2019

TANGIBLE INFORMATION TECHNOLOGY INFRASTRUCTURE ASSETS AND ORGANIZATIONAL AGILITY: AN INVESTIGATION OF MANUFACTURING SMALL AND MEDIUM ENTERPRISES

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Research full-length paper

General Track

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Abstract

This paper investigates the role of tangible IT infrastructure assets –the portfolio of specific applications to which a firm endows itself – in enabling organizational agility and business performance in the context of SMEs. Building upon past literature, we regroup tangible IT infrastructure assets into three categories: IT for flexibility, IT for innovation, and IT for integration. Each category includes a series of specific technologies (i.e., CNC, CAD and ERP). We theorize that tangible IT infrastructure assets positively influence organizational agility and business performance. We employ a survey methodology to test the proposed hypotheses. One hundred and twenty-six manufacturing SMEs completed the survey. The results support the hypothesized relations. This research complements previous research that has studied intangible abstract constructs as antecedents of organizational agility, it confirms the results of past research examining the agility-business performance link, and it addresses the scarcity of strategic IS research in SMEs.

Keywords: performance, agility, strategy, capability, technological infrastructure.

1 Introduction

In today's turbulent environments, businesses need to be agile in order to adapt quickly in the face of change while they also need to exhibit endurance for long-term sustainability. In this scenario, it is not surprising that professional publications give tips on how to increase organizational agility (Baker 2019), on the change management and leadership skills necessary for organizations to become agile (Oss 2019a, 2019b), and on the key role of information technology (IT) in enabling businesses' agility ("Organizational Agility, Keep It Lean" 2019).

As a reflection of this, the strategic Information Systems (IS) literature focuses on how IT enables firms' organizational agility, among other organizational capabilities, and business performance (e.g., Bharadwaj 2000; Chae et al. 2014; Chen 2012; Chen et al. 2014, 2015; Liu et al. 2013). Thus, organizational agility, defined as "the ability to detect and respond to opportunities and threats with ease, speed , and dexterity" (Tallon and Pinsonneault 2011, p. 464), is one way in which IT resources influence firm performance (Sambamurthy et al. 2003). Different IT resources have been identified as antecedents of organizational agility, such as IT competencies (Chakravarty et al. 2013), knowledge assets (Côrte-Real et al. 2017), IT ambidexterity (Lee et al. 2015), IT infrastructure related assets (Fink and Neumann 2009; Liu et al. 2013), and business intelligence and communication technologies (Park et al. 2017).

With a few exceptions (e.g., Lu and Ramamurthy 2011; Roberts and Grover 2012), the majority of these studies, while studying different (although sometimes overlapping) constructs, have one thing in common: the operationalization of the construct is always an abstract mental representation of the IT resource in question (e.g., Chakravarty et al. 2013; Côrte-Real et al. 2017; Fink and Neumann 2009; Ghasemaghaei et al. 2017; Lee et al. 2015; Liu et al. 2013; Mikalef and Pateli 2017; Park et al. 2017; Tallon and Pinsonneault 2011). This occurs despite the fact that, in some occasions, the name of the construct might be perceived as a tangible IT infrastructure asset such a specific information technology. For example, Lee et al. (2015) explore IT ambidexterity, composed of IT for exploitation and IT for exploration, which they operationalize as a self-perceptual measure that captures the reutilization of legacy systems (i.e., exploitation) and the experimentation with new IT (i.e., exploration). There is high value in capturing abstract representations of technology, and so it is helpful to tell enterprises, for example, that, in order to be agile, they need to nurture both the capacity to reuse older systems and the capacity to experiment with novel technologies. This focus on abstract theoretical concepts, however, has left unexplored other IT resources that represent more concrete and tangible aspects of technology. As a consequence, the role of tangible IT infrastructure assets such as an ERP or CAD/CAM system in enabling organizational agility, has, for the most part, been ignored. Calls have thus been made to fill this first research gap through more studies on how specific technologies enable organizational capabilities such as organizational agility (Ortiz de Guinea and Raymond 2020).

Second, the overwhelming majority of studies have either focused on large enterprises (e.g., Lee et al. 2015; Lu and Ramamurthy 2011), studied both large and small and medium enterprises (SMEs) simultaneously (e.g., Ghasemaghaei et al. 2017; Liu et al. 2013), or appeared not to provide information about the size of the sampled enterprises (e.g., Chakravarty et al. 2013; Park et al. 2017; Roberts and Grover 2012). There are two reasons for which this might be problematic. First, prior management studies have demonstrated that differences in organizational size affect performance outcomes (Benito-Osorio et al. 2016; Hong and Oxley 2016; Hwang et al. 2015), so conclusions drawn from samples composed of large enterprises might not be generalizable to SMEs. Second, SMEs are critical for any country's economy. In Spain, the context of this study, SMEs encompass 99.6% of all enterprises and employ 53.4% of the total number of working individuals (*Cifras PyME: Datos Abril 2019* 2019). Hence, there are calls for research on the strategic management of IT in the specific context of SMEs (Street et al. 2017).

Third, environmental uncertainty, although having been identified as the fundamental problem with which managers must deal with (Kearns, & Lederer, 2004), has often been ignored in studies investigating the value of IT for different performance outcomes (e.g., Chae et al. 2014; Ray et al. 2005; Wang et al. 2012). Some have characterized as 'surprising' this lack of attention to the environment in which firms operate (Pezeshkan et al. 2016) since environmental uncertainty critically conditions managers' decisions and actions (Miller 1993) and thus, the level and extent of IT adoption and assimilation in organizations (Abdul Hameed and Counsell 2012).

In order to address these three gaps, the objective of this paper is to study how tangible IT infrastructure assets influence organizational agility and business performance in manufacturing SMEs, taking into consideration environmental uncertainty under which these firms operate. More specifically, and in order to provide a more complete nomological network, we also investigate environmental uncertainty as an antecedent of tangible IT infrastructure assets and organizational agility, as well as the link between organizational agility and performance.

The rest of the paper is organized as follows. First, we start with the theoretical background where we develop our research model and hypotheses; herein, we also review the literature on IT resources as antecedents of organizational agility. Second, the methodology in the form of a survey is explained. Third, the results are presented. Finally, the paper ends with discussion of this research contributions and future avenues for research.

2 Theoretical background

2.1 Environmental uncertainty

Environmental uncertainty, in general, is understood as the extent to which the business environment in which firms operate is perceived to remain unchanged or to be in constant evolution (Duncan 1972). Three main dimensions characterize environmental uncertainty: dynamism, heterogeneity, and hostility (Aragón-Correa and Sharma 2003; Mikalef and Pateli 2017; Miller and Friesen 1983). Dynamism refers to the rate and unpredictability of the changes that occur in the environment (Mikalef and Pateli 2017). Heterogeneity deals with the diversity and complexity of the market in which firms operate (Mikalef and Pateli 2017). Finally, hostility captures both the level of competition and the scarcity of key resources in the environment (Mikalef and Pateli 2017). Environmental uncertainty is a key factor influencing the different decisions and actions taken by managers in their firms (Miller 1993). Decisions such as which technologies to invest in, adopt, and use within a business enterprise are thus influenced by the degree of environmental uncertainty such enterprise faces (Abdul Hameed and Counsell 2012). Thus, firms adopt and use different technologies either in reaction to environmental demands or to take advantage of environmental opportunities (Damanpour and Schneider 2006). In a nutshell, it is believed that the greater uncertainty in the environment, the greater the adoption and use of IT. Thus, several studies have demonstrated that higher competitiveness and uncertainty in an environment exert considerable influence on the adoption and use of different tangible IT assets, such as EDI (electronic data interchange) (Iacovou et al. 1995; Premkumar et al. 1997; Premkumar and Ramamurthy 1995) or ERP (Chang et al. 2012). As a result,

Hypothesis 1: Environmental uncertainty positively influences the extent of tangible IT infrastructure assets in use.

Environmental characteristics also influence organizational forms and abilities(Sherehiy et al. 2007). For example, in relatively static and predictable environments, organizations become ore mechanistic, whereas in unstable and unpredictable environments, organizations adopt organic forms or designs that allow them to develop the agility necessary to survive, respond, and adapt (Sherehiy et al. 2007). In other words, environmental uncertainty motivates organizations to become agile, that is, to seize opportunities in the environment, to detect threats, and to respond quickly to such opportunities and threats (Zhang and Sharifi 2000). The variety of environmental pressures that a firm experiences, drives it to develop agility in order to both deal and take advantage of such pressures (Zhang and Sharifi 2000). Consequently, the more uncertainty faced by firms, the higher their organizational agility:

Hypothesis 2: Environmental uncertainty positively influences organizational agility.

2.2 Tangible IT infrastructure assets

To understand the concept of tangible IT infrastructure assets and its relation to organizational agility and business performance, it is important to review the literature on IT resources. Thus, in this section, we review this literature and then provide the rationale for linking tangible IT infrastructure assets to organizational agility and business performance.

2.2.1 IT resources and tangible IT infrastructure assets

According to Piccoli and Ives (2005), IT resources include IT assets and IT capabilities. At the same time, IT assets and IT capabilities have different components that have been identified in the literature. For example, IT capabilities are intangible assets developed in order to deal with the unique challenges that are inherent to different technologies, and include among others: a) technical skills (i.e., "the ability to design and develop effective information systems" , Piccoli and Ives 2005, p. 756); b) IT management (i.e., the ability to envision innovative and feasible technological solutions to business problems, provide leadership for the IS function, evaluate different technology options, and manage IT projects, Mata et al. 1995) ; and c) relationship asset (i.e., a respectful and trusting relation between the IS function and the business that enables both IS specialists and users to work together effectively (Piccoli and Ives 2005). For example, the IT capabilities investigated as antecedents of organizational agility include IT competencies (Chakravarty et al. 2013), IT enabled dynamic capabilities (Mikalef and Pateli 2017), and the alignment between IS and business strategy (Tallon and Pinsonneault 2011).

In contrast, IT assets that are available to the firm include IT infrastructure assets and information repositories (Piccoli and Ives 2005). The firm's IT infrastructure is the portfolio of systems and applications available to it (Broadbent and Weill 1997; Piccoli and Ives 2005), while information repositories are a collection of logically related data organized in a way that can be accessed and utilized for decision-making (Piccoli and Ives 2005). In practice, research to date has not differentiated between information repositories and IT infrastructure assets, and has included the former into the latter. In any case, although the notion of IT infrastructure assets appears to have a tangible orientation with a focus on concrete and specific technologies, it is often operationalized as intangible IT assets that focus more on the tasks that technology, in general, affords.

For example, Chakravarty et al. (2013) studied IT competencies as including both the firm's IT infrastructure and IT capabilities. While IT capabilities comprised technical and management skills, IT infrastructure was defined as including technological physical assets (Chakravarty et al. 2013). However, the operationalization of IT infrastructure did not encompass specific systems or applications but rather four items that measured the degree of investments in and emphasis on state of the art IT infrastructure and on planning for the renewal of IT assets (Chakravarty et al. 2013). Likewise, Fink and Neumann (2009) focused on different IT infrastructural elements, such as IT compatibility, which was operationalized through five items that measure the extent to which different systems are compatible with one another. In a similar vein, Ghasemaghaei et al. (2017) investigated data analytics' use and operationalized the construct as the extent and means to which a firm use data analytics tools without ever specifying what tools these might be. Finally, Liu et al. (2013, p. 1455) focused on flexible infrastructure as "the firm's ability to establish a complete set of technological resources, which provides the foundation for the development of IT applications". This flexible infrastructure was operationalized as a four-item scale that evaluated the connectivity, compatibility and modularity of the firm's IT infrastructure, without identifying any specific system or application.

Two studies, however, have operationalizations that identify concrete technologies or specific tangible IT infrastructure assets. Thus, Lu and Ramamurthy (2011, p. 936) focused on IT infrastructure capability and one of its components was IT infrastructure capability, defined as the extent to which a firm "provides a globally integrated platform that enforces standardization and integration of data and processes". The operationalization of this last construct identified the relative performance of a firm in using different infrastructure technologies such as data management services and architecture, network communication services, application portfolio and services (e.g., ERP) and other technologies (e.g., servers, large-scale processors, etc.) (Lu and Ramamurthy 2011). In a similar vein, Roberts and Grover (2012, p. 265), focused on web-based customer infrastructure tools that encompass the "online mechanisms that organizations can adopt to interact with customers in order to support different customer NPD roles". They measured such construct by asking respondents whether their organization had specific web-based tools made available to customers through their website, and then through a series of operations they calculated an index to capture the web-based resource infrastructure for each firm (Roberts and Grover 2012).

With this paper, we hope to contribute to these studies and investigate how tangible IT infrastructure assets, that is, specific technologies, enable organizational agility and business performance. By focusing on specific technologies, we believe the results of this research will be highly useful to practitioners as they will offer insight into the convenience or not of investing in certain technologies. Recent research agrees and thus, there are calls for studying how different specific technologies enable (or disable) the wide range of organizational capabilities needed by business firms to compete successfully (Ortiz de Guinea and Raymond 2020).

2.2.2 Tangible IT infrastructure assets, organizational agility, and business performance

Manufacturing firms, the context of this study, represent organizations in which different and diverse tangible IT infrastructure assets are daily utilized. Although rather scarce, the literature on these firms has provided categorizations of tangible IT infrastructure assets (Hoon Yang et al. 2007; Kotha and Swamidass 2000; Raymond and Croteau 2009). Such categorizations have grouped information technologies based on their enablement of related activities or processes (Hoon Yang et al. 2007; Kotha and Swamidass 2000; Raymond and Croteau 2009). After reviewing this literature and previous categorizations of IT, Uwizeyemungu et al. (2018) grouped IT infrastructure assets into three main categories: IT for flexibility, IT for innovation, and IT for integration. First, IT for flexibility regroups technologies such as computer numerical control (CNC) or automated handling, which, embedded in product service production processes, provide greater flexibility to such processes, hence their name (Uwizeyemungu et al. 2018). Second, IT for innovation encompasses technologies employed for the design of new products or services such as computer-aided design (CAD). Finally, IT for integration includes transactional and administrative applications whose role is to facilitate coordination (e.g., EDI and Intranets) or to increase efficiency through business and system integration (e.g., ERP, MRP). Following such categorization, we specify IT infrastructure assets as a formative construct composed of IT for flexibility, IT for innovation, and IT for integration. More specifically, following Roberts and Grover (2012), each set of technologies represents an index variable capturing the total number of the technologies in each category in use in a given firm. In this way, the three IT categories capture different aspects of the construct, and as such the construct is specified as formative (Petter et al. 2007). Table 1 offers a view of all the technologies regrouped by category.

We theorize that tangible IT assets, formed by the three categories, positively influence both organizational agility and business performance (see Figure 1). In general, firms, by acquiring, developing, and utilizing different IT applications, increase their repertoire of feasible responses to environmental changes (Fichman 2004; Richardson et al. 2014; Tallon et al. 2016), which makes their IT infrastructure a platform for organizational agility and performance (Sambamurthy et al. 2003). For example, flexibility, a property of agile organizations, hinges on the successful implementation of advanced manufacturing technologies such as computer numerical control (CNC), automated handling, and applications for logistics and optimization (Vastag et al. 1994). Such applications serve to better stream internal and external processes for production and distribution. For example, CNC allows for the automatic control of manufacturing tools via computer systems which makes the manufacturing process more flexible, precise, and efficient. Automated handling creates value for the organization via a more flexible management and control of inventory, while applications for logistics and optimizing also influence agility by providing a better and more flexible management of the downstream and upstream processes of a given firm, supporting agility in manufacturing (Gunasekaran and Yusuf 2002), and ultimately, business performance.

Tangible IT infrastructure assets used in manufacturing SMEs		**Item in the operationalization of the category**
IT for flexibility	Logistics / Optimization (e.g., routing, loading, distribution)	ITFlexibility1
	Computer Aided Maintenance	ITFlexibility2
	Computer Numerical Control (CNC)	ITFlexibility3
	Automated handling	ITFlexibility4
IT for innovation	CAD / CAM (computer aided design, computer aided manufacturing)	ITInnovation1
	Computer modelling /Simulation	ITInnovation2
	Rapid prototyping applications	ITInnovation3
IT for integration	MRP / MRP II / ERP (enterprise resource planning)	ITIntegration1
	CRM (customer relationship management)	ITIntegration2
	External communication network (e.g., extranet, EDI)	ITIntegration3
	Internal communication network (Intranet)	ITIntegration4
	Mobile computing (e.g., cloud computing)	ITIntegration5

Table 1. Tangible IT infrastructure assets grouped by their three dimensions.

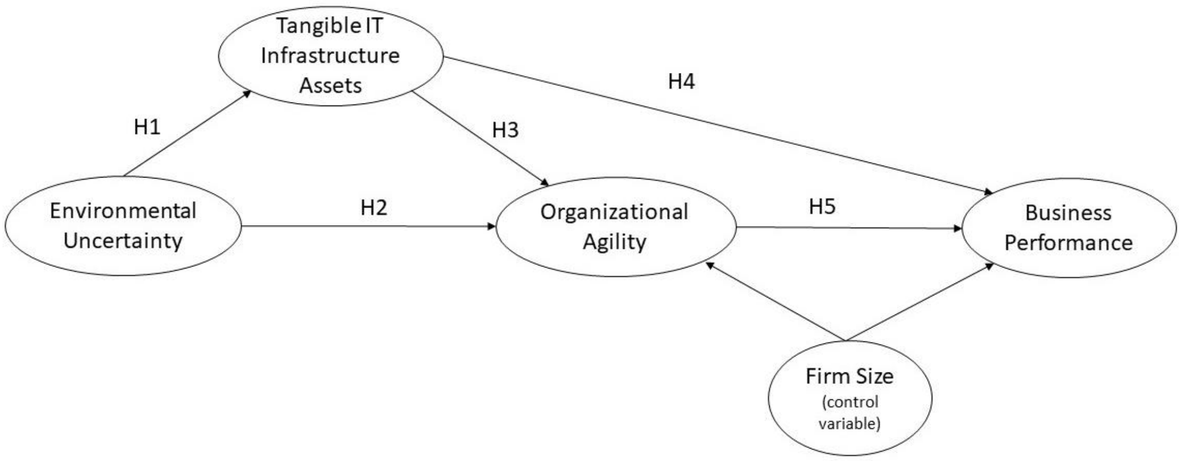

Figure 1. Research model.

Technologies encompassed into the category of IT for innovation also appear to be positive for organizational agility. The technological enablers that allow a manufacturing business to become agile include CAD /CAM, rapid prototyping and computer modelling and simulation applications (Vinodh, Devadasan, and Shankar 2010; Vinodh, Devadasan, Vasudeva Reddy, et al. 2010). For example, interactive CAD systems, apart from generating designs with repetitive accuracy, offer the advantage of easy modification of design to satisfy customer's specific requirements (Sarcar et al. 2008). Such applications allow for the exploration of new product opportunities (Ortiz de Guinea and Raymond 2020) and thus, for quickly switching over to new products in order to reduce the time to reach the market, allowing organizations to adapt to customer demands more easily (Gunasekaran and Yusuf 2002; Thilak et al. 2018). All in all, these technologies allow for the fast launching of new product models and rapid adjustment of manufacturing systems to meet market demands (Mehrabi et al. 2000) in order to ensure business performance.

Finally, IT for integration encompassing enterprise systems (ES), such as ERP and CRM, external and internal communications networks, and mobile computing are believed to increase organizational agility (Davenport 1998) by speeding up activities, allowing integration, and enabling collaborations and distributed operations (Huang and Nof 1999). ES allow for three different types of integration that can facilitate organizational agility: vertical (i.e., between different hierarchical levels), horizontal (i.e., between departments or functions within an organization), and technical (i.e., between different systems in order to be compatible with each other) (Seethamraju and Seethamraju 2009), which allows for a more efficient collaboration and faster decision-making across functional units by breaking traditional 'silos' (Liu et al. 2013). Likewise, the confluence of ES with mobile computing and different networks allows better collaboration within an organization (Konsynski and Tiwana 2004), thus enabling agility. Furthermore, loose coupling, a characteristic of web services (WS), service-oriented architecture (SOA) and business process management suites (BPMS), is becoming embedded in ES (Trinh et al. 2012), making these agility-enabling applications (Chen et al. 2007). For example, in a study of fifteen large organizations that have implemented ERP, it was found that the majority of organizations, when faced with environmental changes, would look for a response among the prebuilt business processes embedded into the ERP (Goodhue et al. 2009). Additionally, the disposition of add-ons in such systems, including special functionalities, enable different capabilities that firms can utilize to respond to agility challenges, taking into consideration their unique needs (Goodhue et al. 2009). As a result, we posit that tangible IT infrastructure assets positively influence organizational agility and business performance:

Hypothesis 3: The extent of tangible IT infrastructure assets in use positively influence organizational agility.

Hypothesis 4: The extent of tangible IT infrastructure assets in use positively influence business performance.

2.3 Organizational agility and business performance performance

It has been theorized that agility can improve a firm's performance by expanding its repository of feasible competitive actions and responses to changes in the environment (Sambamurthy et al. 2003). Thus, organizational agility fosters a firm's ability to respond to environmental challenges in a purposeful manner and to develop and offer new or modified quality services and products (Alegre and Sard 2015; Cegarra-Navarro et al. 2016). Firms with greater organizational agility do not only adjust better to market demands but they also sense environmental threats and opportunities for competitive action more easily (Sambamurthy et al. 2003). This adaptive process of sensing and adapting is paramount for firms to endure market shifts and facilitate business performance. As a result, firms that lack the capacity to be agile are less able to adapt their existing routines and processes to the demands of the environment (Cegarra-Navarro et al. 2016), which erodes their competitive position and, ultimately, their business performance. Consistent with this theorizing, past research has found that organizational agility has a positive effect on firm performance (Cegarra-Navarro et al. 2016; Mikalef and Pateli 2017; Tallon and Pinsonneault 2011). As a result, we posit that:

Hypothesis 5: Organizational agility positively influences business performance.

3 Methodology

The methodology of this study takes the form of a survey. This survey was administered via telephone to manufacturing SMEs in Spain, randomly taken from a database of Spanish enterprises. The respondents were functional managers who had extensive knowledge of the tangible IT infrastructure assets in use and of the business growth and financial situation of their firm. The response rate was 8.9%, resulting in a sample size of 126 SMEs. The sampled firms' mean age was 34 years and their mean size was 100 employees. The majority of firms belong to industries requiring high technical knowledge such as the chemical industry (10.3%) or industries encompassing the manufacturing of machinery (13.5%), metallic products (12.7%), or motor vehicles (7.9%).

The different constructs included in this study were measured as follows. In terms of tangible IT infrastructure assets, and taking Uwizeyemungu et al. (2018) as a starting point, we asked respondents to whether they used each of the different technologies grouped under IT for flexibility, IT for innovation, and IT for integration (see Table 1). Taking a similar approach to that of Roberts and Grover (2012), the sum of the use/not use (i.e., 1/0) of each technology gave an index measure to each of the three dimensions of tangible IT infrastructure assets. As explained above, tangible IT infrastructure assets represent a formative construct and thus, were operationalized as such. The other research constructs were specified as reflective because each item of each measure captured the underlying nature of its respective construct (Petter et al. 2007). Thus, organizational agility was measured with 8 items adopted from Tallon and Pinsonneault (2011). Business performance was measured by 8 items adopted from Croteau and Raymond (2004) that ask about the growth and profitability of a given firm relative to other comparable firms. Environmental uncertainty was operationalized as a second order construct and each dimension, dynamism, heterogeneity, and hostility, was measured by 4, 3, and 5 items respectively adopted from Mikalef and Pateli (2017)[1]. All items forming the reflective constructs employed a Likert scale from 1 to 5. Finally, firm size was included as a control variable, and simply captured the number of full-time employees or equivalent of the firms composing the sample.

Because the original items from the literature were in English, and Spain was the context of this study, a Spanish version of all the items was elaborated following the guidelines of blind back-translation suggested by cross-cultural research methodologists to assure measurement invariance (Brislin 1976). That is, the original English version of the measures was translated to Spanish by a first translator. A second translator translated the version in Spanish back into English. Then, two independent English native speakers compared the original version in English to that resulting from the translation in Spanish. No substantial differences between the two English versions were reported.

After this and before the administration of the questionnaire, a pretest took place with 9 Spanish individuals: 4 graduate students, 1 professor, and 4 SME owners. The purpose of the pretest was to make sure that the participants understood and could easily answer the questions, and that potential wording artifacts were reduced (Dillman 2011). Each pretest was followed by an evaluation of the feedback from the tester, and by a decision on how to address the tester's comments.

4 Results

We analyzed the data with the SmartPLS3 software. PLS is a component-based structural equation modeling technique that allows for the simultaneous evaluation of the measurement and structural models. Thus, we first evaluate the psychometric properties of the measures with the assessment of the

[1] Due to space constraints, we cannot provide details of the measures. However, such details are available upon request from the authors.

measurement model. Then, we evaluate the research model through the examination of the structural model.

4.1 Measurement model

In order to assess the validity of our formative measure, tangible IT infrastructure assets, we followed the recommendations of Cenfetelli and Bassellier (2009). Thus, we first assessed the possibility of multicollinearity through the examination of the different indexes' variance inflator factor (VIF). The indexes for IT for flexibility, IT for innovation, and IT for integration had VIFs between 1.075 and 1.186 (see Table 3), below the recommended threshold of 3.3 (Diamantopoulos and Siguaw 2006). Furthermore, the weights of the indexes were significant, although at $p<.10$ for IT for flexibility and IT for innovation. This, however, is not surprising, since with formative measurement, indicators compete in explaining their associated construct and thus, there is a limit to the number of indicators that can have a significant weight (Cenfetelli and Bassellier 2009). To deal with this issue, one recommendation is to consider whether the facets described by the formative indicators tap into a single construct by examining the significance of their loadings on that construct (Cenfetelli and Bassellier 2009). In this case, all the loadings were significant, and thus, the index items capturing each dimension of tangible IT infrastructure assets are interpreted as important and not overlapping.

	VIF	**Weights**	**Loadings**
IT for flexibility	1.186	0.543†	0.807**
IT for innovation	1.111	0.400†	0.608**
IT for integration	1.075	0.485*	0.657**

†p<.10; *p<.05; **p<.01; ***p<.001

Table 2. Weights and loadings of formative items on their respective construct.

The rest of the measures were all reflective, with one of them, environmental uncertainty, conceptualized and operationalized as a second-order construct. To deal with this, a mixture of the repeated indicator approach and the latent variable scores was applied in two stages (Ringle et al. 2012). First, the repeated indicator approach was utilized in order to obtain the latent variable scores of the first-order constructs. The indicators loaded above the threshold of .70 on their respective dimension (dynamism, heterogeneity, and hostility). Second, the latent variable scores became manifest variables in the measurement model of the higher order construct. The manifest variables of dynamism and heterogeneity loaded above .85 on environmental uncertainty (see Table 3). However, hostility loaded below the .70 threshold. As a result, the model was trimmed to drop hostility. It is important to note, however, that analyses of the hypotheses were performed with the original model and the trimmed one, both leading to similar results.

Looking at all reflective variables, composite reliability values were greater than the .80 recommended guideline (Lance et al. 2006) (see Table 4). All of the latent variables demonstrated AVE (average variance explained) scores equal or greater than .50 (Chin 1998). The square root of the AVE of each construct was greater than its correlations with any other construct (see Table 4). Finally, all individual items loaded higher on their respective construct than on any other construct (see Table 3).

	Agility	Environmental Uncertainty	Firm Size	IT Infrastruc-ture	Business Performance
Dynamism	0.280	**0.850**	0.069	0.064	-0.136
Heterogeneity	0.327	**0.913**	-0.048	0.170	0.033
BusinessPerformance1	0.133	-0.132	-0.163	0.158	**0.754**
BusinessPerformance2	0.274	-0.093	-0.168	0.199	**0.781**

BusinessPerformance3	0.290	0.021	-0.144	0.132	**0.748**
BusinessPerformance4	0.210	-0.043	-0.254	0.237	**0.819**
BusinessPerformance5	0.322	0.043	-0.12	0.232	**0.841**
BusinessPerformance6	0.280	-0.007	-0.18	0.197	**0.857**
BusinessPerformance7	0.214	-0.066	-0.142	0.197	**0.825**
BusinessPerformance8	0.278	-0.046	-0.081	0.25	**0.745**

Table 3. Loadings and cross-loadings.

	Agility	Environmental Uncertainty	Firm Size	IT Infrastruc-ture	Business Performance
FirmSize	-0.098	0.004	1.000	0.245	-0.198
ITInfrastFlexibilityIndex	0.194	0.082	0.203	0.807	0.237
ITInfrastInnovationIndex	0.194	0.107	0.077	0.608	0.106
ITInfrastIntegrationIndex	0.156	0.109	0.214	0.657	0.171
OrganizAgility1	0.667	0.204	-0.2	0.239	0.207
OrganizAgility2	0.737	0.187	-0.056	0.183	0.200
OrganizAgility3	**0.819**	0.34	-0.155	0.222	0.274
OrganizAgility4	**0.691**	0.133	0.041	0.227	0.184
OrganizAgility5	**0.680**	0.219	0.031	0.179	0.161
OrganizAgility6	**0.793**	0.355	-0.082	0.098	0.276
OrganizAgility7	**0.695**	0.213	-0.046	0.206	0.193
OrganizAgility8	**0.521**	0.221	0.02	0.114	0.266

Table 3. Loadings and cross-loadings (continued).

	Composite reliability	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
(1) Business performance	0.933	0.798				
(2) Environmental uncertainty	0.875	-0.046	0.882			
(3) Tangible IT infrastructure assets	-	0.254	0.140	-		
(4) Agility	0.887	0.318	0.346	0.258	0.707	
(5) Firm size	-	-0.198	0.004	0.245	-0.098	-

Table 4. Composite reliability, correlations, and square root of AVE on diagonals.

4.2 Structural model

The evaluation of the structural model consisted of two assessments: an evaluation of the significance of the path coefficients and an examination of the explanatory power of the exogenous constructs. Hypothesis 1, which theorized a positive relation between environmental uncertainty and IT is marginally supported (at $p < 0.10$). Hypothesis 2, which posited a positive relation between environmental uncertainty and organizational agility is supported. Hypotheses 3 and 4, proposed that the extent of tangible IT infrastructure assets in use would positively affect organizational agility and business performance respectively, and both are supported. Finally, Hypothesis 5, which proposed a positive relation between organizational agility and business performance is also supported. The exogenous variables explain 1%, 23% and 18% of the variance of the extent of tangible IT infrastructure assets in use, organizational agility and business performance respectively. Finally, the control variable, firm size, exerts a significant and negative influence on both business performance and organizational agility (i.e., as firm size increases, business performance and organizational agility decrease).

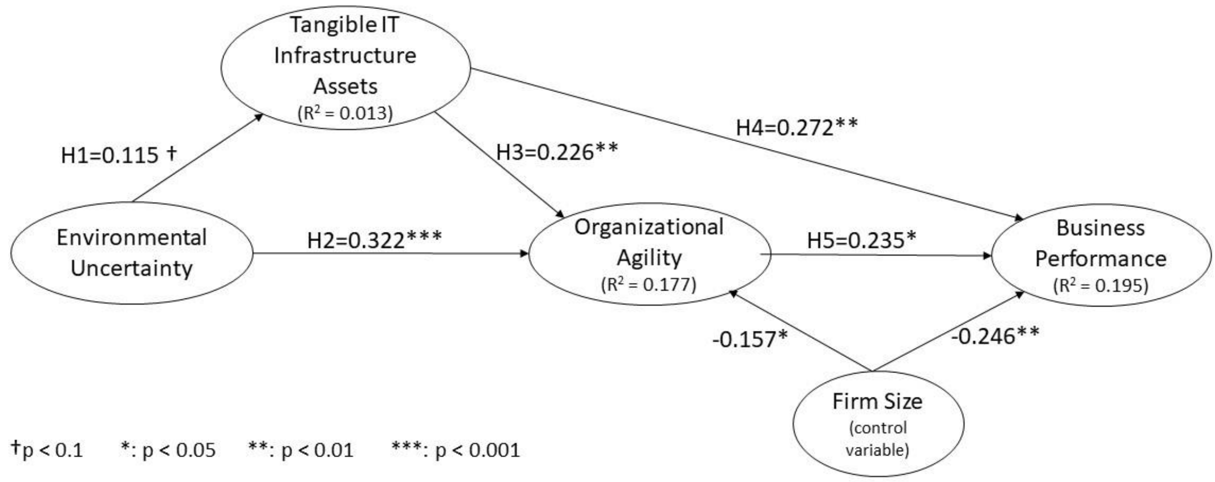

Figure 2. Results of the structural model.

5 Discussion

Our objective was to investigate how the extent of use of tangible IT infrastructure assets influence organizational agility and business performance in the specific context of manufacturing SMEs. Our results suggest that the disposition and use of tangible IT infrastructure assets – formed by IT for flexibility, IT for innovation, and IT for integration (Hoon Yang et al. 2007; Kotha and Swamidass 2000; Raymond and Croteau 2009; Uwizeyemungu et al. 2018) – positively influence organizational agility. The first category, IT for flexibility, encompasses computer aided maintenance, CNC, automated handling, and applications for logistics and/or optimization. The second category, IT for innovation includes CAD/CAM, modelling/simulation applications and rapid prototyping. Finally, the third category, IT for integration, regroups MRP/MRPII/ERP, CRM, external communication network (e.g., extranet, EDI), internal communication network (Intranet) and mobile computing. In positively linking these specific technologies to organizational agility and business performance, this paper contributes in several ways to IS research.

We contribute by answering recent calls for research into the identification of specific information technologies as enablers (or disablers) of organizational capabilities (Ortiz de Guinea and Raymond 2020). In fact, except for a few papers (e.g., Lu and Ramamurthy 2011; Roberts and Grover 2012), the majority of the literature has concentrated on intangible and abstract representations of IT (e.g., Chakravarty et al. 2013; Fink and Neumann 2009; Ghasemaghaei et al. 2017; Liu et al. 2013). While we see value in this approach, we believe that identifying specific technologies as positively influencing organizational agility provides additional knowledge to IS researchers and is of high relevance for IS practitioners. Demonstrating that the disposition and use of specific tangible IT infrastructure assets facilitate manufacturing SMEs' sensing of and responsiveness to environmental challenges as well as their growth and profitability offers these firms a specific portfolio of different types of specific technologies (e.g., CNC, rapid prototyping, ERP) that they can utilize in hopes of improving their agility and performance. Such concrete implications for practitioners are important because they provide actionable-items (e.g., the convenience of the adoption and use of technologies such as CNC, CAD/CAM and ERP) that are under control of the executive team and which its implementation is dependent on each firm's situation (e.g., its IT expertise, financial situation and top-management support for IT,). We thus hope these implications help in bridging the gap between IS research and practice (Benbasat and Zmud 1999; Rosemann and Vessey 2008; Straub and Ang 2011).

The positive effect of environmental uncertainty on the firm's use of tangible IT infrastructure, although statistically significant, is weak (only 1% of shared variance between the two constructs). In contrast, our results appear to support the view that environmental uncertainty is a factor that motivates organizations to develop their agility, that is, their capability to identify opportunities and threats and take opportunity or action in an adequate and timely manner. In other words, stable environments foster organizational rigidity, while unstable ones stimulate the attentiveness and dexterity of organizations. This supports the idea, hardly tested but widely assumed and especially in manufacturing enterprises, that a changing and more unpredictable environment creates the need for organizations to become more agile (Zhang and Sharifi 2000).

Our results demonstrating the positive influence of organizational agility on business performance support prior theorizing on how increased agility improves performance by expanding a firm's wide range of competitive moves and responses to environmental changes (Sambamurthy et al. 2003). Furthermore, our results are consistent with previous studies who have empirically evaluated this relationship (e.g., Cegarra-Navarro et al. 2016; Mikalef and Pateli 2017; Tallon and Pinsonneault 2011). Besides allowing for better adaptation of business processes, organizational agility also allow enterprises to achieve greater process 'richness' via better sequencing and coordination of business activities along the value chain (Mikalef and Pateli 2017). Something that, according to our results, is positively influenced by the use of specific information technologies, that is, technologies regrouped under the guise of IT for flexibility, IT for innovation, and IT for integration.

Our focus on manufacturing SMEs is also a contribution to the literature. Despite the economic importance of these firms, they remain under-investigated in IS strategic research (Street et al. 2017). Our results thus suggest that, although many manufacturing SMEs lack key resources needed to attain stability and efficiency (Orser et al. 2012), their extended use of the specific information technologies at their disposal should facilitate their achievement of organizational agility and business performance. This is an important insight since SMEs' are believed to be stabilizers of a country's economy: although their growth is negatively affected during economic crises, this negative effect on growth is higher for larger firms (Varum and Rocha 2013). Thus, our results suggest that tangible IT infrastructure assets are critical in enabling SMEs to become more agile and thus, capable of dealing with changes and shifts in market demands and other environmental conditions.

5.1 Limitations

This research, as any other study, is not free of limitations. One clear limitation is the cross-sectional nature of our study; as a result, causality cannot be inferred. Second, the manufacturing SMEs studied here operate mainly in the chemical industry and manufacturing industries of machinery, equipment, and metallic products. Because there is great heterogeneity among SMEs with respect to the market in which they operate, future research could focus on investigating how specific information technologies enable organizational agility and other organizational related outcomes in industries whose environmental uncertainty, knowledge requirements and technical intensity vary more than in the firms sampled in this study. Finally, given the low response rate, we cannot assure the representativeness of the sample.

5.2 Future Research

Apart from the research opportunities stemming from the limitations, other avenues for future inquiry exist. In this study, for example, we focused on organizational agility and business performance. However, other organizational capabilities exist for which certain specific technologies could be critical. In this line, recent research also argues for studies linking specific technologies to different dynamic capabilities (e.g., sensing capabilities, learning capability, coordination capability, integration capability) identified in the literature (Pavlou and El Sawy 2010). For example, CAD/CAM and rapid prototyping could enable manufacturing SMEs' learning capability, while networks and ES could facilitate these firms' attainment of coordination and integration capabilities.

This study has taken a variance approach, however, future studies could rather take a configurational approach (El Sawy et al. 2010; Wilden et al. 2016), grounded in complexity theory (Merali et al. 2012). Such approach differs from the variance one, in that, among on other things, it is not centered on estimating the net effects of independent variables as the variance approach does (Ortiz de Guinea and Webster 2017); instead, it views independent variables in combination, identifying the different combinations of independent variables that enable a given outcome (Ragin 2006). Thus, the configurational approach also allows for equifinality, in contrast to the unifinality of the variance approach, which means that the same outcome can be reached through different means and starting positions (Meyer et al. 1993). This means that different configurations of variables could be equally effective in reaching the same outcome (Gresov and Dazin 1997). This approach could be valuable in providing firms with different combinations of tangible IT infrastructure assets that they can emulate, given their existing IT portfolio, financial health, organizational capabilities and strategic stance.

5.3 Conclusion

This research has examined the link between tangible IT infrastructure assets and organizational agility, which in turn positively influences competitive performance, in the context of manufacturing SMEs. By linking specific tangible IT infrastructure assets to organizational agility in this context, this research provides SME managers with a specific portfolio of technologies that they can employ in order to increase their firm's agility. Finally, we also encourage researchers to look at how specific technologies enable (or disable) other organizational capabilities, such as organizational learning and absorptive capacity, that are believed to influence business performance.

Acknowledgements

This research was supported by a grant from the "Retos de la Sociedad" program of the Ministry of Economy, Industry and Competitiveness of the Government of Spain (ECO2017-88924R).

References

Abdul Hameed, M., and Counsell, S. 2012. "Assessing the Influence of Environmental and CEO Characteristics for Adoption of Information Technology in Organizations," *Journal of Technology Management & Innovation* (7:1), pp. 64–84.

Alegre, J., and Sard, M. 2015. "When Demand Drops and Prices Rise. Tourist Packages in the Balearic Islands during the Economic Crisis," *Tourism Management* (46), pp. 375–385.

Aragón-Correa, J. A., and Sharma, S. 2003. "A Contingent Resource-Based View of Proactive Corporate Environmental Strategy," *Academy of Management Review* (28:1), pp. 71–88. (https://doi.org/10.5465/AMR.2003.8925233).

Baker, M. A. 2019. "Staying the Course: Increasing Enterprise Agility in the Age of Uncertainty," *Entrepreneur*. (https://www.entrepreneur.com/article/333983).

Benbasat, I., and Zmud, R. W. 1999. "Empirical Research in Information Systems: The Practice or Relevance," *MIS Quarterly* (23:1), pp. 3–16.

Benito-Osorio, D., Colino, A., Guerras-Martín, L. A., and Zúñiga-Vicente, J. A. 2016. "The Internal Diversification-Performance Link in Spain: Does Firm Size Really Matter?," *International Business Review* (25:2), pp. 548–558.

Bharadwaj, A. S. A. 2000. "A Resource-Based Perspective on Information Technology Capability and Firm Performance: An Empirical Investigation," *MIS Quarterly* (24:1), pp. 169–196.

Brislin, R. W. 1976. *Translation: Approaches and Research*, (Gardness Press.), New York, NY.

Broadbent, M., and Weill, P. 1997. "Management by Maxim: How Business and IT Managers Can Create IT Infrastructures," *Sloan Management Review* (38), pp. 77–92.

Cegarra-Navarro, J.-G., Soto-Acosta, P., and Wensley, A. K. 2016. "Structured Knowledge Processes and Firm Performance: The Role of Organizational Agility," *Journal of Business Research* (69:5), pp. 1544–1549.

Cenfetelli, R. T., and Bassellier, G. 2009. "Interpretation of Formative Measurement in Information Systems Research," *MIS Quarterly* (33:4), pp. 689–707.

Chae, H. C., Koh, C. E., and Prybutok, V. R. 2014. "Information Technology Capability and Firm Performance: Contradictory Findings and Their Possible Causes," *MIS Quarterly* (38:1), pp. 305–326.

Chakravarty, A., Grewal, R., and Sambamurthy, V. 2013. "Information Technology Competencies, Organizational Agility, and Firm Performance: Enabling and Facilitating Roles," *Information Systems Research* (24:4), pp. 976–997.

Chang, S.-I., Hung, S.-Y., Yen, D., and Lee, P.-J. 2012. "Critical Factors of ERP Adoption for Small- and Medium-Sized Enterprises: An Empirical Study," in *International Comparisons of Information Communication Technologies: Advancing Applications*, IGI Global, pp. 205–230.

Chen, J. L. 2012. "The Synergistic Effects of IT-Enabled Resources on Organizational Capabilities and Firm Performance," *Information & Management* (49), pp. 142–150.

Chen, M., Zhang, D., and Zhou, L. 2007. "Empowering Collaborative Commerce with Web Services Enabled Business Process Management Systems," *Decision Support Systems* (43:2), pp. 530–546.

Chen, Y., Wang, Y., Nevo, S., Benitez-Amado, J., and Kou, G. 2015. "IT Capabilities and Product Innovation Performance: The Roles of Corporate Entrepreneurship and Competitive Intensity," *Information & Management* (52:6), pp. 643–657.

Chen, Y., Wang, Y., Nevo, S., Jin, J., Wang, L., and Chow, W. S. 2014. "IT Capability and Organizational Performance: The Roles of Business Process Agility and Environmental Factors," *European Journal of Information Systems* (23:3), pp. 326–342.

Chin, W. 1998. "The Partial Least Squares Approach to Structural Equation Modeling," in *Modern Methods for Business Research*, Hillsdale, NJ: Lawrence Erlbaum Associates, pp. 295–336.

Cifras PyME: Datos Abril 2019. 2019. (http://www.ipyme.org//Publicaciones/CifrasPYME-abril2019.pdf).

Côrte-Real, N., Oliveira, T., and Ruivo, P. 2017. "Assessing Business Value of Big Data Analytics in European Firms," *Journal of Business Research* (70:Supplement C), pp. 379–390. (https://doi.org/10.1016/j.jbusres.2016.08.011).

Croteau, A.-M., and Raymond, L. 2004. "Performance Outcomes of Strategic and IT Competencies Alignment," *Journal of Information Technology* (19:3), pp. 178–190.

Damanpour, F., and Schneider, M. 2006. "Phases of the Adoption of Innovation in Organizations: Effects of Environment, Organization and Top Managers 1," *British Journal of Management* (17:3), pp. 215–236.

Davenport, T. H. 1998. "Putting the Enterprise into the Enterprise System," *Harvard Business Review* (76:4).

Diamantopoulos, A., and Siguaw, J. A. 2006. "Formative versus Reflective Indicators in Organizational Measure Development: A Comparison and Empirical Illustration," *British Journal of Management* (17:4), pp. 263–282.

Dillman, D. A. 2011. *Mail and Internet Surveys: The Tailored Design Method–2007 Update with New Internet, Visual, and Mixed-Mode Guide*, John Wiley & Sons.

Duncan, R. B. 1972. "Characteristics of Organizational Environments and Perceived Environmental Uncertainty," *Administrative Science Quarterly*, pp. 313–327.

El Sawy, O. A., Malhotra, A., Park, Y., and Pavlou, P. A. 2010. "Seeking the Configurations of Digital Ecodynamics: It Takes Three to Tango," *Information Systems Research* (21:4), pp. 835–848. (https://doi.org/10.1287/isre.1100.0326).

Fichman, R. G. 2004. "Real Options and IT Platform Adoption: Implications for Theory and Practice," *Information Systems Research* (15:2), pp. 132–154. (https://doi.org/10.1287/isre.1040.0021).

Fink, L., and Neumann, S. 2009. "Exploring the Perceived Business Value of the Flexibility Enabled by Information Technology Infrastructure," *Information & Management* (46:2), pp. 90–99. (https://doi.org/10.1016/j.im.2008.11.007).

Ghasemaghaei, M., Hassanein, K., and Turel, O. 2017. "Increasing Firm Agility Through the Use of Data Analytics: The Role of Fit," *Decision Support Systems* (101), pp. 95–105. (https://doi.org/10.1016/j.dss.2017.06.004).

Goodhue, D. L., Chen, D. Q., Boudreau, M. C., and Cochran, J. 2009. *Addressing Business Agility Challenges with Enterprise Systems*.

Gresov, C., and Dazin, R. 1997. "Equifinality: Functional Equivalence in Organizational Design," *Academy of Management Journal* (22:2), pp. 431–452.

Gunasekaran, A., and Yusuf, Y. Y. 2002. "Agile Manufacturing: A Taxonomy of Strategic and Technological Imperatives," *International Journal of Production Research* (40:6), pp. 1357–1385.

Hong, S., and Oxley, L. 2016. "Why Firm Size Matters: Investigating the Drivers of Innovation and Economic Performance in New Zealand Using the Business Operations Survey," *Applied Economics* (48:55), pp. 1–17.

Hoon Yang, K., Lee, S. M., and Lee, S.-G. 2007. "Adoption of Information and Communication Technology: Impact of Technology Types, Organization Resources and Management Style," *Industrial Management & Data Systems* (107:9), pp. 1257–1275.

Huang, C.-Y., and Nof, S. Y. 1999. "Enterprise Agility: A View from the PRISM Lab," *International Journal of Agile Management Systems* (1:1), pp. 51–60.

Hwang, Y. S., Hwang, M. H., and Dong, X. 2015. "The Relationships among Firm Size, Innovation Type, and Export Performance with Regard to Time Spans," *Emerging Markets Finance & Trade* (51:5), pp. 947–962.

Iacovou, C. L., Benbasat, I., and Dexter, A. S. 1995. "Electronic Data Interchange and Small Organizations: Adoption and Impact of Technology," *MIS Quarterly* (19:4), pp. 465–485. (https://doi.org/10.2307/249629).

Kearns, G.S., and Lederer, A.L. 2004. "The Impact of Industry Contextual Factors on IT Focus and the Use of IT for Competitive Advantage," *Information & Management* (41:7), pp. 899–919.

Konsynski, B., and Tiwana, A. 2004. "The Improvisation-Efficiency Paradox in Inter-Firm Electronic Networks: Governance and Architecture Considerations," *Journal of Information Technology* (19:4), pp. 234–243.

Kotha, S., and Swamidass, P. M. 2000. "Strategy, Advanced Manufacturing Technology and Performance: Empirical Evidence from US Manufacturing Firms," *Journal of Operations Management* (18:3), pp. 257–277.

Lance, C. E., Butts, M. M., and Michels, L. C. 2006. "The Sources of Four Commonly Reported Cutoff Criteria: What Did They Really Say?," *Organizational Research Methods* (9:2), pp. 202–220.

Lee, O.-K. (Daniel), Sambamurthy, V., Lim, K. H., and Wei, K. K. 2015. "How Does IT Ambidexterity Impact Organizational Agility?," *Information Systems Research* (26:2), pp. 398–417. (https://doi.org/10.1287/isre.2015.0577).

Liu, H., Ke, W., Wei, K. K., and Hua, Z. 2013. "The Impact of IT Capabilities on Firm Performance: The Mediating Roles of Absorptive Capacity and Supply Chain Agility," *Decision Support Systems* (54:3), pp. 1452–1462.

Lu, Y., and Ramamurthy, K. (Ram). 2011. "Understanding the Link between Information Technology Capability and Organizational Agility: An Empirical Examination," *Mis Quarterly*, pp. 931–954.

Mata, F. J., Fuerst, W. L., and Barney, J. B. 1995. "Information Technology and Sustained Competitive Advantage: A Resource-Based Analysis," *MIS Quarterly*, pp. 487–505.

Mehrabi, M. G., Ulsoy, A. G., and Koren, Y. 2000. "Reconfigurable Manufacturing Systems: Key to Future Manufacturing," *Journal of Intelligent Manufacturing* (11:4), pp. 403–419.

Merali, Y., Papadopoulos, T., and Nadkarni, T. 2012. "Information Systems Strategy: Past, Present, Future?," *The Journal of Strategic Information Systems*. (http://www.sciencedirect.com/science/article/pii/S0963868712000145).

Meyer, A. D., Tsui, A. S., and Hinings, C. R. 1993. "Configurational Approaches to Organizational Analysis," *Academy of Management Journal* (36:6), pp. 1175–1195.

Mikalef, P., and Pateli, A. 2017. "Information Technology-Enabled Dynamic Capabilities and Their Effect on Competitive Performance: Findings from PLS-SEM and FsQCA," *Journal of Business Research* (70), pp. 1–16.

Miller, D. 1993. "The Architecture of Simplicity," *Academy of Management Review* (18:1), pp. 116–138.

Miller, D., and Friesen, P. H. 1983. "Strategy-Making and Environment: The Third Link," *Strategic Management Journal* (4:3), pp. 221–235.

"Organizational Agility, Keep It Lean." 2019. *Quality Magazine*. (https://www.qualitymag.com/articles/95466-organizational-agility-keeping-it-lean).

Orser, B., Riding, A., and Stanley, J. 2012. "Perceived Career Challenges and Response Strategies of Women in the Advanced Technology Sector," *Entrepreneurship & Regional Development* (24:1/2), pp. 73–93. (https://doi.org/10.1080/08985626.2012.637355).

Ortiz de Guinea, A., and Raymond, L. 2020. "Enabling Innovation in the Face of Uncertainty through IT Ambidexterity: A Fuzzy Set Qualitative Comparative Analysis of Industrial Service SMEs," *International Journal of Information Management* (50), pp. 244–260.

Ortiz de Guinea, A., and Webster, J. 2017. "Combining Variance and Process in Information Systems Research: Hybrid Approaches," *Information and Organization* (27:3), pp. 144–162.

Oss, M. E. 2019a. "For 'agile' Organizations, Change Management Is Performance Management," *Open Minds*. (https://www.openminds.com/market-intelligence/executive-briefings/for-agile-organizations-change-management-is-performance-management/).

Oss, M. E. 2019b. "Who Do You Need to Lead an Agile Organization," *Open Minds*. (https://www.openminds.com/market-intelligence/executive-briefings/who-do-you-need-to-lead-an-agile-organization/).

Park, Y., El Sawy, O. A., and Fiss, P. C. 2017. "The Role of Business Intelligence and Communication Technologies in Organizational Agility: A Configurational Approach.," *Journal of the Association for Information Systems* (18:9), pp. 648–686.

Pavlou, P. A., and El Sawy, O. A. 2010. "The 'Third Hand': IT-Enabled Competitive Advantage in Turbulence Through Improvisational Capabilities," *Information Systems Research* (21:3), pp. 443–471. (https://doi.org/10.1287/isre.1100.0280).

Petter, S., Straub, D., and Rai, A. 2007. "Specifying Formative Constructs in Information Systems Research," *MIS Quarterly* (31:4), pp. 623–656.

Pezeshkan, A., Fainshmidt, S., Nair, A., Lance Frazier, M., and Markowski, E. 2016. "An Empirical Assessment of the Dynamic Capabilities–Performance Relationship," *Journal of Business Research* (69:8), pp. 2950–2956. (https://doi.org/10.1016/j.jbusres.2015.10.152).

Piccoli, G., and Ives, B. 2005. "IT-Dependent Strategic Initiatives and Sustained Competitive Advantage: A Review and Synthesis of the Literature," *MIS Quarterly* (29:4), pp. 747–776.

Premkumar, G., and Ramamurthy, K. 1995. "The Role of Interorganizational and Organizational Factors on the Decision Mode for Adoption of Interorganizational Systems," *Decision Sciences* (26:3), pp. 303–336. (https://doi.org/10.1111/j.1540-5915.1995.tb01431.x).

Premkumar, G., Ramamurthy, K., and Crum, M. 1997. "Determinants of EDI Adoption in the Transportation Industry," *European Journal of Information Systems* (6:2), pp. 107–121.

Ragin, C. C. 2006. "Set Relations in Social Research: Evaluating Their Consistency and Coverage," *Political Analysis* (14:3), pp. 291–310.

Ray, G., Muhanna, W. A., and Barney, J. B. 2005. "Information Technology and the Performance of the Customer Service Process: A Resource-Based Analysis," *MIS Quarterly* (29:4), pp. 625–652. (http://www.jstor.org/stable/25148703).

Raymond, L., and Croteau, A. M. 2009. "Manufacturing Strategy and Business Strategy in Medium-Sized Enterprises: Performance Effects of Strategic Alignment," *IEEE Transactions on Engineering Management* (56:2), pp. 192–202.

Richardson, S. M., Kettinger, W. J., Banks, M. S., and Quintana, Y. 2014. "IT and Agility in the Social Enterprise: A Case Study of St Jude Children's Research Hospital's 'Cure4Kids' IT-Platform for International Outreach," *Journal of the Association for Information Systems* (15:1), p. 2.

Ringle, C. M., Sarstedt, M., and Straub, D. W. 2012. "A Critical Look at the Use of PLS-SEM in MIS Quarterly," *MIS Quarterly* (36:1), iii–xiv.

Roberts, N., and Grover, V. 2012. "Leveraging Information Technology Infrastructure to Facilitate a Firm's Customer Agility and Competitive Activity: An Empirical Investigation," *Journal of Management Information Systems* (28:4), pp. 231–270. (http://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=74981421&site=ehost-live).

Rosemann, M., and Vessey, I. 2008. "Toward Improving the Relevance of Information Systems Research to Practice: The Role of Applicability Checks," *Mis Quarterly*, pp. 1–22.

Sambamurthy, V., Bharadwaj, A., and Grover, V. 2003. "Shaping Agility Through Digital Options: Reconceptualizing the Role of Information Technology in Contemporary Firms," *MIS Quarterly* (27:2), pp. 237–263.

Sarcar, M. M. M., Rao, K. M., and Narayan, K. L. 2008. *Computer Aided Design and Manufacturing*, PHI Learning Pvt. Ltd.

Seethamraju, R., and Seethamraju, J. 2009. "Enterprise Systems and Business Process Agility-a Case Study," in *2009 42nd Hawaii International Conference on System Sciences*, IEEE, pp. 1–12.

Sherehiy, B., Karwowski, W., and Layer, J. K. 2007. "A Review of Enterprise Agility: Concepts, Frameworks, and Attributes," *International Journal of Industrial Ergonomics* (37:5), pp. 445–460.

Straub, D., and Ang, S. 2011. "Editor's Comments: Rigor and Relevance in IS Research: Redefining the Debate and a Call for Future Research," *MIS Quarterly*, iii–xi.

Street, C., Gallupe, B., and Baker, J. 2017. "Strategic Alignment in SMEs: Strengthening Theoretical Foundations," *Communications of the Association for Information Systems* (40), Article 20.

Tallon, P. P., and Pinsonneault, A. 2011. "Competing Perspectives on the Link between Strategic Information Technology Alignment and Organizational Agility: Insights from a Mediation Model," *Mis Quarterly*, pp. 463–486.

Tallon, P. P., Queiroz, M., Coltman, T. R., and Sharma, R. 2016. "Business Process and Information Technology Alignment: Construct Conceptualization, Empirical Illustration, and Directions for Future Research," *Journal of the Association for Information Systems* (17:9), p. 563.

Thilak, V. M. M., Devadasan, S. R., Vinod, M., and Sunil, D. T. 2018. "Infusing Functional Agility in Pump Industry by Using Bluetooth Enabled Mobile Phone," *International Journal of Business Excellence* (14:4), pp. 499–522.

Trinh, T., Molla, A., and Peszynski, K. 2012. "Enterprise Systems and Organizational Agility: A Review of the Literature and Conceptual Framework," *Communications of the Association for Information Systems* (31:1). (http://aisel.aisnet.org/cais/vol31/iss1/8).

Uwizeyemungu, S., Raymond, L., Poba-Nzaou, P., and St-Pierre, J. 2018. "The Complementarity of IT and HRM Capabilities for Competitive Performance: A Configurational Analysis of Manufacturing and Industrial Service SMEs," *Enterprise Information Systems* (12:10), pp. 1336–1358.

Varum, C. A., and Rocha, V. C. 2013. "Employment and SMEs during Crises," *Small Business Economics* (40:1), pp. 9–25.

Vastag, G., Kasarda, J. D., and Boone, T. 1994. "Logistical Support for Manufacturing Agility in Global Markets," *International Journal of Operations & Production Management* (14:11), pp. 73–85.

Vinodh, S., Devadasan, S. R., and Shankar, C. 2010. "Design Agility through Computer Aided Design," *Journal of Engineering, Design and Technology* (8:1), pp. 94–106.

Vinodh, S., Devadasan, S. R., Vasudeva Reddy, B., and Ravichand, K. 2010. "Agility Index Measurement Using Multi-Grade Fuzzy Approach Integrated in a 20 Criteria Agile Model," *International Journal of Production Research* (48:23), pp. 7159–7176.

Wang, N., Liang, H., Zhong, W., Xue, Y., and Xiao, J. 2012. "Resource Structuring or Capability Building? An Empirical Study of the Business Value of Information Technology," *Journal of Management Information Systems* (29:2), pp. 325–367.

Wilden, R., Devinney, T. M., and Dowling, G. R. 2016. "The Architecture of Dynamic Capability Research: Identifying the Building Blocks of a Configurational Approach," *The Academy of Management Annals* (10:1), pp. 997–1076.

Zhang, Z., and Sharifi, H. 2000. "A Methodology for Achieving Agility in Manufacturing Organizations," *International Journal of Operations & Production Management* (20:4), pp. 496–512.