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Adapting ERP Systems in the Post-implementation Stage: Dynamic IT Capabilities for ERP

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Abstract

Background: *Firms recently rely on enterprise systems, such as enterprise resource planning (ERP), to integrate, automate, and support business strategy and operations. However, uncertain environments require firms continuously adapt their ERP systems to meet changing business demands in the post-implementation stage. What capability can drive ERP post-implementation adaptation (PIA) deserves further research. Based on the dynamic capabilities view, we propose that dynamic IT capabilities for ERP, namely IT sensing, IT learning, IT integration, and IT coordination capability, can drive ERP-PIA.*

Method: *A cross-sectional and matched-pair mail survey of both business and IS executives was administrated for collecting data from the top 1,000 manufacturing firms in Taiwan. Partial least squares structural equation model (PLS-SEM) was constructed for measurement validation and hypotheses testing.*

Results: *Based on 128 samples (74 firms), our findings demonstrate the importance of the dynamic IT capabilities for achieving higher levels of ERP-PIA. ERP-PIA can facilitate greater organizational benefits from system use.*

Conclusions: *This study conceptualizes and empirically demonstrates the importance of ERP-PIA, which provides a specific example of IT/IS adaptation. This study also conceptualizes dynamic IT capabilities for ERP, and theorizes how these capabilities interact to enable firms to adapt ERP systems to fulfill the emergent demands. This study improvs the understanding of the roles of dynamic IT capabilities for ERP in enabling ERP-PIA and organizational benefits through a richer theoretical framing than that of prior studies.*

Keywords: Enterprise Resource Planning (ERP), Enterprise Systems, Post Implementation, Dynamic Capabilities, Organizational Benefits From System Use.

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Introduction

Contemporary firms are facing increasingly globalized and uncertain business environments. Therefore, increasing firms have relied on enterprise systems (ES), such as enterprise resource planning (ERP) systems, to improve operation efficiency and support business strategy in responding to the environments (Jiang et al., 2019; Rezvani et al., 2017; Shao, 2019). ERP systems recently have become the most typical and pervasive ES in firms and been greatly infused into firms' daily operations (Barth & Koch, 2019; Elragal & Hassanien, 2019; Peng et al., 2018). Various organizational benefits brought by ERP systems (e.g., operational, managerial, strategic, and organizational benefits) have been widely demonstrated in the literature (Jiang et al., 2019; Staehr et al., 2012).

However, given rapidly changing business environments and newly emerging technologies, firms are not only forced to adapt their business activity, strategy and structure but also their information systems (Aanestad & Jensen, 2016; Barth & Koch, 2019). ERP systems inevitably require to be adapted after initial implementation completion and use for a certain period (Aanestad & Jensen, 2016; Albert et al., 2015; Oseni et al., 2017). Otherwise, ERP systems can become legacy, and some functionalities are outdated (Furneaux & Wade, 2011). ERP systems would thus misfit with firms' business activity, strategy and structures, thereby compromising the organizational benefits derived from the initial implementation (Aanestad & Jensen, 2016; Rettig, 2007). ERP post-implementation adaptation (PIA), i.e., the post-implementation change of an ERP to meet changing business demands (Khoo et al., 2011; Oseni et al., 2017)., therefore, would be a critical driver of the organizational benefits from system use in the long run (Seddon et al., 2010; Staehr et al., 2012).

ERP, however, cannot adapt or renew by itself but relies on the firm's capability (Vessey & Ward, 2013). This thus raises a research question: *What capability will drive ERP-PIA?* We argue that dynamic IT capabilities for ERP will enable ERP-PIA. Dynamic IT capabilities for ERP, namely IT sensing, IT learning, IT integrating, and IT coordinating capability, are a higher-order capacity of a firm to purposefully modify its existing ERP-related resource base into new ones (Helfat et al., 2007). According to the dynamic capabilities view (DCV) (Teece et al., 2016; Teece et al., 1997), firms with specific dynamic capabilities can sense and then address the requirements of environment changes by integrating and reconfiguring internal and external resources (Gregory et al., 2015). By continuous identifying potential opportunities and undertaking a series of action plans (i.e., ERP upgrade and enhancement projects) (Barth & Koch, 2019; Daniel et al., 2014; Seddon et al., 2010), Dynamic IT capabilities for ERP enable firms to adapt their ERP systems to meet their emergent business demands (Daniel et al., 2014; Staehr et al., 2012; Zhu et al., 2010), thereby facilitating organizational benefits. For example, facing the advent of cloud computing and market turbulence, a firm may sense the business needs of cloud ERP, which provides better information access, information sharing, and scalability (Liu et al., 2018; Walther et al., 2018), and undertake a upgrade project of existing ERP to fulfil said needs (Barth & Koch, 2019; Daniel et al., 2014; Liu et al., 2018; Walther et al., 2018).

Furthermore, according to DCV, environmental turbulence, defined as the frequency and amplitude of change in the environment and general conditions of uncertainty (Duncan, 1972; Wilden & Gudergan, 2015), can influence how firms utilize their dynamic capabilities (Chakravarty et al., 2013). In the stable environment, which tends to be predictable and incremental, with low rates of change (Duncan, 1972; Wilden & Gudergan, 2015), the dynamic capabilities play a relatively minor role. In contrast, under the turbulent environments, dynamic capabilities play a crucial role in helping firms gain competitiveness (Peteraf et al., 2013). This is because environmental turbulence often creates new opportunities and facilitates firms to change their business activity, strategy, and structure (Pavlou & El Sawy, 2011). That is, environmental turbulence may enhance firms' utilization of dynamic IT capabilities to adapt their ERP systems. Thus, in this study, we further investigate that *whether the effects of*

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dynamic IT capabilities for ERP on ERP-PIA would be more significant under the turbulent environment.

Overall, this study draws upon DCV to develop a research model to examine how the dynamic IT capabilities for ERP help firms adapt their ERP systems to obtain organizational benefits, and whether environmental turbulence moderates such the relationship between the dynamic IT capabilities and ERP-PIA. Our result indicates that dynamic IT capabilities for ERP drive ERP-PIA, thereby increasing organizational benefits. However, environmental turbulence fails to moderate the relationship between the dynamic IT capabilities for ERP and ERP-PIA.

This study contributes to the literature in two aspects. First, although prior studies often imply that firms need to adapt their information systems to meet business demands (Cao et al., 2013; Daniel et al., 2014; Vessey & Ward, 2013; Wagner & Newell, 2007), less studies empirically demonstrate the effects of such adaptation on organizational benefits. This study argues a positive effect of ERP-PIA on the organizational benefits, and then empirically confirms that after ERP systems go live, continual upgrades and enhancements of the systems are necessary to gain organizational benefits (Aanestad & Jensen, 2016; Khoo et al., 2011; Oseni et al., 2017; Zhu et al., 2010). This study thus provides a specific example of IT/IS adaptation. As the pervasiveness of ERP systems in recent firms, ERP-PIA would be an important step for firms to achieve IT/IS adaptation. Second, this study, based on the DCV, develops the concepts of dynamic IT capabilities for ERP and empirically demonstrate how these capabilities drive ERP-PIA success. It confirms and extends our understanding on the importance of dynamic capabilities on organizational performance, especially the dynamic IT capabilities for ERP in this study.

This paper is organized as follows. In the subsequent section, we review the literature related to ERP improvement and adaptation on the post-implementation stage, identify the research constructs, and derive the research hypotheses and model. The research methods and measurements are then described, followed by the data analysis. The managerial and research implications, future research directions, and study limitations are discussed. Finally, the study conclusions are presented.

Conceptual Development

Organizational Benefits from System Use

The organizational benefits from system use have been widely studied in the literature. In this study, we primarily use the findings of Seddon et al. (2010), who noted that the organizational benefits from system use can be "an overall measure of senior management's perception of the benefits from the IT-based application." This implies that the organizational benefits from system use can be measured based on the senior management's perceived benefits. We further determine the benefits, including the operational, managerial, organizational, and strategic benefits (Shang & Seddon, 2002). In almost every case, these organizational benefits from system use vary over time (Seddon et al., 2010). Therefore, the senior management may perceive different levels of organizational benefits from system use in different circumstances and environments. They may perceive the declining benefits when a misfit between business operations and ERP systems emerges and their firms are unable or unwilling to undertake the adaptation of the ERP systems. In this study, we adapt Seddon's definition and focus on the benefits derived from overall improvement in ERP investment after the ERP becomes stable. We expect that the benefits expected by senior managers will persist in higher levels because of ERP-PIA.

ERP Post-implementation Adaptation

Recent studies have often implied that information systems, such as ERP systems, need to evolve or adapt to fulfill the evolving demands and environment after go-live (Cao et al., 2013; Daniel et al., 2014; Vessey & Ward, 2013; Wagner & Newell, 2007). However, there is a general negligence about the empirical demonstration of the effects of ERP-PIA on organizational benefits and the capabilities that drive ERP-PIA. We review the literature about ERP post-implementation and summarize the issues related to ERP-PIA in Table 1. We noted that the following points:

1. Studies published in the top journals have focused mainly on ERP or ES implementation issues (Baillien et al., 2011; Hung et al., 2013; Lee & Myers, 2009; Mu et al., 2015; Saraf et al., 2013; Shao e al., 2017; Sykes et al., 2014).

2. Most studies regarding ERP or ES in the post-implementation stage have focused primarily on whether and how to gain more benefits from the initial ERP implementation (Baillien et al., 2011; Galy & Sauceda, 2014; Karimi et al., 2007; Nicolaou & Bhattacharya, 2006; Sykes et al., 2014; Trinh-Phuong et al., 2012).

3. The studies about post-implementation ERP often adopt the qualitative methodologies to explore the concepts related to ERP adaptation (Barth & Koch, 2019; Davenport et al., 2004; Galy & Sauceda, 2014; Ha & Ahn, 2013; Koh et al., 2011; Nicolaou, 2004; Oseni et al., 2017).

4. Although some studies have proposed or implied ERP-PIA or other relevant concepts, they focus more on the customization of the initial ERP in the implementation stage (Nicolaou, 2004; Wagner & Newell, 2007), instead of adapting ERP systems during the post-implementation stage. Few studies have investigated ERP-PIA and its effects and antecedents (Oseni et al., 2017).

Although the aforementioned studies have contributed to the knowledge about ERP post-implementation, the issues we proposed require further examination. In this paper, we conceptualize ERP-PIA as the extent to which a firm implements the post-implementation change of an ERP to fulfill the changing business demands, which includes the functional upgrades or continual enhancement of said ERP (Frohlich & Dixon, 1999; Khoo et al., 2011; Oseni et al., 2017). This ERP upgrade and enhancement should (1) provide new features or (2) improve existing features to ensure that the system fulfills the business demands (Khoo et al., 2011; Oseni et al., 2017). The definition of ERP-PIA excludes the infrastructure upgrade that migrates an implemented system to a new platform, without implementing new functionality to change user behavior or business processes (Oseni et al., 2017; Seddon et al., 2010). In fact, this ongoing evolutionary nature of the ERP system implies that firm-inherent capabilities influence whether firms engage in ERP adaptation because it grows out of the current situation and is accomplished over time (Albert et al., 2015).

Table 1 - Literature related to ERP-PIA		
References	**Research findings and concepts related to ERP-PIA**	**Research gaps**
Davenport et al. (2004) Methods: Survey Theory: None Phase: Onward and upward	Davenport et al. noted that only organizations that have invested the time and resources necessary to extensively implement ES through their organizations will be able to capitalize on their promise of better integration and seamless information flows between functions, business units, and geographies.	Davenport et al. indicated that the "extensive implementation" of ES through organizations is important, which implies the concept of ERP-PIA.
Nicolaou (2004) Methods: Case study Theory: None Phase: Onward and upward	Nicolaou suggested that post-ERP applications introduced at the stage of post-implementation maturity, such as sales-force automation, customer relationship management, data mining, and supply chain management systems, promise to increase efficiency while handling transactions, improve decision-making, and further transform the methods of conducting business. On the post-implementation stage, firms institute the process review boards that handle user requests to either further customize the system or to implement additional functionality through bolt-on applications. Therefore, the post-implementation review (PIR) in Nicolaou's case is user-driven and is initiated in response to problems.	Nicolaou implied that ERP-PIA would facilitate transaction efficiency, and PIR is critical for identifying the problems of the ERP system and fulfilling further demands of the system. Although he proposes concepts that are similar to those used in this study, the study focuses more on identifying and reviewing the problems of initial ERP implementation. The study also lacks a comprehensive and theoretical framework to explain how appropriate bolt-on applications projects can be identified and deployed.
Wagner & Newell (2007) Methods: Case study Theory: Situated Learning Phase: Shakedown	Wagner and Newell demonstrated that the timing of user participation is important in the context of ES implementation because using the IS in everyday work alerts users to new ideas about how the IS can potentially improve practice. They indicate that the vanilla ES can be seen as a prototype that may subsequently require modification. The prototype is a system 'in use' that will continue to evolve as the organization does. This is in tandem with the idea of growth and emergence, as opposed to design, wherein user acceptance will never be complete because organizations are constantly changing. Therefore, IS development needs to be seen as a continuous process of evolution with no final design being possible or warranted.	Wager and Newell's findings contribute to our study with their PIA concepts that reflect users' informal learning and improvisation and formal processes of continuous and iterative IS development. Nevertheless, their study does not address how to drive ERP-PIA. Their idea focuses more on configuring or customizing the ERP system, instead of extending the new functionalities of ERP.

Seddon et al. (2010) Methods: Qualitative data Theory: Models based on Hong & Kim (2002), Davenport et al. (2004), and Gattiker & Goodhue (2005) Phase: Onward and upward	Seddon et al. demonstrated that ongoing major ES business improvement projects are a critical construct for organizational benefits from system use, from the perspective of the senior management.	Although they demonstrated that ongoing major ES business improvement projects are crucial for organizational benefits, they do not deliberate what the ERP systems would be after the projects (i.e., ERP-PIA) and what factors can drive a firm to realize its ERP improvement.
Koh et al. (2011) Methods: Grounded theory Theory: None Phase: Onward and upward	Koh et al. indicated that many real-life emerging business issues can lead firms to implement additional modules for ERP. They demonstrated drivers, barriers, and critical success factors (CSFs) for ERP II implementation. They also demonstrate four types of drivers (benefits) for ERP II implementation. The main barriers of ERP II can be encapsulated in two distinct categories: issues relating to technological infrastructure, and more importantly, general business issues spanning the extended enterprise. They also demonstrated some CSFs for both ERP and ERP II implementation and some CSFs for ERP II-specific implementation.	Koh et al. implied the concepts of ERP-PIA. Although they demonstrated many antecedents of ERP II implementation, there is still no clear answer regarding how to enable the implementation of ERP II.
Staehr et al. (2012) Methods: Case study Theory: based on the framework from Orlikowski (1993) Phase: Shakedown and onward and upward	Staehr et al. proposed a framework to explain how and why business benefits are achieved through ERP systems. New projects/extension of projects to leverage off the ERP system is a critical business benefit driver. They also indicate that the ERP system has become a reliable backbone, from which to launch new business projects, such as e-business.	Following Seddon et al.'s (2010) findings, Staehr et al. also indicated that new projects/extensions of projects are crucial for leveraging off the ERP system. However, they neglect what the ERP system would be (ERP-PIA) after projects and how the projects are generated.
Ha and Ahn (2013) Methods: Survey Theory: None Phase: Onward and upward	Ha and Ahn demonstrated that continuous process improvement and systems integration/extension are critical for business process performance, and competency of internal ERP team, user training, interdepartmental collaboration/communication, and top management are crucial antecedents of continuous	Ha and Ahn contributed several findings for our concept of ERP-PIA, especially the construct continuous systems integration/extension. However, this construct focuses more on the number of new modules or solutions in the post-implementation stage, but does not explain what factors

	process improvement. They argued that the initial implementation success is not the final goal; ERP systems should still change and evolve after go-live.	drive a firm to implement new modules or solutions. They neglect the crucial concepts of the evolution and adaptation of ERP.
Cao et al. (2013) Methods: Database data analysis Theory: Real option theory Phase: Shakedown and onward and upward	Cao et al. argued that whether adopters' decision to enhance ERP initial investments (upgrade and extension) are affected by observed performance benefits, performance-enhancing post-implementation reviews (PIRs), and timing considerations. They argued about whether organizations recognize, value, and manage IT projects according to the logic of real options. Firms make ERP system enhancement decisions in ways that are consistent with real options thinking.	They contributed the three antecedents of ERP system upgrade and extension for our study: observed performance benefits, performance-enhancing PIRs, and timing considerations. They answered the question about what factors lead managers to make ERP upgrade and extension decisions. However, they do not explain how to identify appropriate opportunities and action plans for ERP upgrade and extension. The study focuses on the performance or outcomes of initial ERP implementation affecting ERP enhancement.
Galy & Sauceda (2014) Methods: Survey Theory: None Phase: Shakedown and onward and upward	Galy and Sauceda focused primarily on investigating the relationship between managerial actions and financial ratios on the post-implementation stage. The authors also mentioned that once ERP is implemented or live, the ERP project does not end; it instead continues indefinitely.	They mention the concepts of ERP adaptation, but primarily focus on investigating the benefits provided by initial ERP.
Oseni et al. (2017) Methods: Review Theory: None Phase: Onward and upward	Oseni et al. (2017) reviewed studies related to ERP post-implementation amendments, which encompass the activities of maintenance, enhancements, and upgrades. They further develop a framework to identify the main themes, inherent gaps, and specific research areas of ERP post-implementation amendments.	Oseni et al.'s study provides crucial insights for the current research. Their review informs us that studies have neglected to investigate critical factors for initiating amendments and the successful implementation of amendments. Studies also lack the understanding of outcomes resulting from amendments. This study can respond to their call, contributing new insights for the literature.
Barth & Koch (2019) Methods: Literature view and qualitative interviews Theory: None Phase: Onward and upward	Barth & Koch (2019) identified 14 critical success factors for ERP upgrade projects. Effective project management, external support, the composition of the ERP team, and the usage of a multiple system landscape play a critical role for the success of the ERP upgrade.	Their study contributed many insights for the current study and for building up specific dynamic IT capabilities for ERP. Nevertheless, we still lack knowledge about the concepts of evolution and adaptation of ERP.

Effects of ERP-PIA on Organizational Benefits from System Use

As we contemplated, today's firms are facing greater environmental changes (Tallon et al., 2019). Such a changing environment makes achievement of business objectives difficult (Tallon et al., 2019). To achieve business objectives, a firm inevitably needs to adapt its business activity, strategy, and structure (Mu et al., 2015; Teece, 2014, 2018). ERP-PIA provides the firm an adapted system that continuously meets the emergent information and business needs. The system functionalities can thus synergize business strategy and operations (Zhou et al., 2018), achieving a balance alignment between the system and business (Chang et al., 2011; Mu et al., 2015; Shao, 2019). This also facilitates the assimilation of system functionalities in business operations, resulting in greater organizational benefits from system use (Shao, 2019). In contrast, failure to adapt an ERP can cause the misalignment between the system and business strategy and operations, and increase core rigidities and inertia in the firm, impeding the achievement of business objectives and thereby firm performance (Furneaux & Wade, 2011; Liang et al., 2017). Therefore, this study proposes the following hypothesis:

H1: A firm's ERP-PIA is positively associated with its organizational benefits derived from system use.

Dynamic Capabilities View

To investigate what capability drives ERP-PIA, we note six potential theoretical lenses from the literature. The first one is institutional theory (DiMaggio & Powell, 1983). Based on this theory, researchers often propose that the mimetic, coercive, and normative forces are the drivers of system implementation and assimilation (Liang et al., 2007; Saraf et al., 2013). Although institutional theory may be good for explaining the external forces that drive firms to adapt their ERP systems and how they do so, it does not explain what internal capabilities can enable firms to adapt their ERP to fulfill the emergent demands. Information processing theory (IPT) is another potential theory (Galbraith, 1973). According to IPT, the emergent needs or uncertainties can serve as information processing needs, and adaptation can enhance the information processing capability to fulfill the needs (Chen & Chou, 2009; Gattiker & Goodhue, 2005; Tian & Xu, 2015). However, as an institutional theory, IPT does not explain whether a firm's internal capabilities can drive ERP-PIA. The third potential theory is the real option theory (ROT). According to ROT, the new IT functionalities can serve as options that may benefit firms in the future (Cao et al., 2013). This perspective however cannot address our research questions. Moreover, the technology – organization – environment framework (Tornatzky & Fleischer, 1990) may be useful (Zhu et al., 2010). However, it is too simple and rough to provide insights for the current research context. This framework pays more attention to the influences of the "contexts," instead of a firm's capabilities. Situated learning perspective is another lens used in the post-implementation research field (Wagner & Newell, 2007). However, it is more suitable for explaining user learning. Finally, the framework of mutual adaptation of technology and organization (Leonard-Barton, 1988) can explain the adaptation of the misalignments between technology and organization. However, the framework addresses less about how to achieve adaptation. Thus, we draw upon the DCV because it provides insights to address our research questions.

According to the DCV, firms cannot rest on their laurels as the business environment becomes more globally integrated and new forms of technology and competition arise (Helfat et al., 2007). Firms must develop dynamic capabilities to renew the methods through which they make their living, to match the changing environment, and create some competitive advantages Helfat et al., 2007; Peteraf et al., 2013). A dynamic capability is the capacity of a firm to purposefully create, extend, or modify its resource base (Helfat et al., 2007). The resource base of a firm includes tangible, intangible, and human resources and the operational capabilities that the firm owns, controls, or has access to on a preferential basis (Helfat et al.,

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2007). According to this definition, firms with dynamic capabilities can create a resource base, or portions of a resource base, extend their current resource base to derive more of the same results, and modify their resource base to change their businesses, including in response to changes in the external environment (Eisenhardt & Martin, 2000; Helfat et al., 2007). According to Helfat et al. (2007), we propose and define *dynamic IT capabilities for ERP as a higher-order capacity of a firms to purposefully create, extend, or modify its existing ERP-related resource base (e.g., ERP-related functionalities) into new ones*.

Dynamic IT Capabilities

Although DCV may be useful for explaining how firms seek some competitive advantages, it has often been criticized for its abstract concepts and paradox, and the lack of an empirically grounded understanding about the construct (Pavlou & El Sawy, 2011; Peteraf et al., 2013). Researchers consider dynamic capabilities as hidden or invisible, complex and tacit, difficult to observe, and causally ambiguous, thus making dynamic capabilities difficult to examine. Pavlou & El Sawy (2011) identified these difficulties and proposed a measurable model of dynamic capabilities by conceptualizing, operationalizing, and measuring dynamic capabilities. They rely on the notion proposed by Eisenhardt & Martin (2000): "dynamic capabilities actually consist of identifiable and specific routines that often have been the subject of extensive empirical research in their own right." Maritan (2007) supported Eisenhardt & Martin (2000) and noted that "it is difficult to observe a dynamic capability that an organization possesses unless it is put into use and processes are the mechanisms that make it happen." Therefore, by identifying a specific dynamic capability and its routines in a firm, we can develop, measure, and understand dynamic capabilities. Pavlou & El Sawy (2011) followed this logic and drew on literature regarding strategic management to propose an identifiable set of dynamic capabilities in the new product development context. Based on the original papers by Teece et al. (1997) (reconfiguring, learning, integrating, and coordinating) and Teece (2007) (sensing, seizing, and reconfiguring assets), Pavlou & El Sawy (2011) proposed dynamic capabilities that can be used as tools for reconfiguring the existing operational capabilities, including sensing, learning, integration, and coordination capabilities. They identified the measurable routines of these four dynamic capabilities. Their approach provides a useful insight to develop a measurable model of dynamic IT capabilities for ERP in this study. Following Pavlou & El Sawy (2011), we draw upon IT sensing, IT learning, IT integration, and IT coordination capability as dynamic IT capabilities for ERP. However, we adapt and re-interpret these capabilities into our research context. We argue that dynamic IT capabilities of ERP can (re)configure existing ERP resources and operational capabilities, facilitating ERP-PIA. We determine the four dynamic IT capabilities for ERP in the following section.

IT Sensing Capability

According to DCV (Teece, 2007), to identify opportunities when they emerge, firms must constantly scan, search, and explore markets. These activities involve the reading of market trends and customer needs, the structural evolution of industries and markets, and likely supplier and competitor responses (Teece et al., 2016). This information can help firms to calibrate the required transformation and effectuate the required adjustments with minimum cost, thereby seizing a market opportunity ahead of competition (Teece et al., 1997). These activities highlight the critical role of the IT sensing capability. It is defined as the ability to read and interpret the organizational needs and environmental demands for ERP improvement (Pavlou & El Sawy, 2011). In our research context, firms must sense the environment and business units to gather the organizational needs, market demands, competitor moves, business partner's needs, and new IT for managers to identify the new requirements of ERP improvement (Mu et al., 2015), and decide to engage in exploratory activities to evaluate these requirements with new ERP improvement plans. This also implies the importance of the information from line functions. According to Pavlou & El Sawy (2011), three basic routines of the sensing capability are generating, disseminating, and responding information. Generating

Information is conducted to identify demands, recognize rigidities, and detect resource combinations (Galunic & Rodan, 1998). These activities focus on searching and gathering information about the occurrences in the business ecosystem, including internal and external environments (Teece, 2007). Disseminating information is conducted to interpret information, make sense of events and developments, and explore new opportunities (Kogut & Zander, 1996). Responding to information is conducted to initiate plans to capitalize on information. For instance, a firm with the IT sensing capability can reconfigure their existing ERP and relevant daily operations. Generating information raises the firm's potential to identify new demands from business units and environments (Mu et al., 2015; Seddon et al., 2010). Disseminating information helps the firm to interpret the functionalities required and identify the appropriate ERP improvements and potential rigidities of the firm (Seddon et al., 2010). Responding to information facilitates the firm to initiate ERP improvement plans, identify available resources, invest resources in the plans, and identify approaches to overcome rigidities (Cao et al., 2013).

IT Learning Capability

Teece et al. (1997) and Teece (2007) have highlighted the crucial role of learning capability in dynamic capabilities. Teece et al. (1997) noted that learning is a process through which repetition and experimentation create new knowledge and enable tasks to be performed with increased efficiency and speed. This process implies that a firm requires specific knowledge, creative activity, and the ability to understand user decision-making, and practical wisdom (Teece, 2007). In our research context, we argue that to adapt ERP, firms must engage in learning to understand users' behavior, finding new IT solutions, and finally, creating new knowledge about IT and users to adapt ERP (Wagner & Newell, 2007). Therefore, IT learning capability is defined as the ability to revamp existing functionalities of ERP with new knowledge (Pavlou & El Sawy, 2011). It can be viewed as absorptive capacity (Cohen & Levinthal, 1990; Zahra & George, 2002). According to Zahra & George (2002), the four underlying routines of the learning capability are acquiring, assimilating, transforming, and exploiting knowledge. Acquiring knowledge refers to identifying and acquiring new information and knowledge that is critical for operations. Assimilating knowledge refers to analyzing, processing, interpreting, and understanding new information and knowledge. Transforming knowledge refers to combining existing knowledge and the newly acquired and assimilated knowledge. Exploiting knowledge refers to refining, extending, and leveraging existing competencies or creating new ones by incorporating acquired and transformed knowledge into its operations. In our research context, acquiring IT knowledge refers to a firm obtaining new knowledge about ERP and other IT, such as new IT functionalities, users' responses about the existing system (Wagner & Newell, 2007), and users' practical wisdom from their social network (Sykes et al., 2014). Recently, with the rapid advancements in IT, firms must pay more attention to new IT applications and practices that may be used to advance existing systems, such as big data analysis and new AI algorithm (Ali et al., 2018; Elragal & Hassanien, 2019). Assimilating IT knowledge refers to articulating and understanding new knowledge about ERP, ES, and other technologies. For example, firms often assimilate new knowledge about ERP from consultants (Ko et al., 2005) or other information sources. Transforming IT knowledge refers to renewing existing knowledge about ERP and ES with newly acquired and assimilated knowledge. Exploiting IT knowledge allows a firm has the ability to propose ERP improvement plans (i.e., ERP upgrade and enhancement projects (Barth & Koch, 2019; Daniel et al., 2014; Seddon et al., 2010)) based on the new knowledge obtained from acquiring and assimilating routines to reconfigure ERP and daily operations.

IT Integrating Capability

To reconfigure the existing resource base, firms must integrate new resources and operational capabilities into the current one, with a high-level collective logic (Galunic & Rodan, 1998; Pavlou & El Sawy, 2011). New resources and operational capabilities created by learning

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capability often emerge as individual capabilities. Without integrating the existing resource base through a collective sense, new resources and operational capabilities will operate individually, thereby creating diversity and impeding synergy. In our research context, individual modules of an ERP must work together as a whole, which is the key to creating benefits for firms (Markus & Tanis, 2000). Individual ERP improvement plans are identified by sensing and learning capabilities and thus requires to be integrated to the current ERP. In this study, based on the concepts of program management (PMI, 2013), we define IT integrating capability as the ability to combine new capabilities provided by individual ERP improvement plans into an existing ERP. It also means to ensure the benefits of new capabilities delivered to an existing ERP. Therefore, based on the principles of benefits delivery from program management (PMI, 2013), two routines, namely alignment and value delivery, can be identified. Alignment refers to the ability to ensure the linkage of proposed ERP improvement activities and ERP improvement directions (Daniel et al., 2014). Value delivery is the ability to ensure that new functionalities and subsystems obtained by proposed ERP improvements can deliver the promised effects to an existing ERP. These two routines are abilities to ensure that new functionalities or subsystems can be aligned with and deliver the expected capabilities to an existing ERP, thus creating a consolidated system.

IT Coordinating Capability

To reconfigure operational capabilities, such as ERP functionalities, the effective coordination of tasks and resources and the synchronization of activities is required (Helfat & Peteraf, 2003). Coordinating capability aims to administer tasks, activities, and resources to deploy new operational capabilities, thus enabling reconfiguration (Pavlou & El Sawy, 2011). Coordinating capability is crucial because the scarcity of resource always limits the firm's ability to provide sufficient resources for the tasks and activities of reconfiguration (PMI, 2013; Reiss et al., 2006). The coordinating capability refers to deploying resources to tasks and activities appropriately. The routines of coordinating capability are to assign the appropriate resources to tasks (Helfat & Peteraf, 2003), appoint the right person to the right task (Eisenhardt & Martin, 2000), identify complementarities and synergies among tasks and resources (Pavlou & El Sawy, 2011; PMI, 2013), and dynamically allocate resources to tasks and activities with a program sense (PMI, 2013). In the ERP-PIA context, IT coordinating capability is the ability to orchestrate and deploy tasks and resources among IT activities and projects, such as possible ERP improvement projects and others (Seddon et al., 2010). IT coordinating capability can help a firm to effectively develop new capabilities of ERP. The four routines of IT coordinating capability are as follows: (1) assigning appropriate resources, including financial support, IT personnel, consultants, and relevant stakeholders' supports, to ERP improvement projects (Wang et al., 2006); (2) appointing the right person, such as IT personnel, to the right improvement project; (3) creating portfolio of the right priority among resources and tasks of ERP improvement projects and others, thus creating synergies (Daniel et al., 2014; Reiss et al., 2006); and (4) allocating and reallocating resources to balance ERP improvement projects and other projects (Daniel et al., 2014; PMI, 2013).

Effects of Dynamic IT Capabilities for ERP on ERP-PIA

We argue that the dynamic IT capabilities for ERP can induce firms to adapt their ERP through four methods. First, by generating, disseminating, and responding to the needs of ERP improvement through different sources (IT sensing capability), firms are more likely to set up initial ERP improvement plans. Second, by quickly recognizing, assimilating, and applying new knowledge on IT and ERP (IT learning capability), firms are more likely to propose new functionalities or subsystems (e.g., through improvement projects (Seddon et al., 2010)) to improve their ERP. Third, by integrating new functionalities or subsystems with existing ERP (IT integrating capability), firms can implement an improved system and the new functionalities can deliver the promised effects, thus enabling ERP adaptation. Finally, to coordinate resources in the right ways (IT coordinating capability), firms are able to implement new functionalities or subsystems with more efficiency. By integrating these capabilities, firms can facilitate their ERP-PIA. Therefore, the current study proposes the following hypothesis:

H2: A firm's dynamic IT capabilities for ERP are positively associated with its ERP-PIA.

Dynamic IT Capabilities for ERP and ERP-PIA in Turbulent Environments

The proposed effect of dynamic IT capabilities for ERP on ERP-PIA is likely to be moderated by the level of environmental turbulence, which is defined in terms of the frequency and amplitude of change in the environment and general conditions of uncertainty (Duncan, 1972; Wilden & Gudergan, 2015). Environmental turbulence emerges from three key sources: market turbulence (i.e., uncertainty in market demands or rate of change in the composition of customers and their preferences) (Wilden & Gudergan, 2015), competitive turbulence (i.e., the number of competitors in the field and their moves) (Jap, 2001), and technological turbulences (i.e., the frequency of technical breakthroughs) (Rai & Tang, 2010). In a stable environment, these turbulences occur, but they tend to be predictable and incremental, with low rates of change (Duncan, 1972; Wilden & Gudergan, 2015). In this environment, dynamic capabilities tend to play a relatively minor role, but in turbulent environments, dynamic capabilities have been demonstrated as a crucial role in helping firms to gain competitiveness (Peteraf et al., 2013). Because environmental turbulence often creates new opportunities, this enhancing firms' incentives to employ dynamic capabilities for reconfiguring existing resource bases to pursue new opportunities (Pavlou & El Sawy, 2011). These new opportunities also lead firms to recognize the gap between their existing and ideal resource bases and capabilities (Wilden & Gudergan, 2015), which increases the need for firms to reconfigure, thereby enhancing the value of dynamic capabilities (Teece et al., 1997). In our research context, we note that firms in turbulent environments have higher incentives to pursue new opportunities that prompt changes in their business activities (Chen & Chou, 2009), thus resulting in increased discrepancy between the activities and the functionalities of ERP. The needs of ERP-PIA will likely increase. In this condition, firms with dynamic IT capabilities can reconfigure their existing functionalities of ERP, such as legacy and outdated functionalities, to provide an improved match for the business activities and respond to the environment. Therefore, we argue that ERP-PIA may be more significantly facilitated by dynamic IT capabilities in turbulent environments (Eisenhardt & Martin, 2000).

H3: The positive relationship between a firm's dynamic IT capabilities for ERP and ERP-PIA is positively moderated by environmental turbulence.

Control Variables

Although dynamic IT capabilities for ERP are expected to influence firms to adapt their ERP, they are not the only factors that influence ERP-PIA and organizational benefits from system use. In the literature, the constructs related to IT environments, the IT department's capabilities, and IT resources may play critical roles in shaping ERP-PIA. Therefore, we first include IT turbulence, IT mindfulness, and IT financial resources as control variables. IT turbulence refers to the extent to which IT is included in an industry's changes (Mu et al., 2015). IT mindfulness is defined as the ability of the IT department to be alert about clients' needs, to recognize the related unexpected problems and opportunities and to respond in a contextually appropriate manner (Mu et al., 2015). Moreover, the constructs related to organizational capabilities and resources may also influence ERP-PIA. Therefore, we include adaptive agility and firm size as control variables. Adaptive agility is defined as the ability of a firm to detect and respond to market dynamics in a defensive manner (Chakravarty et al., 2013). Finally, the longer that the ERP has been in place, the more likely a firm adapts the ERP to fit its business activities. Therefore, we specify the time (monthly) since the overall ERP was deployed in production as a control variable.

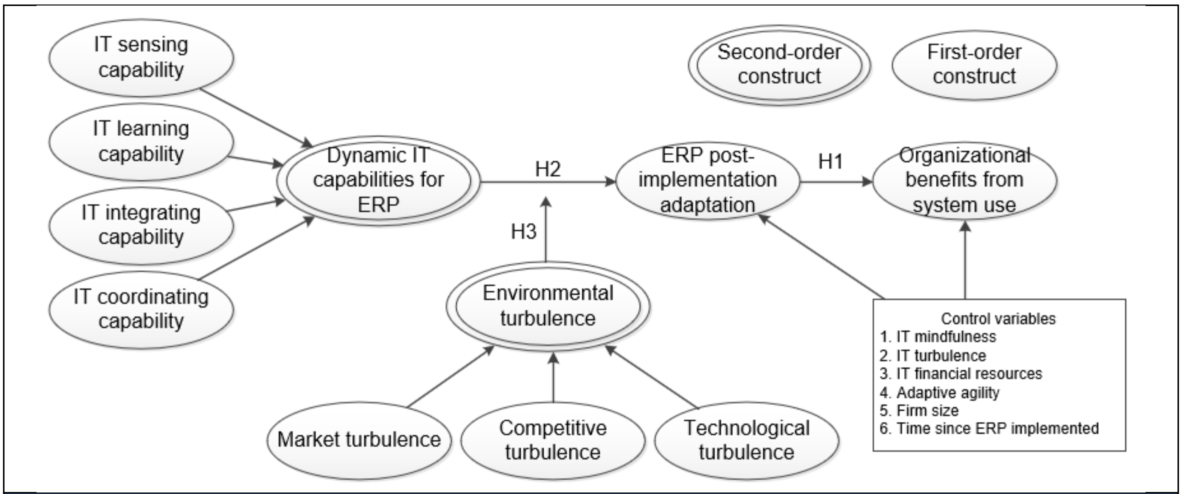

Figure 1 - Research model

Research Methodology

Instrument Development

Data were collected with a carefully developed self-reported survey instrument. We developed and validated our measures using the guidelines in the MIS literature (MacKenzie et al., 2011). We first reviewed the literature to develop measures that were suitable for the current study, had face validity and a minimal overlap between constructs. To establish content validity, the measurement items were independently evaluated by each of the researchers. The researchers then jointly discussed each construct and its items until they agreed regarding the appropriateness of all the measures. After compiling an English version of the questionnaire, the survey items were first translated into Chinese by a bilingual researcher, and verified and refined for translation accuracy by two MIS professors. The Chinese version of the draft was pretested by four senior managers (including business executive, senior business manager, and IS executive) for ensuring face and content validity, thus resulting in the wording modifications of some survey items. We operationalized the constructs using multi-item reflective measures, with a 7-point Likert scale. The measures are provided in Appendix A and are discussed below.

Based on Pavlou & El Sawy (2011), the proposed set of dynamic IT capabilities for ERP was captured with a reflective-formative model. The model posits formative constructs for the second-order construct and reflective indicators for the first-order measurable capabilities. Dynamic IT capabilities for ERP are thus modeled with a second-order model that is formed by the four IT capabilities. The four capabilities differ from each other, with each of the four capabilities offering a unique component to the overall ability to reconfigure existing ERP. We operationalized the four capabilities independently. IT sensing capability was characterized by generating (Seddon et al., 2010), disseminating (Seddon et al., 2010), and responding to (Cao et al., 2013) information about the organizational needs and environmental demands for ERP upgrade, extension, or consolidation. The IT learning capability was characterized by acquiring (Sykes et al., 2014; Wagner & Newell, 2007), assimilating (Ko et al., 2005), transforming, and exploiting knowledge about ERP, ES, and other IT. The IT integrating capability captures the ability to align existing ERP with proposed new functionalities that deliver promised value (Daniel et al., 2014; PMI, 2013). The IT coordinating capability captures resource allocation and reallocation (Daniel et al., 2014; PMI, 2013), task and resource assignment (Wang et al., 2006), and task and resource priority (Daniel et al., 2014; Reiss et al., 2006).

Environmental turbulence was also captured using a reflective-formative model and formed the three environmental turbulences (Pavlou & El Sawy, 2011; Wilden & Gudergan, 2015). We operationalized the three turbulences independently. Market turbulence was measured by assessing changes in customer preferences, ease of forecasting marketplace changes, and changing customer bases (Pavlou & El Sawy, 2011; Wilden & Gudergan, 2015). Competitive turbulence assessed the degree of competition, extent of promotion and price wars, and rate of competitive moves (Wilden & Gudergan, 2015). Technological turbulence was measured by evaluating the speed and frequency of technological change, technical opportunity, and the difficulty of technological forecasting (Wilden & Gudergan, 2015).

The ERP-PIA items were developed based on our definition and studies about ERP upgrade and enhancement (Khoo et al., 2011; Oseni et al., 2017) and IT adaptation (Wagner & Newell, 2007). The respondents were asked to assess the degree to which the system has provided new functionalities to support business activities, after the initial ERP was implemented. Three types of business activities, including strategic activities, primary and supportive activities of value chain, and one overall measurement were developed. The respondents were also asked to indicate whether the specific business activity was critical to the firm (coded as 1 or 0, respectively). Only the activities identified as critical were used to create the measure of ERP-PIA for each firm because some firms may not engage in all business activities. Therefore, their ERPs are less likely to be improved to support those unengaged business activities. The individual measures of the critical activities of each type were averaged to obtain a single value for ERP-PIA.

The measuring question of organizational benefits from system use were adapted from Seddon et al. (2010). The respondents were asked to assess how your firm satisfies the listed benefits from the organization's overall investment in ERP, compared with that of your major competitors. The set of benefits were drawn from Shang & Seddon (2002).

The measuring items of IT mindfulness, IT turbulence, and adaptive agility were adopted from Mu et al. (2015) and Chakravarty et al. (2013).

Data Collection

A cross-sectional and matched-pair mail survey of both business and IS executives was administrated for collecting data from the top 1,000 manufacturing firms, based on the 2016 Directory of the Top 5,000 Largest Firms, which was published by the China Credit Information Services Ltd. Two informants can not only mitigate the common method bias (Podsakoff et al., 2003) but also ensure that the appropriate people answer their questionnaire based on their own knowledge, thereby increasing the information accuracy (Huber & Power, 1985). After accounting for undelivered and invalid mails, the effective mailing was 947 firms. Survey packages were separately mailed to the business and IS executives of each target firm. The business executives were requested to complete the questionnaire related to organizational benefits from system use, ERP-PIA, and environmental turbulences. However, IS executives were requested to complete the questionnaire related to dynamic IT capabilities, financial resources, IT turbulence, and time since ERP implemented. A completed sample must have the returned surveys of both business and IS executives of a target firm.

For the first-round mail survey, 135 surveys of business executives and 156 surveys of IS executives were returned, thereby yielding 24 completed samples. However, many returned surveys cannot be matched pairs. Therefore, we conducted the second round of mail survey. We mailed survey packages to the IS executives (and business executives) who packages were returned in the first round and requested their help to distribute questionnaires to the suitable business executives (and IS executives). A total of 76 matched-pair samples were returned, thereby yielding an effective response rate of 8%. Because we focus on ERP post-implementation stage (i.e., upward and onward stage), we select the samples that the implemented ERP program had already gone live after (at least) 5 years. Therefore, 128 samples (74 firms) are available for subsequent analysis. Tables 2 and 3 present the characteristics of the sample.

Table 2 - Profile of the respondents (N = 74)

Business exe. title	No.	%	IT exe. title	No.	%
General Manager	4	5	CIO	1	1
Business Director	2	3	IT Director	3	4
Business Manager	34	46	IT Engineer	17	23
Business Supervisor	16	22	IT Manager	19	26
Business Executive	11	15	IT Supervisor	26	35
Others	5	7	Others	4	5
Missing	2	3	Missing	4	5

Table 3 - Profile of the responding firms (N = 74)

Industry	No.	%	No. of employees	No.	%
Automobile	4	5	1-250	27	36
Chemical	10	14	251-500	14	19
Computer and electronics	22	30	501-1,000	16	22
Food	3	4	1,001-2,000	9	12
Machine and tool	7	9	>2,000	8	11
Metals and materials	17	23			
Textile	4	5			
Others	7	9			

The nonresponse bias was assessed using the procedure recommended by Armstrong & Overton (1977). Considering the last group of respondents as the most likely to be similar to nonrespondents, a comparison of the first and last quartile of the respondents provides a test of response bias. No significant differences were noted between the first and last quartile of all the samples that were found on our key research variables, based on the t test. Therefore, the nonresponse bias should not be a serious concern in this study.

Data Analysis

Using SmartPLS Version 3.2.8, a partial least squares (PLS) structural equation model was constructed for measurement validation and hypotheses testing. The PLS should be appropriate for our study because it is recommended for second-order and formative construct (Hair et al., 2017b). We used SmartPLS to estimate our model with a path weighting scheme (Hair et al., 2017b). We used nonparametric bootstrapping with 10,000 replications, no sign changes, and bias-corrected and accelerated bootstrap to obtain the estimates (Aguirre-Urreta & Rönkkö, 2018; Hair et al., 2017b).

Measurement Validation

We assessed the validity and reliability of the items and constructs based on the guidelines by Hair et al. (2017b). Our reflective measures exhibited good internal consistency and exceeded the suggested 0.7 threshold for the rho_A, Cronbach's alpha, and composite reliability (CR), except for IT financial resources (Table 4) (Hair et al., 2017b). The outer loadings for all items exceeded the suggested 0.7 threshold and were significant at the 1% level (Hair et al., 2017b), thereby proving indicator reliability. We further assessed the convergent validity using Fornell & Larcker (1981) average variance extracted (AVE) criterion.

The AVEs exceeded the minimum threshold value of 0.5 (Table 4) (Hair et al., 2017b). These combined results demonstrated the convergent validity of our constructs.

Discriminant validity is established in the following situations: (1) the items load higher on the construct that they are intended to measure than that of other constructs; (2) the square root of the AVE by each construct is higher than the interconstruct correlations; and (3) the heterotrait-monotrait ratio of correlation (HTMT) is significantly smaller than 1 (Hair et al., 2017a; Hair et al., 2017b). The crossloadings were computed by calculating the correlations between a latent variable's component scores and the manifest indicators of other latent constructs (Hair et al., 2017b). Without exception, all the items loaded higher on their own construct than that of other constructs (Appendix B). As presented in Table 4, the square root of the AVE for each construct was greater than 0.75 and also higher than the correlations between the construct and other constructs, thus indicating that all the reflective constructs share more variances with their indicators than they do with other constructs and sufficient discriminant validity. The HTMT values presented in Table 5 were significantly lower than 1, with 95% confidence interval, thereby indicating clear discriminant between two constructs. Therefore, our measures exhibited sufficient discriminant validity.

Table 4 - Interconstruct correlations and reliability measures

Construct	ρ_A	α	CR.	AVE	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Sensing	0.96	0.96	0.97	0.82	**0.91**													
2. Learning	0.97	0.97	0.97	0.88	0.73	**0.94**												
3. Integrating	0.97	0.97	0.97	0.90	0.74	0.79	**0.95**											
4. Coordinating	0.94	0.93	0.95	0.79	0.64	0.71	0.73	**0.89**										
5. ERP-PIA	0.94	0.93	0.95	0.82	0.31	0.35	0.34	0.30	**0.90**									
6. Comp. tur.	0.85	0.85	0.90	0.68	-0.08	0.07	0.11	-0.03	0.17	**0.83**								
7. Market tur.	0.88	0.88	0.93	0.81	0.18	0.19	0.16	0.10	0.39	0.49	**0.90**							
8. Tech. tur.	0.93	0.89	0.95	0.90	0.22	0.16	0.10	0.06	0.23	0.42	0.51	**0.95**						
9. Org. benefits	0.96	0.96	0.97	0.60	0.30	0.33	0.31	0.23	0.67	0.31	0.35	0.51	**0.77**					
10. IT mind.	1.05	0.90	0.91	0.78	0.60	0.72	0.69	0.72	0.22	0.00	0.04	0.14	0.20	**0.88**				
11. IT tur.	0.95	0.92	0.95	0.87	0.35	0.38	0.20	0.37	0.15	0.05	0.17	0.36	0.27	0.39	**0.93**			
12. IT fin. res.	0.70	0.57	0.81	0.69	0.43	0.49	0.54	0.47	0.23	0.11	0.05	0.14	0.29	0.49	0.07	**0.83**		
13. Adap. agility	0.95	0.93	0.95	0.82	0.21	0.07	0.19	0.13	0.39	0.30	0.22	0.32	0.63	0.00	0.07	0.20	**0.90**	
14. MLMV	1.00	0.91	0.93	0.78	0.13	0.10	0.07	0.02	0.27	0.00	0.07	0.27	0.45	0.08	0.27	0.13	0.28	**0.88**

Note: Square roots of AVE are presented on the diagonal.

Table 5 - The heterotrait-monotrait ratio of correlations (HTMT)

Construct	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Sensing														
2. Learning	0.75													
3. Integrating	0.77	0.82												
4. Coordinating	0.67	0.74	0.77											
5. ERP-PIA	0.31	0.35	0.35	0.31										
6. Comp. tur.	0.12	0.09	0.12	0.09	0.19									
7. Market tur.	0.20	0.20	0.17	0.12	0.44	0.55								
8. Tech. tur.	0.24	0.18	0.13	0.10	0.25	0.47	0.56							
9. Org. benefits	0.31	0.34	0.32	0.25	0.69	0.34	0.37	0.54						
10. IT mind.	0.58	0.70	0.66	0.72	0.17	0.04	0.06	0.16	0.18					
11. IT tur.	0.38	0.41	0.22	0.41	0.15	0.12	0.18	0.38	0.28	0.46				
12. IT fin. res.	0.57	0.67	0.75	0.63	0.30	0.18	0.18	0.20	0.36	0.57	0.12			
13. Adap. agility	0.22	0.08	0.20	0.16	0.40	0.33	0.24	0.35	0.66	0.13	0.12	0.24		
14. MLMV	0.12	0.09	0.07	0.10	0.25	0.10	0.14	0.29	0.45	0.11	0.28	0.16	0.28	

For the second-order formative constructs, dynamic IT capabilities for ERP, and environmental turbulence, we first assessed the formative measurement model for collinearity. The variance inflation factor (VIF) is a useful statistic to assess collinearity, with values lower than 5

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indicating the absence of multi-collinearity (Hair et al., 2017b). We found that the VIF of first-order constructs of dynamic IT capabilities for ERP and environmental turbulence are below 5, thus indicating that collinearity is not a critical problem. Finally, we assessed the significance and relevance of the first-order reflective constructs for the second-order formative construct. We conducted the bootstrapping procedure with 10,000 samplings. The result reveals that all path coefficients, from first-order constructs to the second-order constructs, are significant at p < 0.001 level (Table 6), thus revealing the significant contribution of the first-order constructs to the second-order construct.

Table 6 - Path coefficients from the first-order constructs to the second-order construct

First-order constructs	Path coefficients to **dynamic IT capabilities for ERP**	*p* values
1. IT sensing cap.	0.326	0.000
2. IT learning cap.	0.302	0.000
3. IT integrating cap.	0.245	0.000
4. IT coordinating cap.	0.251	0.000
First-order constructs	Path coefficients to **environmental turbulence**	*p* values
1. Competitive tur.	0.447	0.000
2. Market tur.	0.488	0.000
3. Technological. tur.	0.292	0.000

Safeguards Against and Assessment of Common Methods Variance

Common method variance (CMV) was tackled using three approaches. First, a multiple informant approach allowed us to mitigate the CMV (Podsakoff et al., 2003). Second, we used Harmon's single-factor test to assess the CMV (Podsakoff et al., 2003). A total of 12 factors with eigenvalue >1 were extracted and collectively accounted for 83.57% of the variances in the data, with the first factor accounting for 32.2% of the variances. Third, we incorporated the measured latent marker variable (MLMV) approach in our survey to detect and correct for CMV while using PLS (Chin et al., 2012). This approach requires collecting multiple items that have no nomological relationship with the research items. We followed the guidelines provided by Chin et al. (2012) and carefully selected MLMV indicators. We adopted the items used to measure "trying new features" in Microsoft Office (Sun, 2012) and slightly modified the targeted software to Microsoft Word, which has more widespread use in companies. We then conducted the construct level correction (CLC) approach to partial out the CMV effects at the structural model in our data analysis (Chin et al., 2012). CLC involves creating a similar quantity of CMV control constructs as the constructs in the research model. Each CMV control uses the same entire set of MLMV items. In our research model, the CMV construct was modeled as impacting ERP-PIA and organizational benefits. Therefore, the more accurate estimates of the structural paths can be obtained (Chin et al., 2012).

Structural Model

We first assessed multi-collinearity by examining each set of predictor constructs separately for each subpart of the research model (Hair et al., 2017b). In our model, all the VIF of endogenous constructs are less than two, which is below the five threshold (Hair et al., 2017b), thus indicating no multi-collinearity problem in our model. To assess the significance of the path coefficients in the inner model, SmartPLS was applied to generate 10,000 samples using a bootstrapping technique with a PLS algorithm, no sign changes, a path weighting scheme, and bias-corrected and accelerated bootstrap (Aguirre-Urreta & Rönkkö, 2018; Hair et al., 2017b). We applied the two-stage approach to create the interaction term with the standardized approach that was suggested by Hair et al. (2017b) for testing the moderating effects. The full model has an R^2 of 56.2% for the organizational benefits derived from system use. R^2 for ERP-PIA is 30.7%. With omission distance equal to 5, all the cross-validated redundancy Q^2 values of endogenous constructs are higher than zero, thus indicating that the exogenous constructs have predictive relevance for the endogenous constructs under consideration (Hair et al., 2017b).

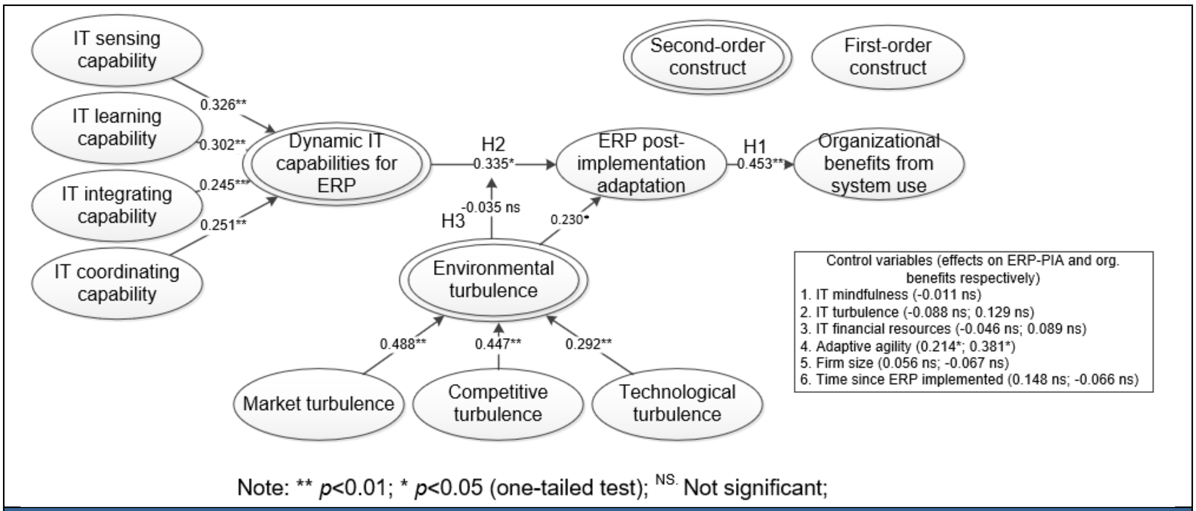

Figure 2 - Structural model

The results demonstrate that ERP-PIA has a significant effect on the organizational benefits from system use, thus supporting H1 ($\beta = 0.453$; $p < 0.001$; observed statistical power: 0.999). The dynamic IT capabilities for ERP are positively associated with ERP-PIA, thus supporting H2 ($\beta = 0.335$; $p < 0.01$; observed statistical power: 0.924). However, environmental turbulence fails to moderate the relationship between dynamic IT capabilities and ERP-PIA, rejecting H3 ($\beta = -0.035$; $p > 0.05$). Nevertheless, we note that the direct effect of environmental turbulence on ERP-PIA is significant ($\beta = 0.230$; $p < 0.01$; observed statistical power: 0.924). Finally, most effects of the control variables on ERP-PIA or organizational benefits are insignificant except for the effects of adaptive agility on ERP-PIA and organizational benefits. Overall, we noted support for two of the three hypotheses in the research model. These findings are discussed below.

Summary of Results

Consistent with our arguments that propose the positive effect of ERP-PIA on organizational benefits from system use, we note the empirical support for H1. This result suggests that a firm that adapts its ERP to match its business activities and operations can gain higher organizational benefits from system use. Our result confirms that after ERP go live, continual upgrades and enhancements of the system are necessary when business operations and activities change or new opportunities emerge from internal and external environments (Aanestad & Jensen, 2016; Khoo et al., 2011; Oseni et al., 2017; Zhu et al., 2010).

The results demonstrate that dynamic IT capabilities for ERP are positively associated with ERP-PIA (H2). This result suggests that through IT sensing, IT learning, IT integrating, and IT coordinating capabilities, firms are able to identify opportunities and undertake a series of action plans to improve the system. Within dynamic IT capabilities for ERP, IT sensing capability plays the most crucial role in enabling ERP-PIA ($\beta = 0.326$; $p < 0.01$). As suggested by Pavlou & El Sawy (2011), sensing capability can be an initiator for other dynamic capabilities because all changes made by a firm can only occur if the firm first senses the need to change. IT learning capability is the second important capability ($\beta = 0.302$; $p < 0.01$), followed by IT sensing capability. This reveals that learning new knowledge about ERP, ES, or IT can help firms to determine new methods to improve ERP, which in turn enables improved organizational benefits. Finally, IT integrating capability plays a less crucial role in

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the dynamic IT capabilities for ERP (β = 0.245; $p < 0.01$). The reason may be that the modularized architecture of recent ERP ensures that upgrades and enhancements are easily implemented and integrated (e.g., cloud ERP and subscription-based ERP (Liu et al., 2018; Walther et al., 2018)). New add-on functionalities, modules, and subsystems can be easily integrated with existing ERP without changing existing functionalities, thereby resulting in less importance of IT integrating capability.

According to the results of H1 and H2, we further conducted a mediation test to examine the indirect effect of dynamic IT capabilities for ERP on organizational benefits from system use through ERP-PIA. We followed the guidelines suggested by Zhao, Lynch, and Chen (2010). We first tested the total direct effect of dynamic IT capabilities for ERP on organizational benefits from system use; the results show that dynamic IT capabilities for ERP significantly influences organizational benefits from system use (β = 0.200; $p<0.05$). We then tested our research model with an additional direct path from dynamic IT capabilities for ERP to organizational benefits from system use. The result shows the direct path is insignificant (β = -0.005; $p>0.5$). We also found very small f^2 (0.00; calculated by the comparison between included (R^2 for organizational benefits= 56.2%) and excluded (R^2 for organizational benefits = 56.2%) models). As we expected, these results suggest that ERP-PIA fully mediates the relationship between dynamic IT capabilities for ERP and organizational benefits from system use. This informs that without ERP-PIA, a firm cannot gain organizational benefits through dynamic IT capabilities for ERP directly. As the DCV suggested (Schilke, 2014; Teece, 2014), ERP-PIA, as the adaptation of ordinary capabilities, can support daily operations and meet environmental changes continuously, which can bring various performances for the firm. Dynamic IT capabilities for ERP, however, as a higher-level capacity, are mainly used to provide adaptability for the firm to adapt its ERP systems. Thus, without ERP-PIA, dynamic IT capabilities for ERP are still “abilities” but concretize nothing in the firm. This result reflects the suggestion of Teece (2014) that dynamic capabilities do not operate alone to effectuate performance, but require to accompany ordinary capabilities with good strategy. Also, as the review of Schilke et al. (2018), ERP-PIA can be considered as IT/IS resource changes that are the intermediate outcomes of dynamic capabilities. That is, ERP-PIA is a causal mechanism through which dynamic IT capabilities affect performance outcomes. Schilke et al. (2018) further indicate that only four percent of their sampling articles explicitly examines possible causal mechanisms, suggesting a gap in the literature. Thus, our result responds to their call by demonstrating the intermediate role of ERP-PIA.

Although many studies have suggested that dynamic capabilities are more valuable in highly turbulent environments (Pavlou & El Sawy, 2011; Peteraf et al., 2013; Teece et al., 2016; Teece et al., 1997; Wilden & Gudergan, 2015), we have not noted evidence to support the moderating effect of environmental turbulence on the relationship between dynamic IT capabilities and ERP-PIA (H3). Nevertheless, a part of proponents of DCV suggest that dynamic capabilities are still crucial in moderately dynamic environments (Peteraf et al., 2013). This may suggest that dynamic IT capabilities can also work in the general case to render ERP-PIA (Peteraf et al., 2013), as the direct effect of dynamic IT capabilities on ERP-PIA we demonstrated.

Although the moderating effect of environmental turbulence on the relationship between dynamic IT capabilities and ERP-PIA is insignificant, we find support for the direct effect of environmental turbulence on ERP-PIA (β = 0.230; $p < 0.01$). The reason may be that when environmental turbulence emerges, firms have no choice but to rapidly respond to the turbulence by adapting their ERP without utilizing dynamic IT capabilities for ERP.

Implications for Research and Practice

Our results provide five implications for both research and practice. First, we provide new insights to the understanding of adaptability theories and phenomena in the ERP post-implementation with the DCV. This study reveals that four critical dynamic IT capabilities can help a firm to adapt its ERP and overcome inertia. The results of this study address the gaps in the literature, such as institutional theory, IPT, ROT, technology-organization-environment framework, situated learning perspective, and the framework of mutual adaptation of technology and organization.

Second, we elaborate how firms can gain increased benefits from system use and theorize ERP-PIA as a critical role, which is limited in the literature. Most prior studies have implied that ERP needs to evolve or adapt to fulfill the changing demands and environment after going live and achieving stability (Aanestad & Jensen, 2016; Cao et al., 2013; Seddon et al., 2010; Staehr et al., 2012; Wagner & Newell, 2007). However, few studies have developed the constructs related to ERP-PIA and empirically examined how ERP-PIA benefits firms (Oseni et al., 2017). There have also been few attempts to describe or theorize constructs related to IT/IS adaptation in the IS research. This study addresses such research issue, and contributes to the literature by demonstrating that ERP-PIA, as an example of IT/IS adaptation, is the key to achieving greater organizational benefits from system use.

Third, some may argue that ERP-PIA is similar to ERP assimilation. However, while ERP assimilation focuses on which ERP diffuses across business activities and becomes routinized in the activities (Liang et al., 2007; Mu et al., 2015; Saraf et al., 2013; Shao, 2019; Shao et al., 2017), ERP-PIA focuses on which ERP is adapted to provide new functionalities and continuously support the activities. Therefore, their definitions are different but can be complemented. The new functionalities provided by ERP-PIA must be diffused and routinized across the business activities. Without ERP-PIA, routinized ERP is likely to become rigid; the necessary changes to ERP will not be made, and the ERP will not be effectively assimilated by the firm. Therefore, this study suggests that both ERP-PIA and ERP assimilation are crucial for deriving benefits from system use.

Fourth, all ERP systems emphasize the embedded best practices that provide generic industry solutions (Wang et al., 2006). However, this means that the best practices in the past are the standard practices today, thus creating equifinality for firms. ERP, therefore, cannot provide advantages for firms. This study suggests that ERP-PIA is the solution for helping firms to create multifinality. By adapting ERP and injecting idiosyncratic details into the systems, firms can configure a specific combination of their ERP and relevant systems to fit business activities and operations (Teece, 2014). Therefore, these systems can be perceived as valuable, rare, and inimitable resources that can provide some advantages for firms, at least in a limited time, based on the suggestions of the resource-based view (Barney, 1991; Teece, 2014).

Finally, the four dynamic IT capabilities for ERP denote that to enable ERP-PIA, managers must entangle bottom-up and top-down functions. Top managers need to sense the needs from the bottom of their firms (IT sensing capability) and create a learning atmosphere for the bottom (line) functions (IT learning capability), instead of forcing the bottom functions to completely follow the decisions from the top. This can help firms to understand what is actually required for ERP and what can be improved by new IT and knowledge because most ERP users are in the line functions. Thereafter, the managers need to integrate new capabilities into existing ERP (IT integrating capability) and allocate resources among a series of improvement projects (IT coordinating capability), with a top-down logic. Without these capabilities, ERP-PIA is less likely to be initialized and implemented (Daniel et al., 2014), increasing rigidity of existing ERP.

Conclusion

In this study, we developed and tested a nomological network that links dynamic IT capabilities for ERP, environmental turbulence, ERP-PIA, and organizational benefits from system use, based on the DCV. The empirical results support the model and the findings provide specific actionable guidance for practitioners regarding how to adapt ERP in the post-implementation stage. This study differs from prior studies about ERP post-implementation in several ways, thereby adding to the cumulative body of knowledge in this crucial research domain. First, we conceptualize and empirically demonstrate the importance of ERP-PIA on obtaining greater organizational benefits from system use. Second, we conceptualize four dynamic IT capabilities for ERP, namely IT sensing, IT learning, IT integrating, and IT coordinating capability, and theorize how these capabilities interact to enable firms to adapt ERP systems to fulfill the emergent demands. Third, we show that dynamic IT capabilities are valuable no matter in stable or turbulent environment. Overall, we provide a crucial step toward improving the understanding of the roles of dynamic IT capabilities for ERP in enabling ERP-PIA and organizational benefits, through a richer theoretical framing than that of prior studies.

This study has several limitations. First, although we propose new concepts of dynamic IT capabilities for ERP and four IT capabilities, including sensing, learning, integrating, and coordinating capability, these constructs are specific to ERP improvement and enhancement contexts. Thus, the generalization of this study to other information systems may be limited and need to further adapt. Future studies can further develop more comprehensive IT capabilities to enhance generalization. For example, IT learning capability can focus not only on learning processes but also on learning specific information and knowledge domains. Second, we used cross-sectional data to assess our model. Although the proposed research hypotheses were derived theoretically, the results still reflect associations instead of causality. Third, this study relies on perceptual measures, which may not accurately reflect the true relationships among the theoretical constructs we examined. However, because managers generally make their decisions and act based on their perceptions, this may not be a severe limitation. Fourth, the response rate of the survey appears low, resulting in small sample size. This should be expected because we used a multiple informant approach for the survey to reduce the common method bias and obtain data from more appropriate informants. However, small sample size may also limit our generalization. Finally, although the possibility of nonresponse bias was checked and ruled out statistically, the representativeness of the sample, and thus, the generalizability of the results, may be a limitation of this study.

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Appendix A. Constructs and measurement items

<table>
<tr><th colspan="2">Construct and scale indicators</th></tr>
<tr><td colspan="2"><u>IT sensing capability (Mu et al., 2015; Pavlou & El Sawy, 2011)</u>
● Our IT staff frequently meets formally with colleagues from other functions (e.g., marketing, finance) to discuss emerging ERP-related business needs.
● Our IT unit continuously collects information about new ERP-related business needs in other functional areas of the organization.
● Our IT unit performs formal reviews on a regular basis to identify new business needs.
● Our IT unit periodically review the likely effect of changes in our business environment on ERP and relevant systems.
● Our IT unit often review ERP and relevant systems to ensure it is in line with what the other functions want.
● Our IT unit periodically devote a lot of time initiating plans for ERP and relevant systems improvements.</td></tr>
<tr><td colspan="2"><u>IT learning capability (Pavlou & El Sawy, 2011)</u>
● Our IT unit has effective routines to acquire new information and knowledge related to ERP and relevant systems from various sources.
● Our IT unit has adequate routines to assimilate new information and knowledge related to ERP and relevant systems.
● Our IT staff is effective in transforming existing knowledge about ERP and relevant systems into new one.
● Our IT unit is effective in utilizing knowledge to come up with multiple ERP and relevant systems improvement plans.
● Our IT unit is effective in developing new knowledge that has the potential to improve ERP and relevant systems.</td></tr>
<tr><td colspan="2"><u>IT integrating capability (Daniel et al., 2014; Kearns & Sabherwal, 2006; PMI, 2013)</u>
● Our IT unit is able to propose new IT projects that align with our ERP and relevant systems improvement directions.
● Our IT unit ensures that planned new IT functionalities can be integrated with existing ERP and relevant systems functionalities.
● Our IT unit ensures that planned new systems deliver expected effects on existing ERP and relevant systems.
● Our IT unit has a global perspective of planned new IT functionalities and existing functionalities from ERP and relevant systems.</td></tr>
<tr><td colspan="2"><u>IT coordinating capability (Daniel et al., 2014; Pavlou & El Sawy, 2011)</u>
● Our IT unit ensures an appropriate allocation of resources (e.g. financial supports, IT personnel, consultants, and relevant stakeholders' supports) within the projects it involved.
● Our IT unit assigns personnel to the projects it involved commensurate with their relevant knowledge and skills.
● Our IT unit ensures appropriate priorities of resources and tasks among the projects it involved.
● Our IT unit ensures the balance of the allocations of resources among the projects it involved.
● Overall, our IT unit is well coordinated.</td></tr>
<tr><td><u>ERP post-implementation adaptation (Mu et al., 2015)</u>
Please rate the degree to which after initial ERP implemented, the system has been improved to provide new functionalities in order to support the following activities.
<u>Strategic activities</u>
● Being a low-cost producer
● Having manufacturing/operations flexibility
● Enhancing supplier linkages
● Enhancing customer linkages
● Providing value-added services
● Enhancing existing products/services
● Entering new markets
<u>Primary activities (value chain)</u>
● Inbound logistics (e.g., purchasing)
● Outbound logistics (e.g., warehousing)
● Manufacturing/operations
● Marketing
● Sales
● Customer services
<u>Support activities (value chain)</u>
● Procurement
● Technology development
● Human resource management</td><td><u>Organizational benefits from system use (Seddon et al., 2010; Shang & Seddon, 2002)</u>
How satisfied is your firm with following benefits from the organization's overall investment in ERP and relevant systems, compared with your major competitors?
● Operational cost reduction
● Cycle time reduction
● Productivity improvement
● Data and information quality improvement
● Customer service improvement
● Better resource management
● Improved decision making and planning
● Performance improvement
● Support for business growth
● Support for business alliance
● Building business innovations
● Building cost leadership
● Generating product differentiation
● Building external linkages
● Building business flexibility for current and future changes
● Changing work patterns
● Facilitating organizational learning
● Better user empowerment</td></tr>
</table>

● Firm infrastructure ● Linkages among key support activities **Overall support** ● Overall, our ERP and relevant systems has evolved to provide many new functions to support our business activities.	● Building common vision
IT turbulence (Mu et al., 2015) ● The use of information technology in our industry is changing very fast. ● A larger number of new product ideas have been made possible through information technology breakthroughs in our industry. ● In our industry, the modes of production and service change often due to novel information technology.	**Competitive turbulence (Rai & Tang, 2010; Wilden & Gudergan, 2015)** ● There is intense competition for market share in our industry. ● Competition in our industry is cutthroat. ● Price competition is a hallmark of our industry. ● One hears of a new competitive move almost every day
Market turbulence (Rai & Tang, 2010; Wilden & Gudergan, 2015) ● Customer preferences change rapidly in our industry. ● It is very difficult to predict any changes in our industry. ● Forecasting demand in our industry is very difficult.	**Technological turbulence (Rai & Tang, 2010; Wilden & Gudergan, 2015)** ● Technological innovations have brought many new product ideas in the recent past. ● The technology in our industry is changing rapidly. ● *It is very difficult to forecast where the technology in our industry will be in the next two to three years.*
Measured latent marker variable (MLMV) (Lee & Wang, 2016) ● I played around with features in Microsoft Word. ● I used some Microsoft Word features by trial and error. ● I tried new features in Microsoft Word. ● I figured out how to use certain Microsoft Word features.	**Financial resources (Chwelos, Benbasat, & Dexter, 2001; Zhu, Kraemer, & Dedrick, 2004)** ● Our firm's IT operating budget is sufficient. ● Our firm is affordable to pay for ERP-related costs and ongoing operation expenses.

Appendix B. Cross loadings

	Sensing	Learning	Integ.	Coord.	ERP-PIA	Comp. tur.	Market tur.	Tech. tur.	Org. ben.	IT mind.	IT tur.	Fin. Res.	Adap.	MLMV
Sensing 1	**0.91**	0.70	0.72	0.61	0.30	-0.03	0.25	0.22	0.28	0.61	0.30	0.37	0.21	0.13
Sensing 2	**0.93**	0.69	0.68	0.62	0.31	-0.05	0.22	0.19	0.29	0.63	0.32	0.36	0.14	0.13
Sensing 3	**0.90**	0.59	0.62	0.50	0.22	-0.16	0.13	0.17	0.20	0.43	0.29	0.41	0.20	0.08
Sensing 4	**0.88**	0.59	0.60	0.57	0.32	-0.02	0.15	0.31	0.34	0.51	0.33	0.43	0.27	0.19
Sensing 5	**0.91**	0.71	0.71	0.59	0.28	-0.12	0.13	0.13	0.24	0.52	0.32	0.33	0.18	0.09
Sensing 6	**0.92**	0.67	0.70	0.56	0.27	-0.05	0.11	0.17	0.27	0.55	0.33	0.42	0.14	0.10
Learning 1	0.70	**0.95**	0.75	0.66	0.29	0.01	0.10	0.11	0.26	0.68	0.38	0.43	0.05	0.05
Learning 2	0.65	**0.95**	0.71	0.64	0.31	0.10	0.19	0.20	0.30	0.69	0.37	0.49	0.01	0.05
Learning 3	0.62	**0.93**	0.74	0.67	0.33	0.11	0.14	0.13	0.36	0.69	0.29	0.46	0.04	0.10
Learning 4	0.71	**0.92**	0.72	0.69	0.37	0.07	0.26	0.20	0.34	0.64	0.45	0.47	0.16	0.16
Learning 5	0.73	**0.95**	0.78	0.68	0.32	0.05	0.19	0.13	0.27	0.68	0.31	0.46	0.08	0.10
Integrating 1	0.75	0.79	**0.94**	0.65	0.34	0.05	0.19	0.12	0.30	0.64	0.19	0.50	0.21	0.09
Integrating 2	0.71	0.76	**0.95**	0.66	0.38	0.16	0.20	0.19	0.34	0.66	0.22	0.52	0.19	0.10
Integrating 3	0.67	0.73	**0.95**	0.75	0.30	0.12	0.13	0.04	0.28	0.66	0.18	0.53	0.19	0.01
Integrating 4	0.68	0.72	**0.96**	0.73	0.27	0.08	0.10	0.05	0.27	0.67	0.18	0.53	0.15	0.06
Coordinating 1	0.50	0.57	0.54	**0.87**	0.26	-0.10	0.05	0.07	0.22	0.64	0.40	0.41	0.10	0.04
Coordinating 2	0.61	0.65	0.60	**0.89**	0.30	-0.04	0.16	0.15	0.25	0.68	0.43	0.44	0.12	0.08
Coordinating 3	0.58	0.61	0.64	**0.90**	0.29	0.08	0.08	0.09	0.27	0.59	0.32	0.51	0.17	-0.01
Coordinating 4	0.58	0.70	0.77	**0.92**	0.24	-0.04	0.05	-0.06	0.16	0.69	0.20	0.44	0.12	-0.05
Coordinating 5	0.56	0.60	0.68	**0.87**	0.23	-0.04	0.10	0.05	0.15	0.61	0.29	0.32	0.06	0.04
ERP-PIA 1	0.34	0.41	0.34	0.31	**0.94**	0.16	0.36	0.22	0.63	0.25	0.16	0.27	0.40	0.25
ERP-PIA 2	0.25	0.32	0.33	0.26	**0.95**	0.20	0.35	0.18	0.60	0.25	0.12	0.25	0.37	0.23
ERP-PIA 3	0.08	0.13	0.16	0.11	**0.88**	0.12	0.40	0.14	0.49	0.08	0.08	0.10	0.25	0.20
ERP-PIA 4	0.39	0.34	0.37	0.35	**0.85**	0.13	0.33	0.26	0.67	0.20	0.15	0.18	0.39	0.28
Comp. Tur. 1	-0.11	0.02	0.07	-0.11	0.16	**0.89**	0.45	0.30	0.26	-0.04	-0.10	0.08	0.28	-0.06
Comp. Tur. 2	-0.06	0.09	0.09	-0.04	0.14	**0.86**	0.37	0.34	0.22	0.05	0.03	0.05	0.16	-0.04
Comp. Tur. 3	-0.15	0.06	0.06	-0.01	0.06	**0.79**	0.27	0.24	0.14	0.00	0.06	0.08	0.02	-0.03
Comp. Tur. 4	0.04	0.07	0.12	0.05	0.20	**0.76**	0.49	0.50	0.37	-0.01	0.17	0.15	0.49	0.11
Market Tur. 1	0.20	0.18	0.07	0.01	0.22	0.44	**0.83**	0.57	0.26	0.06	0.18	-0.01	0.17	0.16
Market Tur. 2	0.14	0.19	0.21	0.16	0.41	0.47	**0.92**	0.37	0.35	0.06	0.12	0.11	0.20	-0.07
Market Tur. 3	0.15	0.13	0.15	0.10	0.42	0.41	**0.94**	0.43	0.34	-0.02	0.17	0.03	0.23	0.10
Tech. Tur. 1	0.25	0.19	0.17	0.08	0.24	0.32	0.38	**0.93**	0.47	0.11	0.31	0.18	0.32	0.28
Tech. Tur. 2	0.17	0.13	0.04	0.05	0.20	0.46	0.56	**0.96**	0.49	0.16	0.36	0.10	0.29	0.23
OBES1	0.22	0.19	0.22	0.15	0.39	0.13	0.21	0.36	**0.74**	0.12	0.18	0.11	0.42	0.37

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OBES2	0.12	0.19	0.20	0.17	0.51	0.15	0.17	0.21	**0.77**	0.13	0.13	0.06	0.53	0.37
OBES3	0.10	0.15	0.11	0.10	0.45	0.11	0.18	0.33	**0.79**	0.07	0.11	0.17	0.52	0.38
OBES4	0.19	0.20	0.16	0.12	0.49	0.38	0.27	0.38	**0.71**	0.17	0.17	0.11	0.49	0.27
OBES5	0.25	0.28	0.36	0.23	0.50	0.32	0.25	0.43	**0.74**	0.26	0.12	0.35	0.50	0.29
OBES6	0.27	0.31	0.18	0.11	0.36	0.26	0.08	0.33	**0.67**	0.23	0.19	0.27	0.35	0.32
OBES7	0.29	0.34	0.31	0.21	0.60	0.26	0.20	0.30	**0.83**	0.24	0.09	0.30	0.44	0.35
OBES8	0.03	0.11	0.09	-0.05	0.49	0.26	0.25	0.20	**0.74**	-0.01	-0.04	0.08	0.46	0.33
OBES9	0.25	0.30	0.33	0.28	0.59	0.36	0.34	0.48	**0.85**	0.23	0.22	0.31	0.53	0.27
OBES10	0.10	0.19	0.11	0.05	0.47	0.26	0.30	0.49	**0.76**	0.03	0.15	0.17	0.51	0.43
OBES11	0.30	0.31	0.29	0.24	0.58	0.28	0.38	0.55	**0.77**	0.16	0.31	0.23	0.49	0.37
OBES12	0.33	0.36	0.30	0.28	0.53	0.23	0.26	0.42	**0.75**	0.21	0.34	0.22	0.51	0.35
OBES13	0.26	0.26	0.26	0.23	0.66	0.30	0.42	0.54	**0.81**	0.16	0.35	0.24	0.49	0.34
OBES14	0.29	0.23	0.29	0.18	0.58	0.20	0.33	0.45	**0.76**	0.10	0.22	0.25	0.49	0.26
OBES15	0.35	0.25	0.28	0.28	0.42	0.17	0.26	0.52	**0.70**	0.24	0.33	0.29	0.52	0.39
OBES16	0.39	0.35	0.33	0.20	0.44	0.27	0.23	0.41	**0.80**	0.20	0.29	0.30	0.49	0.30
OBES17	0.28	0.31	0.32	0.24	0.56	0.23	0.34	0.37	**0.84**	0.19	0.28	0.27	0.51	0.38
OBES18	0.17	0.25	0.21	0.15	0.56	0.21	0.28	0.25	**0.81**	0.07	0.17	0.19	0.43	0.32
OBES19	0.16	0.18	0.20	0.17	0.54	0.19	0.29	0.34	**0.80**	0.17	0.25	0.25	0.52	0.49
IT_MIND1	0.34	0.43	0.39	0.45	0.00	-0.01	-0.04	0.10	0.01	**0.72**	0.34	0.19	-0.18	-0.02
IT_MIND2	0.54	0.65	0.58	0.64	0.15	-0.02	0.02	0.20	0.16	**0.93**	0.47	0.38	-0.01	0.16
IT_MIND3	0.60	0.71	0.71	0.72	0.25	0.01	0.04	0.10	0.22	**0.98**	0.31	0.52	0.01	0.02
IT Tur. 1	0.34	0.34	0.21	0.36	0.15	0.00	0.06	0.25	0.19	0.38	**0.92**	0.07	0.02	0.28
IT Tur. 2	0.24	0.33	0.11	0.26	0.16	0.09	0.23	0.37	0.29	0.30	**0.96**	0.02	0.02	0.27
IT Tur. 3	0.41	0.40	0.26	0.43	0.10	0.03	0.16	0.36	0.26	0.42	**0.92**	0.13	0.16	0.20
Fin. Res. 1	0.39	0.41	0.46	0.44	0.21	0.07	-0.02	0.14	0.31	0.43	0.12	**0.92**	0.21	0.12
Fin. Res. 3	0.31	0.43	0.47	0.34	0.16	0.14	0.15	0.09	0.14	0.39	-0.03	**0.73**	0.08	0.09
Adapt. Agility 1	0.16	0.03	0.14	0.13	0.34	0.26	0.21	0.29	0.54	0.03	0.14	0.09	**0.92**	0.18
Adapt. Agility 2	0.23	0.12	0.22	0.20	0.48	0.23	0.27	0.30	0.67	0.05	0.13	0.26	**0.92**	0.29
Adapt. Agility 3	0.18	0.10	0.23	0.14	0.30	0.36	0.16	0.25	0.52	0.03	-0.02	0.19	**0.90**	0.28
Adapt. Agility 4	0.15	0.00	0.10	-0.05	0.27	0.27	0.15	0.31	0.51	-0.14	-0.02	0.14	**0.87**	0.27
MLMV 1	0.04	-0.01	-0.01	-0.11	0.02	0.08	0.08	0.23	0.29	0.06	0.20	0.07	0.14	**0.82**
MLMV 2	0.18	0.18	0.12	0.14	0.35	0.03	0.16	0.35	0.52	0.17	0.35	0.13	0.34	**0.92**
MLMV 3	0.08	0.04	0.00	-0.05	0.12	0.02	-0.01	0.25	0.31	0.02	0.20	0.07	0.19	**0.90**
MLMV 4	0.10	0.06	0.06	-0.01	0.30	-0.09	-0.03	0.08	0.37	-0.01	0.13	0.17	0.25	**0.89**

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