customer demands driven by fast changes in technological advancements and geosocial dynamics. Interestingly, all interviewees highlighted the importance of a flexible IT infrastructure to integrate various enterprise systems and applications, which is critical for integrating various business functions and processes for generating quick and effective competitive actions. However, their approaches are different: While the large electronics companies use a mixture of internal and cloud-based infrastructure mainly to support organizational collaborations, the semiconductor company uses only internal infrastructure mainly for security concerns.

All interviewees highlighted the importance of the TMT's capabilities for market awareness and strategic decision-making. They also pointed out the need for both the continuous improvement and innovation of their operations to adapt to fast and uncertain market changes. In such turbulent environments, IT infrastructure and IT applications are fused more with operations and complement the TMT's awareness and motivation, partially automating but not totally automating or replacing them. In particular, regarding the relationship between the TMT and IT, the operational director of a semiconductor company mentioned:

> *Since the market uncertainty is too high and the change is too fast, either IT or TMT itself is not enough. Instead, TMT's involvement and capability supported by IT is critical for timely responses to market changes.*

In this context, the role of IT was highlighted as the integration and processing infrastructure for organizational data, as well as the digitized complementary applications for the TMT's awareness and decision-making (motivation) and their operational implementations. Overall, the insights from the interviews provided strong support for the findings from our configurational analysis using the industry survey data. The validation check results and examples are further summarized in Table E2, Appendix E.

6.2 Refined and Specialized Causal Recipes with Emerging Digital Technologies

In our interviews, we also asked questions about how emerging digital technologies matter in contemporary competitive dynamics. Our interview outcomes provided additional insights into the strategic value and potential utilization of emerging technologies as additional IT assets in today's competitive dynamics (e.g., big data analytics, machine learning and AI, cloud-as-a-service, blockchain, and data visualization), which can extend our causal recipes, especially by further specializing them.

First, big data analytics were frequently mentioned by our interviewees as emerging technologies that enable sophisticated predictions of market competition and customer demands. This increasing prediction power of a firm allows the firm to determine new business opportunities, which is essential, especially under highly uncertain environments. For example, the senior manager of a large electronics firm who is in charge of big data analytics marketing services has formed a data-oriented culture throughout the company over the last several years, providing the company with a new prediction capability in creating new services that can generate new revenues. He mentioned:

> *Our services are built on big data from smart devices sold over the world, which are automatically collected, stored, and analyzed. Data scientists monitor and update analytical models continually with additional data to reflect a changing market in a timely manner. IT feeds information of changing market trends to top managers regularly so that they can make a timely decision for launching a new competitive action, adding or updating services.*

This case implies that the integration configurational causal recipe for large firms under fast and uncertain environments can be further specialized such that big data analytics can complement the awareness and decision capabilities of a firm, not only for the current competition but also for future market demands. This predictive power enabled by big data analytics is also known to enhance operational excellence (Faraj et al., 2018; Tarafdar et al., 2019). For example, Amazon utilizes the "customers who bought this item also bought" algorithm to predict the reading preferences of customers (Faraj et al., 2018). Also, Amazon has invested in big data analytics and could dramatically reduce its delivery time, indicating its potential to optimize operational services. Based on these new insights, we suggest that big data analytics may further specialize the integration recipe into a *predictive integration causal recipe*.

Second, machine learning (ML) and AI technologies were also frequently mentioned as emerging technologies that could replace costly and highly risky organizational processes and decision practices with disruptive digital capacities such as digital twins and AI automation (Berente et al., 2021). For example, the interviewee from a large global pharmaceutical company highlighted the strategic value of the machine learning and AI technologies that have replaced animal and human testing in medicine development, which was not only very time-consuming and costly but also highly risky and sophisticated. Such intelligent digital technologies could also significantly reduce and even replace managerial decisions using data-oriented ML or AI-based automation (Berente et al., 2021). Hence, this case implies that our automation causal recipe can be further specialized because these intelligent digital technologies can expand the scope of automation from a human-oriented and time-consuming process to a highly risky and sophisticated innovative operational and managerial decision process. We call this specialized recipe the *intelligent automation causal recipe*.

Our interviewees also highlighted the strategic roles of emerging network-based technologies such as cloud-as-a-service and blockchain technologies. On the one hand, cloud as a service was discussed as an emerging digital phenomenon that supports more remote and flexible work environments, ranging from providing a virtual platform for remote work and meetings within a firm or across different firms to implementing global enterprise systems (e.g., cloud-based global ERP) that virtually connect all business units in a seamless manner. For example, an interviewee (the division director of a large global electronics company) highlighted the growing importance of cloud-based infrastructure and services for the key task of his division, i.e., electronic product design, which requires heavy collaborations across various departments, roles, and positions using diverse collaboration-based digital applications such as CAD, layout and simulation tools, and remote work applications. The cloud-based technological transition has accelerated his company's virtual integration at various levels and scopes, resulting in more flexible and dynamically integrated work environments. Hence, this case implies another specialized "virtual integration causal recipe."

On the other hand, blockchain technology was also highlighted as an emerging digital technology that has become critical in today's competitive dynamics. Blockchain involves the implementation of a decentralized P2P network to integrate business units, suppliers, and customers, which requires changes in organizational architecture, IT governance, and work relationships (Cui et al., 2024). Although this technology and its applications are still evolving, the aforementioned interviewee from a large global renewable energy company reported that her company is significantly considering adopting blockchain technology and initiating a decentralized business transaction management system, such as P2P-based value transfer and blockchain-based crowdsourcing. This emerging digital phenomenon is relevant to the automation causal recipe, in which IT could substitute for operational innovation capability and reduce centralized decision-making. Hence, this technology could enable a *decentralized automation causal recipe.* Our findings based on the interviews, as well as the examples of possible specializations of our causal recipes with some important requirements for their materialization, are summarized in Table 8.

7 Discussion

7.1 Theoretical Contributions and Implications

In Table 9, we summarize our key findings in comparison with the extant IS and AMC studies on competitive dynamics, highlighting the unique and significant contributions of our study.

First, this study makes important theoretical contributions to the IS competitive dynamics literature by developing a context-specific midrange theory consisting of five theoretical propositions in the form of configurational causal recipes that prescribe specific ways to configure IT assets (i.e., IT infrastructure and IT applications) and AMC factors depending on different organizational and environmental conditions. The propositions provide fundamental baselines from which researchers can develop further specialized configurational recipes to incorporate new affordances of emerging digital technologies, as we demonstrated through theoretical extension with additional qualitative interviews.

Table 8. Summary of the Role of Emergent Technologies (Examples) in Competitive Dynamics

Emerging technologies	**Why and how it matters**	**Examples of specializing the causal recipes**	**Requirements**
Big data analytics	• Predicting market competition and customer demands, especially in highly uncertain environments • Determining new business opportunities • Diffusing data-oriented culture throughout the company • Creating a service that generates revenue • Supporting the TMT's decision-making	Adding predictive digital capacities to the *integration causal* recipe in which big data analytics technologies complement a firm's awareness capability not only for its current competition but also for future opportunities and changes. This could be specialized as a *predictive integration causal* recipe.	• Providing training opportunities to employees • Increasing data scientists (through both new hiring and internal training) • Internet of things to collect data and provide new services
Machine learning (ML) and AI	• Replacing costly and highly risky operations and practices (e.g., replacement of animal and human testing in medicine development) • Building smart factories to further automate process controls and management • Automating operations to maintain high-quality services	Adding intelligent digital capacities to the *automation causal* recipe, in which highly risky and sophisticated organizational decisions (motivations) and processes requiring operational innovations can be totally replaced by new disruptive and intelligent technologies, such as digital twins and AI automation. This could be specialized as an *intelligent automation causal* recipe.	• Developing or purchasing high-quality training datasets • Continuously updating ML and AI models and algorithms through appropriate HR support • Adopting advanced AI systems (e.g., ChatGPT)
Cloud as a service	• Supporting more remote and flexible work environments • Providing a platform of remote and virtual meetings (among employees and with external partners or customers) • Implementing global enterprise systems (e.g., cloud-based global ERP)	Adding virtual digital capacities to the *integration causal* recipe, in which a highly virtualized IT infrastructure (i.e., cloud computing environments and services) comprehensively integrates various HR and operations within a firm and across business units. This could be specialized as a *virtual integration causal* recipe.	• Building new virtual work processes and culture • Appropriately evaluating the best technical option for a firm's cloud-as-a-service environment
Blockchain	Implementing a P2P network to integrate the business, suppliers, and customers	Adding decentralized digital capacities to the *automation causal* recipe, in which business transactions (e.g., P2P-based value sharing and transfer and blockchain-based crowdsourcing) and their management become decentralized and automated. This could be specialized as a *decentralized automation causal* recipe.	Changing organizational architecture, IT governance, and work relationships

Table 9. Key Findings Compared with Extant Competitive Dynamics Research

Contribution points	This study	IS competitive dynamics literature	AMC literature
IT-AMC relationship	• Explicit conceptualization and measurement of IT, AMC factors • Systems theory perspective • Conjunctural causality suggesting that IT and AMC are combined to generate competitive actions • Configuration-based holistic interdependent relationships between IT and AMC in generating competitive actions	• No conceptualization and measurement of AMC factors • No empirical investigation of the relationships between IT and AMC factors • Dominant variance theory perspective • Correlation-based linear relationships between IT and competitive actions	• No consideration of IT in AMC/ competitive dynamics • Correlation-based linear relationships between AMC and competitive actions
IT role in competitive dynamics	• Investigates IT roles in interactions with AMC factors within and across configurations of competitive actions • Explores the multifaceted roles of IT in generating competitive actions in complementing or substituting for AMC factors • Shows that not all AMC factors are always necessary for generating competitive actions due to IT. • Conceptualizes IT assets into IT infrastructure and IT applications, thus investigating more granular, nuanced relationships with awareness, motivation, operational excellence capability, and operational innovation capability	• Studies mostly conceptualize the enabling role of IT in enhancing organizational capabilities (e.g., agility, innovation), which in turn generate competitive actions • Lack of research investigating IT role for AMC • Some studies adopt AMC as a theoretical background • Some studies do not explicitly make IT construct but treat IT as a context. • Some studies conceptualize IT as a single dimension (e.g., IT investment, IT intensity)	• Lack of research on the role of IT in competitive dynamics • All AMC factors are necessary for generating competitive actions.
Contingency effect	• Multidimensional conceptualization of environmental contingency in terms of speed and uncertainty • Firm size contingency • Context-specific midrange theory	• Lack of investigation of internal and external contingency effect on IT-enabled competitive dynamics	• Some moderating and mediating factors • Lack of investigation of internal and external contingency effect on IT-AMC relationship for competitive actions

Second, the study suggests an extended IT-AMC framework to guide researchers in exploring interdependencies beyond the conventional understanding of the linear, independent net effect of IT on organizational capabilities in competitive dynamics. We show how the AMC framework can be extended to holistically reveal the role of information and digital technologies (Burton-Jones et al., 2021). Thus, this study opens novel research avenues on competitive dynamics in digital business environments and responds to the call for IS research to reformulate the assumptions and theories of other disciplines to better explicate the role of IT (Rai, 2017, p. vii).

Third, our findings extend IS research on the role of IT in competitive dynamics. Although this topic has been central in the IS literature (e.g., Dewan & Min, 1997), results have been inconclusive and often contradictory regarding whether and in which conditions IT complements or substitutes for other organizational resources and capabilities (e.g., Dewan & Min, 1997; Havakhor et al., 2019; Tafti et al., 2022). In this study, we addressed this issue by delving into the granular details of complementarity and substitution between specific IT assets (IT infrastructure and IT applications instead of IT investment or IT intensity) and AMC factors. Moreover, by using a configurational approach, our findings reveal the context-specific IT and non-IT complementary/substitution relationships, highlighting the nuanced IT effects given different contingencies of firm size and environmental conditions—an issue rarely addressed in the IS competitive dynamics literature.

7.2 Implications for Practice

This study sheds new light on competitive dynamics by developing configurational mechanisms that help firms understand the holistic interdependent relationships between IT and AMC factors, as well as their nuanced roles in generating competitive actions. These mechanisms thus enable them to make effective configurations to make frequent competitive actions depending on their specific contexts. Our configurational causal recipes can serve as a practical toolkit that helps firms appropriately use not only traditional IT assets (i.e., IT infrastructure and IT applications) but also emerging digital technologies to cope with competitive dynamics that continue to change through digitalization. Our study indicates that information and digital technologies are the fundamental sources for a firm's competitive action generation. Thus, we suggest that IT infrastructure and applications should be designed in a way that automates, autonomizes, innovates, or integrates organizational AMC factors by complementing or substituting for them. For example, real-time data acquisition and presentation by IT assets should be utilized to support the TMT's environmental scanning and decision-making about emerging opportunities, threats, and competitors' moves to generate competitive actions. Likewise, IT assets should be designed in ways that consistently complement operational excellence capability.

Our findings also suggest that IT assets, especially IT applications, should be designed and utilized to substitute for or complement the TMT's decision-making and operational innovation capability, depending on specific contexts. However, this finding does not mean that firms should not have motivation and operational innovation capability; rather, it indicates the nuanced strategic values of IT assets and identifies the specific contexts in which a firm should focus more on certain organizational resources and capabilities. Moreover, our findings from the additional interviews with TMT members of contemporary manufacturing companies indicate the evolving roles of IT assets within a firm with emerging technologies, which can further shape the relationships between IT and non-IT factors. According to our findings, the applications of machine learning and AI technologies can help firms further shape their IT-driven automations to be more intelligent, while the adoption of blockchain technologies can help them transform their IT-driven automations to become more decentralized and thus more locally specialized.

Lastly, our findings also indicate that standardized IT infrastructure and IT applications can help firms quickly integrate organizational resources and capabilities like AMC to generate competitive actions in turbulent environments. Specifically, our findings from the interview outcomes suggest two specific ways of IT-driven firm-level integration using emerging technologies: (1) data-driven predictive integration by implementing big data analytics, and 2) enterprise-wise virtual integration through cloud-as-a-service infrastructure.

7.3 Limitations and Future Research

Our dataset was based on a large, matched survey design representing both business and technology perspectives at 189 manufacturing firms and covers the necessary data for the purpose of our research. However, because the data were collected between 2005 and 2006, they may not capture the specific aspects of recent digital technologies such as cloud computing, big data analytics, and AI. Additionally, our findings from manufacturing industries may have limited generalizability to other industries. We admit that considering novel technologies and diverse industries is important for understanding why they matter for generating competitive actions, which could be a fruitful avenue for future studies. However, it should be noted that our conceptual development of IT infrastructure and IT applications was not premised on specific technologies and therefore captures the overall patterns of interactions of IT assets with AMC factors in generating competitive actions. Moreover, we conducted a complementary validity check to further address concerns about the age of the data. Specifically, to evaluate whether our IT constructs and key findings can be applied to contemporary businesses, we interviewed top managers in diverse manufacturing firms. As summarized in Table E2 (Appendix E), we found strong support that our findings are still valid for firms in the current business environment, especially considering the fundamental baselines of today's competitive dynamics.

Notwithstanding the benefits of using matched-pair survey data from senior managers, we note that our fsQCA samples included firms from only one geographical region that might have unique cultural, social, and economic characteristics. Although our validity check showed the possibility of the generalizability of our findings by interviewing firms from different regions and firms that operate globally, replications of this study with data from more geographically diverse areas would further improve the generalizability of our findings.

In our fsQCA results, we did not identify a specific configuration for slow and uncertain environments. Future research could investigate the configurational causal recipes for firms in such environments, potentially focusing not on frequent competitive actions but rather on the complexity or heterogeneity of competitive actions (Chi et al., 2010) since slow-changing environments may not require frequent actions to achieve a competitive advantage.

We believe our IT-AMC configurational framework provides a robust foundation to illuminate the role of IT in competitive dynamics, particularly the complex and nuanced interdependent relationships between IT and AMC factors considered holistically. We hope that future research along these lines will extend our framework by adding other important factors or applying it to other contexts to advance theories on digital competitive dynamics.

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Appendix A: Literature Summary of Competitive Dynamics in IS Studies

Table A1. IS Studies on Competitive Dynamics Perspective

Study	IT factors	Constructs implicitly reflecting AMC factors	Competitive action	Contingency	Theoretical perspective	Functional form of relationships	Methods (source/ analysis)	Key findings
Sambamurthy et al. (2003); MISQ	• IT competence • Digital options	• Agility for sending and responding (A/C)	• Number of competitive actions • Complexity of competitive actions	• N/A	• Variance theory	• Mediation	• Conceptual	• IT competence enables competitive actions through a nomological network of three organizational capabilities (agility, digital options, & entrepreneurial alertness) and three strategic processes (capability-building, entrepreneurial action, & coevolutionary adaptation). • The organizational capabilities and strategic processes influence competitive actions, which, in turn, affect firm performance.
Overby et al. (2006); EJIS	• IT	• Sensing agility (A) • Responding agility (C)	• N/A	• N/A	• Process theory	• Mediation	• Conceptual	• IT increases the value of digital options (knowledge reach/richness and process reach/richness) • Digital options, in turn, enhance enterprise agility, such as sensing and responding agility.
Pavlou and El Sway (2006, 2010); ISR	• IT-leveraging capability	• Dynamic capabilities (C) • Improvisational capabilities (A/M/C)	• N/A	• Environmental turbulence	• Variance theory	• Mediation	• Empirical (Survey/ SEM)	• IT-leveraging capabilities enable dynamic capabilities and improvisational capabilities. • Dynamic capabilities and improvisational capabilities support operational capabilities, which, in turn, increase competitive advantages in the context of new product development. • Environmental turbulence moderates the main relationships.
Chi et al. (2010); ISR	• IT-enabled capabilities	• Structural holes (A/M) • Network density (M/C)	• Action volume • Action complexity • Action heterogeneity	• N/A	• Variance theory	• Mediation • Moderation	• Empirical (Secondary/ Regression)	• IT-enabled capabilities help coordination and collaboration and positively moderate the relationship between network density and competitive actions. • In generating competitive actions, firms benefit from dense network structure only when they develop a strong IT-enabled capability. Also, IT-enabled capabilities may substitute for structural holes in generating competitive actions.

Joshi et al. (2010); ISR	• IT	• Absorptive capacity (A/C) • Social integration (A)	• Commercialized innovation	• N/A	• Variance theory	• Mediation • Moderation	• Empirical (Secondary/ Regression & SEM)	• A firm's IT-enabled knowledge capabilities enable its competitive actions and firm innovation. • IT-enabled potential absorptive capacity increases IT-enabled absorptive capacity, which leads to innovation. • IT-enabled social integration capacity moderates the positive relationship between ideated and commercialized innovations.
Rai and Tang (2010); ISR	• Structural IT capabilities	• Competitive process capabilities (C)	• N/A	• Inter-org relationship portfolio concentration • Environmental turbulence	• Variance theory	• Mediation	• Empirical (Survey/ Regression)	• A firm's structural IT capabilities (IT integration, IT reconfiguration, & interaction between IT integration and IT reconfiguration) increase the competitive process capabilities. • A firm's interorganizational relationship and environmental turbulence moderate the main relationship.
Vannoy and Salam (2010); ISR	• Information systems	• Conceiving (A) • Enacting (M) • Executing (C)	• Competitive action	• N/A	• Process theory	• N/A	• Empirical (Case/ grounded theory approach)	• IT may enable a firm's process to conceive, enact, and execute competitive actions.
Tallon and Pinsonneault (2011); MISQ	• Strategic IT alignment • IT flexibility	• Firm agility (A/C)	• N/A	• Environmental volatility	• Variance theory	• Mediation • Moderation	• Empirical (Survey/ SEM)	• Strategic IT alignment and IT flexibility have a significant role in generating agility and superior firm performance. • The relationship between agility and firm performance is stronger in a volatile environment.
Roberts and Grover (2012); JMIS	• Customer-based knowledge creation • Operational process execution	• Customer-sensing capability (A) • Customer-responding capability (C)	• Competitive activity (action efficacy)	• Firm size • Firm age • Economic adversity	• Variance theory	• Mediation	• Empirical (Survey/ SEM)	• Alignment between customer-sensing and responding capabilities increases the speed of competitive activities. • Customer-sensing capability is enhanced by the customer-based knowledge creation in interactions between web-based customer infrastructure and analytical ability, while customer-responding capability is improved by operational process execution with IS integration for internal/external coordination.
Chakravarty et al. (2013); ISR	• IT competencies	• Entrepreneurial ability (A/C) • Adaptive ability (A/C)	• N/A	• Environmental dynamism	• Variance theory	• Mediation • Moderation	• Empirical (Survey/ Regression)	• IT competencies enable organizational capabilities (i.e., adaptive ability and entrepreneurial ability) and increase firm performance. • IT competencies facilitate the effect of organizational capabilities on firm performance.

								• Environmental dynamism strengthens both enabling and facilitating roles of IT competencies.
Lee et al. (2015); ISR	• IT ambidexterity	• Operational ambidexterity (C) • Business agility (A/C)	• N/A	• Environmental dynamism	• Variance theory	• Mediation • Moderation	• Empirical (Survey/ SEM)	• IT ambidexterity increases organizational capability by facilitating operational ambidexterity. • The effect of IT ambidexterity on operational ambidexterity is stronger when firms are exposed to environmental dynamism.
Luo et al. (2016); JAIS	• IT assets	• Cross-channel capabilities (A/C)	• Action volume • Action complexity • Action heterogeneity	• Financial resources Firm size	• Variance theory	• Mediation	• Empirical (Secondary/ Regression)	• The quantity and scope of IT assets increase cross-channel capabilities and facilitate competitive actions. • Financial resources moderate the influence of IT assets on cross-channel capabilities.
Park et al. (2017); JAIS	• Business intelligence & communication technologies	• Sensing agility (A) • Decision-making agility (M) • Acting agility (C)	• Acting agility	• Environmental velocity • TMT energy • Organizational size	• Systems theory	• Configuration	• Empirical (Survey/ fsQCA)	• Business intelligence (BI) and communication technologies play a role in how firms achieve organizational sensing agility, decision-making agility, and acting agility in different environmental and organizational contexts. • There are equifinal pathways from BI and communication technologies to organizational agilities depending on boundary conditions.
Benitez et al. (2018); MISQ	• IT infrastructure flexibility	• Sensing (A) • Seizing of opportunities (C)	• M&A activities	• N/A	• Variance theory	• Mediation	• Empirical (Survey/ SEM)	• IT infrastructure flexibility enables business flexibility that increases the sensing and seizing M&A opportunities.
Ravichandran (2018); JSIS	• IT competence	• Organizational capability (A/C)	• N/A	• Firm size • Firm age • Industry	• Variance theory	• Mediation • Moderation	• Empirical (Survey/ SEM)	• IT competence (i.e., IT capabilities, IT investment orientation, and digital platform capabilities) increases organizational capability and firm performance • Innovation capacity amplifies the effect of IT competence on organizational capability.
Queiroz et al. (2022); EJIS	• Corporate IT platform competence	• Business unit agility (A/C)	• N/A	• N/A	• Variance theory	• Mediation • Moderation	• Empirical (Survey/ SEM)	• Corporate IT platform competence enables business unit digitization and, in turn, leads to business unit (BU) agility. • BU's IT autonomy moderates the effect of business process digitization on BU agility and the effect of corporate IT platform competence on BU agility.

Note: This table is not exhaustive but summarizes representative studies published in top-tier journals in the IS area. Studies are ordered by year of publication. Abbreviations are used for journal names: MISQ = *MIS Quarterly*, ISR = *Information Systems Research*, JMIS = *Journal of Management Information Systems*, JAIS = *Journal of Association for Information Systems*, EJIS = *European Journal of Information Systems*, JSIS = *Journal of Strategic Information Systems*. Extant IS studies on competitive dynamics did not explicitly conceptualize AMC factors based on the AMC framework. However, as extant constructs could be considered implicitly reflecting AMC factors, we tried to match each construct to A, M, or C.

Appendix B: Constructs and Measures

Table B1. Measurement Items

Constructs	Items
Competitive actions	How frequently has your firm launched the following competitive actions relative to other firms in your industry? (1 = Not at all to 7 = A great deal) 1. Entering new markets 2. Capturing new customer segments 3. Introducing new products 4. Introducing design changes 5. Introducing new services or solutions
IT infrastructure	Please indicate your degree of agreement with these statements about IT infrastructure of your firm. (1 = Strongly disagree, 7 = Strongly agree) 1. The business units in your firm can share corporate data on the communication networks. 2. The business units in your firm can share IS applications on the communication networks. 3. Your firm has standardized the various components of your IT infrastructure (e.g., hardware, OS, network, database). 4. Your firm has established corporate rules and standards for hardware and operations systems to ensure platform compatibility.
IT applications	Please indicate your degree of agreement with these statements about IT applications of your firm. (1 = Strongly disagree, 7 = Strongly agree) 1. Your firm has standardized IS applications that conduct the business transactions across various business units (e.g., ERP, intranet). 2. Your firm has standardized IS applications that conduct the business transactions with suppliers and customers (e.g., EDI, extranet).
Awareness	Relative to other firms in your industry, please indicate the ability of your top management team to (1 = Very weak, 7 = Very strong) 1. Sense existing business opportunities and threats 2. Analyze the strengths and weaknesses of competitors' strategic movement 3. Anticipate future market needs 4. Identify unexplored market opportunities
Motivation	Relative to other firms in your industry, please indicate the ability of your top management team to (1 = Very weak, 7 = Very strong) 1. Commit funding for risky initiatives to seize future opportunities 2. Commit management support for risky initiatives to seize future opportunities 3. Encourage competitive innovations
Operational excellence capability	Relative to other firms in your industry, please indicate the ability of your operational unit(s) to (1 = Very weak, 7 = Very strong) 1. Reduce the cost of existing business operations (e.g., product/service development and production, supply chain management, customer delivery, employee management) 2. Improve the cycle time of existing business operations 3. Improve the efficiency of existing business operations
Operational innovation capability	Relative to other firms in your industry, please indicate the ability of your operational unit(s) to (1 = Very week, 7 = Very strong) 1. Implement extensive innovations in business operations (e.g., product/service development and production, supply chain management, customer delivery, employee management) 2. Implement radical innovations in business operations 3. Implement operational innovations that are difficult to replicate by other firms
Environmental speed	Please indicate your degree of agreement about how well these statements describe the market and competitive environment that your firm is operating in. (1 = Strongly disagree, 7 = Strongly agree) 1. The actions of competitors in your major markets are changing rapidly. 2. Technological changes in your industry are rapid. 3. Customers' product/service preference changes rapidly.
Environmental uncertainty	Please indicate your degree of agreement about how well these statements describe the market and competitive environment that your firm is operating in. (1 = Strongly disagree, 7 = Strongly agree) 1. Technological changes in your industry are unpredictable. 2. The market competitive conditions are unpredictable. 3. Changes in customers' needs are unpredictable.
Firm size	Last three-year average of total assets

Appendix C: Construct Validity

Table C1. CFA Results of Original Items and Their Convergent Validity

Constructs	Items	Means (*SD*)	Item loadings	Composite reliability	AVE
Competitive actions (CA)	CA1	4.71 (1.25)	0.82**	0.91	0.68
	CA2	4.83 (1.09)	0.81**		
	CA3	5.09 (1.10)	0.83**		
	CA4	4.87 (1.27)	0.81**		
	CA5	4.64 (1.23)	0.83**		
IT infrastructure (ITI)	ITI1	5.42 (1.00)	0.87**	0.92	0.75
	ITI2	5.02 (1.05)	0.90**		
	ITI3	5.29 (1.08)	0.87**		
	ITI4	4.90 (1.09)	0.83**		
IT applications (ITA)	ITA1	5.06 (1.13)	0.88**	0.88	0.79
	ITA2	4.32 (1.18)	0.90**		
Awareness (A)	A1	5.13 (0.96)	0.85**	0.91	0.71
	A2	5.05 (0.88)	0.74**		
	A3	5.10 (0.94)	0.89**		
	A4	5.30 (0.94)	0.89**		
Motivation (M)	M1	4.17 (1.25)	0.93**	0.93	0.82
	M2	4.39 (1.12)	0.93**		
	M3	5.08 (1.12)	0.84**		
Operational excellence capability (C_E)	C_E1	4.81 (0.89)	0.82**	0.91	0.78
	C_E2	4.56 (0.88)	0.92**		
	C_E3	4.76 (0.92)	0.91**		
Operational innovation capability (C_I)	C_I1	4.84 (0.95)	0.88**	0.93	0.81
	C_I2	4.25 (1.01)	0.92**		
	C_I3	4.05 (1.22)	0.89**		
Environmental speed (ES)	ES1	4.50 (1.35)	0.88**	0.88	0.70
	ES2	4.33 (1.47)	0.86**		
	ES3	3.99 (1.36)	0.78**		
Environmental uncertainty (EU)	EU1	3.76 (1.28)	0.80**	0.84	0.63
	EU2	4.22 (1.01)	0.77**		
	EU3	3.69 (1.20)	0.81**		
Firm size (FS)	FS1	8.83 (0.68)	NA	NA	NA
Note: ** $p < 0.01$, * $p < 0.05$					

Table C2. Correlations Among Constructs and Their Discriminant Validity

Constructs	CA	ITI	ITA	A	M	C_E	C_I	ES	EU	FS
Competitive actions (CA)	**0.82**									
IT infrastructure (ITI)	0.15	**0.87**								
IT applications (ITA)	0.13	0.71	**0.89**							
Awareness (A)	0.67	0.19	0.14	**0.84**						
Motivation (M)	0.58	0.18	0.24	0.61	**0.90**					
Operational excellence capability (C_E)	0.66	0.21	0.24	0.62	0.62	**0.90**				
Operational innovation capability (C_I)	0.54	0.26	0.24	0.59	0.56	0.55	**0.88**			
Environmental speed (ES)	0.48	0.13	0.15	0.26	0.49	0.47	0.34	**0.84**		
Environmental uncertainty (EU)	0.18	0.02	0.15	-0.04	0.30	0.27	0.10	0.66	**0.80**	
Firm size (FS)	0.01	-0.03	-0.01	-0.03	-0.06	0.01	-0.06	0.05	0.07	**NA**

Table C3. Cross-Loading Results Among Constructs

Constructs		CA	ITI	ITA	A	M	C_E	C_I	ES	EU	FS
Competitive actions (CA)	CA1	**0.82**	0.11	0.07	0.59	0.49	0.49	0.57	0.39	0.11	-0.01
	CA2	**0.81**	0.14	0.07	0.60	0.51	0.54	0.52	0.33	0.12	-0.05
	CA3	**0.83**	0.16	0.15	0.54	0.40	0.39	0.51	0.40	0.14	0.03
	CA4	**0.81**	0.08	0.10	0.51	0.49	0.35	0.59	0.41	0.16	0.02
	CA5	**0.83**	0.14	0.14	0.51	0.50	0.43	0.53	0.46	0.21	0.05
IT infrastructure (ITI)	ITI1	0.06	**0.87**	0.62	0.19	0.10	0.27	0.17	-0.02	-0.06	-0.02
	ITI2	0.17	**0.90**	0.64	0.20	0.17	0.25	0.19	0.17	0.03	-0.01
	ITI3	0.09	**0.87**	0.56	0.15	0.08	0.16	0.17	0.08	-0.04	0.01
	ITI4	0.19	**0.83**	0.64	0.12	0.26	0.21	0.20	0.19	0.11	-0.08
IT applications (ITA)	ITA1	0.09	0.67	**0.88**	0.15	0.13	0.17	0.18	0.07	0.08	0.03
	ITA2	0.14	0.60	**0.90**	0.10	0.29	0.26	0.24	0.20	0.18	-0.05
Awareness (A)	A1	0.55	0.17	0.05	**0.85**	0.47	0.50	0.53	0.18	-0.08	-0.06
	A2	0.46	0.13	0.11	**0.74**	0.30	0.41	0.37	0.12	-0.07	0.01
	A3	0.60	0.19	0.16	**0.89**	0.62	0.55	0.56	0.27	0.02	0.02
	A4	0.63	0.14	0.15	**0.89**	0.61	0.53	0.60	0.28	-0.01	-0.05
Motivation (M)	M1	0.56	0.14	0.19	0.55	**0.93**	0.50	0.56	0.49	0.33	-0.03
	M2	0.53	0.09	0.17	0.55	**0.93**	0.47	0.53	0.43	0.25	-0.06
	M3	0.50	0.25	0.28	0.56	**0.84**	0.56	0.58	0.42	0.22	-0.06
Operational excellence capability (C_E)	C_E1	0.41	0.22	0.22	0.48	0.38	**0.82**	0.44	0.24	0.01	-0.08
	C_E2	0.50	0.30	0.29	0.52	0.57	**0.92**	0.51	0.31	0.13	-0.07
	C_E3	0.51	0.16	0.14	0.58	0.54	**0.91**	0.48	0.34	0.10	-0.02
Operational innovation capability (C_I)	C_I1	0.61	0.17	0.17	0.64	0.47	0.49	**0.88**	0.35	0.12	0.05
	C_I2	0.58	0.15	0.14	0.53	0.57	0.51	**0.92**	0.38	0.25	0.02
	C_I3	0.60	0.25	0.32	0.50	0.62	0.46	**0.89**	0.51	0.36	-0.04
Environmental speed (ES)	ES1	0.52	0.08	0.10	0.31	0.43	0.34	0.43	**0.88**	0.48	0.02
	ES2	0.40	0.13	0.16	0.29	0.53	0.29	0.46	**0.86**	0.59	0.03
	ES3	0.26	0.11	0.13	0.01	0.23	0.21	0.25	**0.78**	0.60	0.08
Environmental uncertainty (EU)	EU1	0.15	0.02	0.17	0.07	0.36	0.10	0.31	0.51	**0.80**	0.03
	EU2	0.08	-0.03	0.02	-0.06	0.07	-0.01	0.12	0.46	**0.77**	0.06
	EU3	0.18	0.04	0.14	-0.09	0.24	0.12	0.20	0.58	**0.81**	0.09
Firm size (FS)	FS1	0.01	-0.03	-0.01	-0.03	-0.06	-0.06	0.01	0.05	0.07	**1.00**

Appendix D: Truth Table

Table D1. Truth Table for High-Competitive Actions (Calibration with [6, 4, 2] Anchors)

Awareness	Motivation	Operational excellence capability	Operational innovation capability	IT infrastructure	IT applications	Environmental speed	Environmental uncertainty	Firm size	Number	Competitive actions	Raw consistency	PRI consistency
1	1	1	1	1	1	1	1	0	33	1	0.97	0.94
1	1	1	1	1	1	1	1	1	18	1	0.99	0.97
1	1	1	1	1	1	1	0	1	15	1	0.99	0.98
1	0	1	1	1	1	0	0	1	11	1	0.97	0.87
1	1	1	1	1	1	0	0	1	10	1	0.98	0.92
1	1	1	1	1	1	1	0	0	5	1	0.98	0.94
1	1	1	1	1	1	0	0	0	5	1	0.97	0.88
1	0	1	0	1	1	0	0	1	5	1	0.96	0.83
1	1	1	0	1	1	0	0	1	4	1	0.97	0.88
1	0	1	1	1	1	0	0	0	4	1	0.99	0.91
1	0	1	0	1	1	0	0	0	4	1	0.97	0.81
1	1	1	1	1	0	1	1	0	3	1	0.98	0.94
1	1	1	1	1	0	1	0	0	3	1	0.99	0.97
1	1	1	1	1	1	0	1	0	3	1	0.97	0.86
1	1	1	1	0	0	1	1	0	3	1	0.99	0.93
1	1	1	0	1	1	1	1	0	3	1	0.96	0.83
1	0	1	1	1	1	1	0	1	3	1	0.99	0.96
0	0	0	0	0	0	1	0	0	3	0	0.97	0.61

Each row in the truth table represents a combination of cases that have similar membership scores for all conditions. For example, the first row in Table D1 shows that 33 firms have membership in this combination. The truth-table algorithm excludes cases in the crossover cases because they may be included on either side, and that is the default option in the software, which we followed. As an aside, if the exclusion of such cases on the boundary results in too few cases, then the software allows a researcher to decide (based on the knowledge of these cases) whether to add an insignificant value (e.g., 0.001) to each variable so that such cases are not excluded in the analysis, as suggested by Ragin (2008) and Fiss (2011, p. 407). Such an insignificant value does not change the resultant values of the consistency and coverage of each row in the truth table. Given that we followed the default procedure because we had a large dataset, and only a few cases were dropped due to their values on the crossover boundaries, the resultant configurations have clearer boundaries. Based on the guidelines of QCA studies (Greckhamer et al., 2013; Ragin, 2008), we set the minimum acceptable number of cases, thus considering only combinations with at least three cases for subsequent analysis in the truth-table algorithm. Handling the cases in fsQCA depends on the data size, number of variables, and research context. For example, if the dataset size is large enough, e.g., 200 cases for a firm-level study that includes 10 variables, one can use the frequency cutoff of 3 or greater. On the other hand, if a study involves states or countries with only five variables, a smaller cutoff value could be used, such as 1 (Greckhamer et al., 2013).

The column in the truth table for the outcome (i.e., competitive actions) shows the extent to which each row consistently produces the outcome (i.e., high-competitive actions). In fsQCA, there are two consistency measures: (1) raw consistency, which gives credit for "near misses" and penalties for large inconsistencies, and (2) PRI (proportional reduction in inconsistency) consistency, which additionally eliminates the influence of cases that have simultaneous membership in both the outcome and its complement (i.e., *y* and ~*y*). The raw consistency and PRI consistency are calculated with the set membership scores (*Xi* and *Yi*) of the cases, consistent with the QCA literature (e.g., Ragin, 2008, pp 44-48).[16] In our study, we applied two rules, suggested by the QCA literature, to determine the cutoff for consistency (Ragin, 2008). First, for a combination (a row in Table D1) to reliably produce high-competitive actions, its raw consistency and PRI consistency should be above 0.9 and 0.75, respectively. Second, if there is a break point in which the consistency significantly drops between two rows, from a row with a high level of consistency to a row with the next level of consistency, then the break point can be a cutoff for the high outcome group. For example, there is a significant drop in the PRI consistency between the last row with the lowest PRI consistency, 0.61, and the row with the next lowest PRI consistency, 0.83. Thus, we decided on raw and PRI consistencies of (0.90, 0.8) as cutoffs for the high-competitive-actions group, and set a value of 1 in the "Competitive Actions" column for rows with a consistency higher than the cutoffs; otherwise, it is set to 0.

Next, fsQCA applies the QM algorithm and counterfactual analysis (Ragin, 2008) to reduce many combinations into a few configurations. First, using Boolean algebra, it performs the logical reduction of all possible combinations. Then, using counterfactual analysis, fsQCA overcomes the limitations of a lack of empirical instances (Ragin, 2008, p. 162). Specifically, counterfactual analysis distinguishes between "easy" and "included difficult" counterfactuals, resulting in three kinds of sufficient solutions: a complex solution without any counterfactuals, an intermediate one with only "easy" counterfactuals, and a parsimonious one with both "easy" and "included difficult" counterfactuals. See more details in other sources (Fiss, 2007, 2011; Park et al., 2017, 2020; Ragin, 2008).

Table D2. Truth Table for Not-High-Competitive Actions

Awareness	Motivation	Operational excellence capability	Operational innovation capability	IT infrastructure	IT applications	Environmental speed	Environmental uncertainty	Firm size	Number	Not-high-competitive actions	Raw consistency	PRI consistency
0	0	0	0	0	1	0	0	0	3	0	0.96	0.37
1	0	1	0	1	0	0	1	0	4	0	0.87	0.19
1	0	1	1	1	0	0	1	0	4	0	0.85	0.08
1	1	1	1	1	0	1	1	0	3	0	0.81	0.14
1	1	1	1	0	1	1	0	0	3	0	0.80	0.07
1	1	1	0	1	1	1	1	0	3	0	0.80	0.17
1	0	1	0	1	0	0	1	1	5	0	0.79	0.16
1	0	1	1	1	0	0	1	1	11	0	0.79	0.12
1	0	1	1	1	1	0	1	1	3	0	0.79	0.03
1	1	1	0	1	0	0	1	1	4	0	0.78	0.09
1	1	1	1	1	0	0	1	0	5	0	0.77	0.12
1	1	1	1	1	1	0	0	0	3	0	0.76	0.03
1	1	1	1	1	1	1	0	0	3	0	0.74	0.06
1	1	1	1	1	0	0	1	1	11	0	0.73	0.07
1	1	1	1	1	1	0	1	0	5	0	0.66	0.06
1	1	1	1	1	1	0	1	1	17	0	0.60	0.02

For not-high-competitive actions, there is no combination that satisfies both the raw and PRI consistency cutoff (0.9, 0.75) simultaneously. As a result, there is no consistent configuration that reliably results in not-high-competitive actions. If we do not consider PRI consistency and set 0.9 as a cutoff for raw consistency, we can include the first row for making configurations of not-high-competitive actions, which results in one configuration: small and medium-sized firms in slow and certain environments with a presence of IT applications and absence of all other elements. Table D3 is a truth table for sensitivity analysis with different calibration anchors.

[16] Consistency = $\sum min(Xi, Yi) / \sum(Xi)$, PRI Consistency = $[\sum min(Xi, Yi) - \sum min(Xi, Yi, \sim Yi)] / [\sum(Xi) - \sum min(Xi, Yi, \sim Yi)]$, Coverage = $\sum min(Xi, Yi) / \sum(Yi)$, where *Xi* is a set membership score of a case for an element, and *Yi* is a set membership score of a case for the outcome. That is, *Xi* is a calibrated set membership score of case *i* regarding the *X* variable (e.g., awareness), which can be any value between 0 and 1, e.g., 0.13, 0.78, or 0.92 (see Ragin, 2008, pp. 44-48). Note that values of 1, 0.5, and 0.0 for full, crossover, and full non-membership, respectively, are different from how *Xi* is calculated.

Table D3. Truth Table for High-Competitive Actions (Calibration with [7, 4, 1] Anchors for Sensitivity Analysis)

Awareness	Motivation	Operational excellence capability	Operational innovation capability	IT infrastructure	IT applications	Environmental speed	Environmental uncertainty	Firm size	Number	High-competitive actions	Raw consistency	PRI consistency
1	1	1	1	1	1	1	1	0	33	1	0.98	0.95
1	1	1	1	1	1	1	1	1	18	1	0.99	0.97
1	1	1	1	1	1	1	0	1	17	1	0.99	0.98
1	1	1	1	1	1	0	0	1	11	1	0.99	0.93
1	0	1	1	1	1	0	0	1	11	1	0.98	0.89
1	1	1	1	1	1	1	0	0	5	1	0.98	0.94
1	1	1	1	1	1	0	0	0	5	1	0.98	0.88
1	0	1	0	1	1	0	0	1	5	1	0.98	0.85
1	0	1	1	1	1	0	0	0	4	1	0.99	0.93
1	1	1	0	1	1	0	0	1	4	1	0.98	0.89
1	0	1	0	1	1	0	0	0	4	1	0.98	0.84
1	0	1	1	1	1	1	0	1	3	1	1.00	0.97
1	1	1	1	1	0	1	0	0	3	1	0.99	0.96
1	1	1	1	1	0	1	1	0	3	1	0.99	0.94
1	1	1	1	0	0	1	1	0	3	1	0.99	0.94
1	1	1	1	1	1	0	1	0	3	1	0.98	0.87
1	1	1	0	1	1	1	1	0	3	1	0.98	0.85
0	0	0	0	0	0	1	0	0	3	0	0.99	0.71

Appendix E: Validation Check

Table E1. Summary of the Demographics of Our Interviewees

#	Industry	Position & major role	Years in the current position (years in the company)	Knowledge of IT assets	USD total assets (employee, firm size)	Market speed	Market uncertainty	Market competition
1	Pharmaceutical (manufacturing)	Head of business strategy	16 years (27 years)	Moderate	120 billion (8,000, Large)	Low	Low	Global
2	Semiconductor (manufacturing)	Regional CFO & operational director	2 years (9 Years)	High	56 billion (28,000, Large)	High	High	Global
3	Renewable Energy (manufacturing & service)	VP for digital transition of operations	2 years (9 years)	High	Not Available (8,500, Large)	High	Moderate	Global
4	Electronics (manufacturing)	Division director for product design	3 years (30 years)	Moderate	29 billion (20,000, Large)	High	High	Global
5	Electronics (manufacturing)	Director of global business development	2 years (11 years)	Moderate	200 million (370, SME)	High	High	Global
6	Aerospace (manufacturing & service)	VP of satellite operation and imaging service unit	10 years (18 years)	Moderate	177 million (500, SME)	High	Moderate	Global
7	Electronics (manufacturing)	Director of analytics service	9 years (25 years)	High	40 billion (35,000, Large)	High	High	Global
8	Automobile (manufacturing)	CIO	3 years (3 years)	High	6.4 billion (2,200, Large)	Low	Moderate	Global
9	Cosmetics (manufacturing)	CEO	10 years (18 years)	Moderate	1 million (NA*, SME)	High	Moderate	Global
10	Legal Service (service)	CEO for business development and general management	15 years (20 years)	High	6 million (60, SME)	Moderate	Moderate	Global (limited)

Table E2. Summary of the Qualitative Validation Check

Our findings	Summary of responses	Examples provided by participants
IT assets as critical resource for competitive actions (for all contexts)	• Critical for large data processing for new product development and existing product improvement • Critical to standardize and integrate business processes to improve their quality and control • Critical for organizational collaborations and synchronization with other departments or regional business units, especially to continue to improve product quality and decrease costs • Critical for the data visibility across internal units and through the external supply chain, especially for demand-supply management • Critical to facilitate both internal and external collaboration for both data and communications • Critical for the emerging need of remote work environments	• New medicine development through the integration of both proprietary databases for human disease and public data sources (e.g., EMBL-EBI and TCGA) • Pattern analyses and error detection using operational data from various sensors and business processes • Flexible integration of various enterprise systems and modules (e.g., MRP, SCM, finance, and sales) over an IT infrastructure (e.g., using either internal or cloud-based infrastructure or both) • Use of software-as-a-service to provide more mobile and flexible work environments • Use of dashboards to improve data visibility for decision-making • Use of project tracking and coordination applications (e.g., Jira and MS Teams for both internal and external data sharing and communications)
Automation causal recipe (for large firms & SMEs, slow & certain)	• Importance of automated organizational decision-making using transactional and performance data, where the decision-making is quite structured • Operational automations frequently required under highly regulated environments (even for new product development and manufacturing), which are usually done using IT	• Automatic planning for product manufacturing, introduction, and marketing using a planning system • Automation of documentation for structured forms using a document management system for searching and retrieving relevant data from databases • IT-based operational automation for new product manufacturing required by regulations
Autonomy causal recipe (for large firms, fast & certain)	• Reduced TMT involvement in routinized businesses and services by optimizing the visibility of required data (e.g., for demand-supply management)	• Integration of external data sources (e.g., consumer usage data and weather data) using public cloud infrastructure for automatic service control and optimization
Innovation causal recipe (for SMEs, fast)	• Importance of both TMT insights and organizational data extracted and summarized from various departments using IT to make quick decisions • High strategic value of customized IT applications to better support the unique business needs in SMEs • Importance of IT applications for new organizational initiatives	• Use of local vendors' ERP systems designed for small firms, which provides a deeper level of initial and continuous customizations • Use of remote collaboration tools to respond to sudden changes in the work/operational environment (e.g., using MS Teams during pandemics for global collaborations across business units and customer management) • The quick development of new IT applications for fast execution of new initiatives
Integration causal recipe (for large firms, fast & uncertain)	• The critical role of IT in supporting the TMT (e.g., for data-oriented decision-making), but IT is not enough in itself due to the critical role of the TMT's involvement and capabilities under high market uncertainty and rapid change • Importance of design, implementation, and utilization of IT assets to properly complement the TMT's work and operational changes • Importance of process integration and coordination using IT applications	• Utilization of R&D collaboration tools (e.g., Jira) to coordinate project processes like SW development • Integration of various applications (e.g., CAD, simulation tools, and MRP) across different units, such as consumer product design and manufacturing, for data-oriented decision-making • Use of robotic process automation (RPA) to script operational routines for the improvement of operational efficiency and decreasing human error

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