Impact of IT integration on the firm's knowledge absorption and desorption

Jessica Braojos, Jose Benitez, Javier Llorens, Laura Ruiz

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1. Author team

1. Jessica Braojos, Department of Management, IQS School of Management, Ramon Llull University, Barcelona, Spain; Department of Management, School of Business and Economics, University of Granada, Granada, Spain, jbraojos@ugr.es

2. Jose Benitez (corresponding author), Department of Supply Chain Management and Information Systems, Rennes School of Business, Rennes, France, jose.benitez@rennes-sb.com; Department of Management, School of Business and Economics, University of Granada, Granada, Spain, joseba@ugr.es

3. Javier Llorens, Department of Management, School of Business and Economics, University of Granada, Granada, Spain, fllorens@ugr.es

4. Laura Ruiz, Department of Management, School of Business and Economics, University of Granada, Granada, Spain, lauraruiz@ugr.es; Department of Supply Chain Management and Information Systems, Rennes School of Business, Rennes, France, laura.ruiz-santiago@rennes-sb.com

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Abstract

This paper examines the impact of the integration of IT systems with other organizations (IT integration) on the knowledge absorption and desorption of the focal firm. We ran an empirical study in Spain and found that IT integration enables the firm to absorb and desorb knowledge with other organizations, which in turn improves firm performance. This research provides two key contributions to the IS discipline: 1) We introduce the concept of *desorptive capacity* in the IS research and provide a scale for its measure, 2) we provide a theory of IT integration impact on the firm's knowledge absorption and desorption.

Keywords: IT integration capability, knowledge absorptive capacity, knowledge desorptive capacity, IT-enabled organizational capabilities, business value of IT.

1. Introduction

Worldwide IT investment is projected to total $3.8 trillion in 2019, an increase of 3.2% from the expected investment of $3.7 trillion in 2018 (Gartner 2018). A significant percentage of this worldwide investment is the firm's IT investments at the supply chain level (Rai and Tang 2010). As the global competition among firms has been focused at the supply chain level (instead of the focal firm), the firm's integration of IT systems with other organizations (IT integration) has become a critical IT capability to create business value (Rai et al. 2006). The construct IT integration has been examined in IS research in the different contexts: mergers and acquisitions (Benitez et al. 2018a), supply chain (Ward and Zhou 2006, Lai et al. 2008), and IT outsourcing (Ceci et al. 2019). We focus on IT integration capability in the supply chain[1], which is conceptualized as the firm's ability to integrate IT systems of the firm and IT systems of other organizations to coordinate activities with external agents (e.g., suppliers, customers, public institutions, competitors, etc.) (Bharadwaj et al. 2007, Rai and Tang 2010).

Currently, firms across industries are increasingly opening up their innovation processes by exchanging their knowledge with external agents (Chesbrough 2006, French et al. 2017, Roldan et al. 2018). A firm that consistently creates and sustains close relationships with suppliers or customers is in a better position to identify and assimilate new external knowledge (e.g., technological advancements, regulation changes, and customers' preferences) and therefore be able

[1]This study focuses on IT integration capability and its role on the firm's knowledge absorption and desorption. However, we use the terms IT integration capability and IT integration interchangeably for the sake of brevity. The terms capability and capacity are also used interchangeably in this paper.

to use this knowledge to increase firm performance (Kostopoulos et al. 2011, Setia and Patel 2013). Consequently, firms require certain organizational capabilities like abilities to manage internal and external knowledge (knowledge management) to respond effectively to the market (Tanriverdi 2005, Malone et al. 2011). In this sense, the organizational capabilities associated to knowledge management remain critical for firms to be able to compete in the era of digital disruption and supply chain management-based competition (Grant 1996, Lichtenthaler and Lichtenthaler 2009). How does the firm's IT integration capability affect knowledge management capabilities to create business value? This is the general research question this study aims to examine and answer.

We distinguish and focus on two critical knowledge management capabilities: knowledge absorptive capacity (Cohen and Levinthal 1990) and knowledge desorptive capacity (Lichtenthaler and Lichtenthaler 2009). Knowledge absorptive capacity refers to the firm's ability to acquire, assimilate, transform, and exploit external *core/primary knowledge* for commercial ends (Cohen and Levinthal 1990, Zahra and George 2002). Knowledge desorptive capacity refers to the firm's ability to identify and transfer *superficial/secondary (i.e., less important) knowledge*[2] to external partners (e.g., suppliers, customers, public institutions, competitors, etc.) (Lichtenthaler and Lichtenthaler 2009, Lichtenthaler and Lichtenthaler 2010). Companies may not be interested in desorbing core knowledge that can hamper their future strategic positions, but may be interested in desorbing superficial/secondary knowledge while protecting their primary knowledge to obtain incomes, developing partnerships, or entering new markets. While knowledge absorptive capacity covers the outside-inside primary knowledge transfer process, knowledge desorptive capacity refers to an inside-outside secondary knowledge transfer process (Mortara and Minshall 2011, Hu et al. 2015). In this sense, this study covers the key knowledge transfer activities of the continuum for the focal firm and its supply chain. How does the firm's IT integration capability affect the

[2] This study uses the term core knowledge and primary knowledge interchangeably. Core knowledge refers to knowledge that can make the firm special for the customer. Examples of this core knowledge are knowledge on innovative processes and products, know-how, distribution, logistics, and on a disruptive technology. Similarly, this research uses superficial and secondary knowledge interchangeably. Secondary knowledge refers to knowledge that does not have the potential to make the firm special for the customer. Examples of this secondary knowledge are knowledge on operational routines, scheduling, soft technology, and nonrelevant products and suppliers. Our research was developed under the theoretical assumption that organizations exhibit an opportunistic behavior because they play "the game of coopetition" with other organizations by trying to absorb core knowledge but only desorbing secondary knowledge. Our assumption is consistent with the work of Gupta and Govindarajan (2000). Although this assumption might be difficult to prove empirically, we believe it is very rational given the hypercompetition of the current business landscape.

firm's knowledge absorption and desorption? This is the idiosyncratic and specific research question this study aims to examine and answer.

Prior IS research has focused on studying the impact of IT on knowledge absorption (Roberts et al. 2012). This body of research has been studied from a wide range of theoretical approaches such as knowledge management (Alavi and Leidner 2001, Felipe et al. 2016), IT governance (Limaj et al. 2016), IT innovation (Joshi et al. 2010, Carlo et al. 2012), and business value of IT (Bhatt and Grover 2005). Liu et al. (2013) examined the effect of IT capabilities on firm performance through absorptive capacity. Joshi et al. (2010) considered absorptive capacity as an IT-enabled knowledge capability and examine how it was able to increase innovation outputs. Limaj et al. (2016) argue that social information systems act as antecedents of absorptive capacity and that the combination of both enables the firm to generate innovation outcomes. Therefore, prior IS research has argued the impact of IT investments on the development of knowledge absorptive capacity to achieve business goals. However, although prior IS research has not examined whether IT integration may influence the development of knowledge absorptive capacity, we believe it is a critical aspect to shed light given the new rules of the business landscape: the supply chain-based competition/coopetition.

Similarly, prior IS research has not paid enough attention to the role of IT (neither IT integration) in the knowledge desorption, although IT integration might become a foundational capability to create and appropriate business value. Firms can be interested in transferring secondary knowledge (e.g., soft technology) to other external organizations to obtain a licensing income, entry into a foreign market, or access to core knowledge from these external partners (Lichtenthaler and Lichtenthaler 2010, Roldan et al. 2018).

In the current business landscape, firms cannot operate isolated, but depend on external resources and partners (Rai and Tang 2010). However, alliances are not always easy to manage because many of them face strong difficulties in benefiting from the management of knowledge, having doubts about the effectiveness of knowledge exchange, and therefore, becoming reluctant to involve in these processes (Kostopoulos et al. 2011). The failure in managing knowledge can lead to disastrous outcomes ultimately hampering the competitive position of the firm. Given the huge investment firms are making on IT, this is a good opportunity to show whether leveraging a critical IT capability such as IT integration matters in the management of knowledge and may be key to the successful building of capitalization of knowledge. Integrated IT systems offer technical

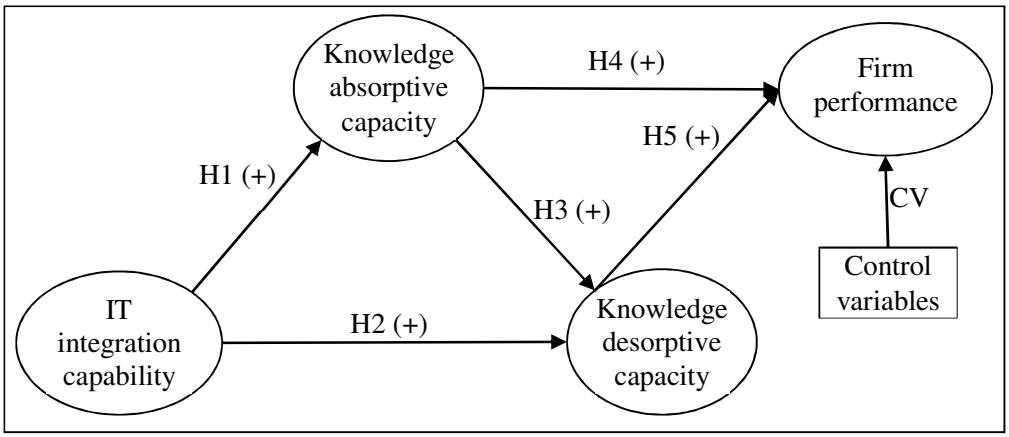
platforms and capabilities to build knowledge management capabilities. This has become critical as competition is now at the inter-organizational (instead of firm) level through the supply chain and alliances with others companies.

We introduce conceptually the construct of *knowledge desorptive capacity* to IS research and examine the impact of IT integration capability on the firm's knowledge absorption and desorption. Our central proposition is that the firm's ability to integrate IT systems of the firm and IT systems of external partners (IT integration capability) enables the focal firm to coordinate their business activities with external partners in a better way, which in turn facilitates to absorb core knowledge and transfer superficial knowledge with external partners to increase its business benefits.

We ran an empirical study in Spain to test our proposed theory. We find that IT integration capability enables the firm to absorb and desorb knowledge with other organizations, which in turn improves firm performance. In this sense, the empirical analysis supports our theory. Figure 1 shows the proposed research model. This research provides two key contributions to the IS research: 1) We introduce the concept of *knowledge desorptive capacity* in the IS research and provide a scale for its measure, 2) we provide and test a theory of IT integration impact on the firm's knowledge absorption and desorption.

The paper continues as follows: 1) the next section presents the theoretical framework, the conceptualization of key constructs, and hypotheses development, 2) the third section explains the research design, 3) the fourth section exposes the empirical analysis and results, 4) the fifth section incorporates the discussion and conclusions.

Figure 1: The research model



2. Theory, the conceptualization of key constructs, and hypotheses development

2.1. IT-enabled organizational capabilities perspective

Business value of IT is one of the golden lines of IS research that captures much attention from IS scholars. Grounded in the resource-based theory and the organizational capabilities theory, the so-called IT-enabled organizational capabilities have emerged as the dominant and well-established perspective to explain how the firm's IT resource investments influence firm performance. IT-enabled organizational capabilities perspective has been proven to be one of the strongest and more evidenced bodies of IS research to disentangle the IT productivity paradox. This perspective suggests that IT resources and capabilities influence firm performance through the development of business/organizational capabilities, thus emphasizing the enabling role of IT (the mediation hypothesis) in creating business value (Benitez and Walczuch 2012). Prior IS research consistent with this perspective has found that organizational learning, knowledge management (Tanriverdi 2005, Pavlou and El Sawy 2006), corporate entrepreneurship (Chen et al. 2015), and business flexibility (Chen et al. 2017, Benitez et al. 2018a, Benitez et al. 2018b) are intermediate processes/organizational capabilities through which IT influences firm performance. We draw on this perspective to propose an indirect impact of IT integration capability on firm performance through knowledge absorptive and knowledge desorptive capacities.

The organizational capabilities theory suggests that variance in performance comes from three types of organizational capabilities: dynamic capability, operational capability, and dual-purpose capability (Helfat and Winter 2011, Benitez et al. 2018a). Dynamic capabilities refer to the ability of the firm to build, integrate, and reconfigure internal and external resources/capabilities, and developing new ones to respond to changes in the environment (Teece 2007). Operational capabilities refer to the ability of the firm to execute operational routines required to perform operational activities (Wu et al. 2010, Benitez et al. 2018c). Dual-purpose capabilities refer to organizational capabilities that can be used at corporate and operational level, then being dynamic as well as operational (Helfat and Winter 2011, Benitez et al. 2018a). Knowledge absorptive capacity and knowledge desorptive capacity have been extensively proposed in prior literature as dynamic capabilities that assist in managing knowledge (Zahra and George 2002, Malhotra et al. 2005, Lichtenthaler 2007). In this sense, we use organizational capabilities theory to conceptualize knowledge absorptive and knowledge desorptive capacities and to explain their causal influence on firm performance.

2.2. Conceptualization of key constructs

The key concepts examined in this study are IT integration capability, knowledge absorptive capacity, knowledge desorptive capacity, and firm performance. IT integration capability is the firm's ability to integrate its IT systems and the IT systems of external partners (e.g., suppliers, customers, public institutions, competitors, etc.) to coordinate business activities with the external partners and provide consistent access to relevant information (Bharadwaj et al. 2007, Rai and Tang 2010, Setia and Patel 2013). IT integration provides an integrated and consistent access and sharing to order, production, customer (e.g., service contracts, feedback) and market-related data (Bharadwaj et al. 2007, Chong et al. 2014).

Knowledge absorptive capacity refers to the firm's ability to acquire, assimilate, transform, and exploit external core knowledge for commercial ends (Cohen and Levinthal 1990). Knowledge absorptive capacity is composed of four ingredients: knowledge acquisition, knowledge assimilation, knowledge transformation, and knowledge exploitation. Knowledge acquisition refers to the firm's ability to gather and identify internal (i.e., within the firm) or external (e.g., market) knowledge about process, product, logistics, and distribution related to innovation. It also involves the development of new knowledge or insights that have the potential to influence the development of new products (Setia and Patel 2013). Knowledge assimilation refers to the analysis, interpretation, and understanding of the information and knowledge obtained. Knowledge transformation refers to the transformation of existing information into new knowledge and to the integration of the new information and knowledge acquired with the existing knowledge of the firm. Finally, knowledge exploitation refers to the ability of exploiting the new integrated information and knowledge into concrete applications or products while constantly considering better ways to exploit knowledge (Zahra and George 2002).

Zahra and George (2002) recognized absorptive capacity as a dynamic capability categorized into two main subsets: potential and realized. Potential absorptive capacity enables a firm's receptiveness to external knowledge (i.e., acquire and assimilate knowledge), while realized absorptive capacity reflects a firm's capacity to leverage absorbed knowledge and transform it into innovation outcomes (i.e., transform and exploit knowledge). Potential absorptive capacity is conceptually covered in our study through knowledge acquisition and knowledge assimilation. Realized absorptive capacity is captured in our investigation through knowledge transformation and knowledge exploitation. We conceptualized and operationalized absorptive capacity as second-

order construct composed of four dimensions (knowledge acquisition, knowledge assimilation, knowledge transformation, and knowledge exploitation). This choice was preferred to operationalize knowledge absorptive capacity as two second-order constructs (potential and realized absorptive capacities) as we believe it is theoretically clear, statistically more parsimonious, and consistent with prior research.[3]

Knowledge desorptive capacity refers to the firm's ability to identify and transfer superficial knowledge to external partners (e.g., suppliers, customers, public institutions, competitors, etc.) (Lichtenthaler and Lichtenthaler 2009, Lichtenthaler and Lichtenthaler 2010). We argue that desorptive capacity has two main components: knowledge identification and knowledge transfer. Knowledge identification refers to the firm's ability to identify external knowledge opportunities that could be relevant to suppliers, customers, or other external organizations (e.g., public institutions and competitors). Knowledge transfer involves the transfer of superficial knowledge (e.g., consultations on product design ideas, production processes, and routines for efficiency, schedule, or technical problems) to external agents (Dyer and Hatch 2006, Lichtenthaler and Lichtenthaler 2009, Potter and Lawson 2013).

The process of desorbing constitutes the opposite direction of absorbing (Lichtenthaler and Lichtenthaler 2009, Lichtenthaler 2013). That is, knowledge desorptive capacity refers to an inside-outside secondary knowledge transfer process (Mortara and Minshall 2011, Hu et al. 2015). There are some contradictory interests when transferring knowledge. On one hand, core knowledge is understood as a source of power and competitive advantage and therefore, firms may be reluctant to share (core) knowledge that has a strategic value for their position in the market (Chiambaretto et al. 2019). On the other hand, firms can have some benefits and strategic interests when transferring superficial knowledge (i.e., reducing costs, sharing risks, obtaining licensing incomes, entering into a foreign market, or exploiting innovative solutions from combining knowledge) (Lichtenthaler and Lichtenthaler 2010). In this sense, organizations can protect from spilling over strategic/core knowledge and can prevent imitation by transferring superficial knowledge. First, organizations can deliver knowledge with a delay that allows the firm to maintain the first-mover

[3]We repeated the empirical analysis by operationalizing knowledge absorptive capacity as two second-order constructs (potential and realized absorptive capacities) where potential absorptive capacity leads to realized absorptive capacity but every other relationship is kept the same as in the proposed research model. We obtain very similar results (β Potential absorptive capacity → Realized absorptive capacity = 0.692^{***}), which suggests the operationalization of knowledge absorptive capacity does not affect the results, findings, and contributions of this study.

advantage (Chiambaretto et al. 2019). Second, organizations can use causal ambiguity by transferring complex or noncodified knowledge that makes it difficult to understand the causes and effects (Dyer and Hatch 2006, Potter and Lawson 2013). Third, organizations can share redundant or supplementary knowledge that overlaps with the receiver's knowledge (Knudsen 2007).

Although value creation has been typically related to cooperation, and value appropriation to competition, firms may be involved in the so-called coopetition phenomenon. Aggressive and disruptive companies (Ajamieh et al. 2016) play often the game of coopetition to finally compete, that is, they cooperate with external competing organizations (e.g., competitors) to capture core knowledge but only giving superficial knowledge (Hoffmann et al. 2018) and then "attacking" in the market. This is what we call opportunistic behavior, a key assumption of our study. Companies play to say that they cooperate to at the end compete and attack. World-class companies have begun to desorb knowledge as a part of their corporate strategies. For example, based on a strong knowledge desorptive capacity with its suppliers' network, Toyota improved their productivity and quality from transferring production knowledge. Because of this transferring of knowledge, Toyota's suppliers were able to learn how to manufacture better products for Toyota. However, this suppliers' learning was only suitable to Toyota's routines and policies, making it difficult to spill over knowledge to benefit Toyota's competitors. As a result, Toyota's vehicles had 40% fewer defects than their competitors with the same supplier network (Dyer and Hatch 2006). Finally, we focus on overall firm performance in terms of innovation, marketing, and financial facets (Pavlou and El Sawy 2006, Braojos et al. 2019). Table 1 presents the definition, dimensions, and informing source of our key constructs.

2.3. IT integration capability and knowledge absorptive capacity

IT integration capability may affect knowledge absorptive capacity. The integration of IT systems of the focal firm and the IT systems of its external partners help the focal firm to acquire, assimilate, transform, and exploit core knowledge from them. First, IT integration enables a firm to exchange rich information in real time (e.g., changes in plans for production and new trip schedule) and consequently facilitates the process of knowledge acquisition (Rai and Tang 2010, Ngai et al. 2012). For example, Cisco created an e-hub connecting suppliers and the company through Internet, allowing all firms to have the same demand and supply data to respond quickly to demand changes (Lee 2004). Second, integrated IT platforms span the organization boundaries connecting experts across organizations. When experts across organizations have access to and share uniform

knowledge, interpretation, and analysis of this knowledge are likely to converge, then assimilation becomes easier (Setia and Patel 2013, Liu et al. 2016). Third, IT integration enables coordination and discussion among external agents, becoming easier for firms to compare and integrate new and existing knowledge (Setia and Patel 2013). For instance, an integrated IT platform that supports electronic meetings makes the discussion of new market trends and the interpretation of existing knowledge in a different manner more likely to occur (Bharadwaj et al. 2007). Last, integrated IT platforms facilitate not only information flow across departments, but also information transparency, which allows a consistent view of the information and facilitates the refinement of existing and new core knowledge to exploit it. Integrated cross-boundary technologies such as e-commerce or social media technology leads to exchange relationships building across the firm and the external partners, allowing the firm to consider new ways of exploiting knowledge and competitive information (Li et al. 2018, Song et al. 2019). In sum, IT integration capability enables knowledge exchange with internal and external agents, enhancing knowledge acquisition, assimilation, transformation, and the exploitation of core knowledge. Therefore, we hypothesize that:

H1: There is a positive relationship between IT integration capability and knowledge absorptive capacity.

Table 1: Definition of key constructs

Construct	Definition	Dimensions	Informing source
IT integration capability	Firm's ability to integrate IT systems of the firm and IT systems of external partners to coordinate business activities	Extent to which an IT system facilitate integrated access and sharing to order, production, customer, and market data	Bharadwaj et al. (2007), Rai and Tang (2010), Setia and Patel (2013)
Knowledge absorptive capacity	Firm's ability to acquire, assimilate, transform, and exploit external core knowledge for commercial ends	Knowledge acquisition: Ability to capture, identify, and develop new relevant core knowledge from external agents Knowledge assimilation: Ability to absorb, analyze, interpret, and understand new core knowledge Knowledge transformation: Ability to combine existing with new core knowledge for future use	Zahra and George (2002), Pavlou and El Sawy (2006), Teece (2007), Liu et al. (2013)

		Knowledge exploitation: Ability to leverage new and existing knowledge to achieve the firm's goals	
Knowledge desorptive capacity	Firm's ability to identify and transfer superficial knowledge to external partners	Knowledge identification: Ability to identify opportunities to transfer superficial knowledge to external partners Knowledge transfer: Ability to transfer superficial knowledge to external organizations	Lichtenthaler and Lichtenthaler (2009, 2010)
Firm performance	Overall firm performance in terms of innovation, marketing, and financial dimensions	Extent to which the firm has achieved a superior innovation, marketing, and financial performance compared with direct competitors	Pavlou and El Sawy (2006), Fang et al. (2008), Kim and Atuahene-Gima (2010)

2.4. IT integration and knowledge desorptive capacity

We propose that IT integration capability may enable the firm to develop a knowledge desorptive capacity. IT integration capability facilitates communication and information sharing along the supply chain of the firm while spanning organizational boundaries, providing access to external agents' information and data, and improving the visibility of this information (Lichtenthaler 2007, Liu et al. 2013), which in turn may enable the focal firm to identify opportunities inside and outside its market to desorb superficial knowledge to external partners. Thus, we expect that the integration of the IT systems of the focal firm with the IT systems of its partners, enable the focal firm to identify knowledge desorption opportunities. On the other side, IT integration capability may enable the focal company to transfer superficial knowledge. Integrated IT systems are likely to become a common digital platform shared by the focal firm and its supply chain, allowing the firm to transfer superficial knowledge about nonrelevant products, suppliers, customers, markets, or technology (Pinjani and Palvia 2013). Therefore, if the firm is able to have better and more integrated IT systems with its partners, this will enable the transfer/desorption of knowledge (Bharadwaj et al. 2007). In summary, IT integration capability enables an organization to identify opportunities to desorb knowledge and transfer internal secondary knowledge to an external partner. Therefore, we hypothesize that:

H2: There is a positive relationship between IT integration capability and knowledge desorptive capacity.

2.5. Knowledge absorptive capacity and knowledge desorptive capacity

This study proposes that the firm's knowledge absorptive capacity is positively related to the firm's knowledge desorptive capacity. First, prior IS research on organizational ambidexterity has found an activity sequence between knowledge/business opportunities exploration and knowledge/business opportunities exploitation (Benitez et al. 2018b, 2018d) in a way that exploration precedes exploitation. Drawn on this prior IS research, we argue that knowledge absorptive capacity may be an antecedent of knowledge desorptive capacity.[4] Second, firms exhibit an opportunistic behavior and it is rational to expect they focus more on knowledge absorption than on knowledge desorption. Thus, a firm may be interested in identifying knowledge transfer opportunities and transferring superficial knowledge to external partners (knowledge desorptive capacity) once has guaranteed the sufficient level of core knowledge internally to survive and compete in the market (Lichtenthaler and Lichtenthaler 2009), and ensuring the company is special for customers. Hu et al. (2015) found that the number of in-licensing deals with external partners leads to a higher number of out-licensing deals. For example, the Fiat Research Centre (CRF), in a period of recession, decided to take an open innovation perspective. It was achieved, first, through the influx of resources from outside the Fiat Group to jointly develop know-how, and secondly, transferring technologies to industries other than the automotive. The revenues from the transfer of CRF technologies to external customers and cash flows resulting from CRF's participation in public-funded research projects allowed CRF to continue investing in the area of fuel-efficient engine technologies (Di Minin et al. 2010). This example illustrates that in some companies knowledge absorption can be an antecedent (and can be associated) with a subsequent knowledge desorption. Therefore, we hypothesize that:

H3: There is a positive relationship between knowledge absorptive capacity and knowledge desorptive capacity.

[4] Based on Lichtenthaler and Lichtenthaler's (2009) work, they argue that while knowledge absorptive capacity is mainly related to exploration activities, knowledge desorptive capacity is mainly related to exploitation activities (e.g., business benefits and entering into a new market). However, we recognize that both exploration and exploitation activities might exist in both knowledge absorptive capacity and knowledge desorptive capacity. This would potentially suggest that different levels of ambidexterity might exist in companies in different organizational capabilities such as knowledge absorptive capacity and knowledge desorptive capacity (please see our future research directions on this topic). We thank the anonymous Reviewer 4 for his/her recommendations on this issue.

2.6. Knowledge absorptive capacity and firm performance

This study proposes a positive relationship between knowledge absorptive capacity and firm performance based on the following arguments. First, firms with the ability to acquire and assimilate new core knowledge such as know-how, customer knowledge, core technologies, operational or market knowledge can rapidly detect new business opportunities (Benitez et al. 2018b). This capability helps firms to envision and identify customer preferences and new tendencies more easily, being easier to understand the market, and pioneering in the development of new products/services, hence improving firm performance (Engelen et al. 2014, Leal et al. 2014). For example, Air Products and Chemicals (a global corporation that sells gases and chemical products for industrial purposes) uses strategies like external partnering or Internet-based knowledge providers to identify external ideas that make the innovation process to work faster (Gronlund et al. 2010). Second, firms with the ability to transform and exploit new knowledge are more likely to respond to changes and effectively shape their internal processes to exploit new opportunities (Liu et al. 2013, Setia and Patel 2013). Firms with the ability to integrate new and existing knowledge may easily respond to changes and generate innovation outcomes (Leal et al. 2014). For example, to make snacks more novel and fun, Procter & Gamble came up with the idea of printing pop culture images on Pringles. To do so, they used their absorptive capacity to find and exploit an ink-jet method developed by a small bakery in Italy for printing edible images, leading to an important sales growth (Huston and Sakkab 2006). In conclusion, the ability to monitor, assimilate, and leverage external core knowledge provide firms up-to-date critical knowledge on customers and markets, which will improve innovation, marketing, and financial firm performance (Zahra and George 2002). Then, firms with superior knowledge absorptive capacity are more likely to exhibit higher firm performance (Pavlou and El Sawy 2006, Benitez et al. 2018d). Therefore, we hypothesize that:

H4: There is a positive relationship between knowledge absorptive capacity and firm performance.

2.7. Knowledge desorptive capacity and firm performance

This study proposes that a positive relationship exists between knowledge desorptive capacity and firm performance. Firms may have different motivations to desorb superficial knowledge with the final-end to increase firm performance. First, firms may transfer superficial knowledge to external organizations established in different product markets to access these new/foreign markets to

compete and increase market share, revenues, and profitability, thus improving firm performance (Lichtenthaler and Lichtenthaler 2010). For example, in the case of technology transfer, firms usually avoid transferring technology to firms within the same industry because of the existence of competitive threats, but instead, they prefer distant markets. This setting constitutes the first motivation to desorb superficial knowledge and improve firm performance: desorbing knowledge in a foreign market to make an entry into this market.

Second, another motivation for firms to identify knowledge transfer opportunities and transferring knowledge to external partners is to have access to the core knowledge from the external partner and thus increase firm performance. For example, in the bio-pharmaceutical industry the out-licensing is of particular importance to have access to the intellectual property of partners such as university know-how that may enhance the research productivity of private firms, and therefore its firm performance (Hu et al. 2015). This is the second mechanism through which knowledge desorptive capacity may influence firm performance. Finally, firms can also desorb knowledge to obtain a licensing income and generate business benefits. In summary, knowledge desorptive capacity can improve performance when firms are able to identify opportunities to exploit its superficial knowledge to obtain monetary gains (e.g., licensing) and strategic or noneconomic gains (e.g., having access to more critical knowledge or establishing in new markets) (Roldan et al. 2018). Therefore, we hypothesize that:

H5: There is a positive relationship between knowledge desorptive capacity and firm performance.

3. Research design and execution

3.1. Sample and data

Because the measures for the constructs studied in this research are not available directly in archival data, we decided to run a survey. The survey instrument was developed following the guidelines provided in prior research (Pavlou and El Sawy 2006, Benitez et al. 2018a). We started the data collection by using the list of the 5000 most admired large firms in Spain included in the Actualidad Economica database in 2015 (http://www.actualidadeconomica.com/). Actualidad Economica is a Spanish business magazine that annually publishes a ranking with the most admired firms in Spain based on sales and other business variables (e.g., innovation activity and employer brand value) (Benitez and Walczuch 2012, Benitez et al. 2018a, 2018b, 2020a). We selected the Spanish market for the following reasons: 1) Spain represents one of the top five economies of the European Union

in terms of the gross domestic product, 2) Spain is an important worldwide market for IT investments, with a forecast of total IT investments of 41,600 million Euros in 2018 (IDC Spain, 2017), and 3) digitization of the supply chain is one of the priorities of Spanish companies (Patwardhan et al. 2018).

This is one of the two studies of a broader research project that aims to examine the impact of technology (IT systems and social media) on a critical portfolio of organizational capabilities and firm performance. Prior to the survey administration, we selected a group of industries that is highly active in new product development (Pavlou and El Sawy 2006) and that usually invested in IT and social media (Kane et al. 2014) from the 5000 most admired firms included in the Actualidad Economica database in 2015: consumer goods, manufacturing, automotive, entertainment, chemical, information and communications, healthcare services, education, and professional services. In this sense, a population of 1826 large Spanish firms was selected. From the list of 1826 firms, 934 were contacted by phone through a well-established consulting vendor. The consulting vendor finally received 151 valid questionnaires from April 5, 2016 to May 18, 2016, giving an effective response rate of 16.167%, which is similar to the response rate obtained in prior IS research (Benitez et al. 2018a) can be considered as satisfactory especially if we recognize the cost and degree of difficulty of accessing top IT and business executives. In this regard, the sample of this study is composed by 151 firms from seven industries: 47 firms (31.130%) operated in the consumer goods, 32 (21.190%) in manufacturing, 21 (13.910%) in automotive, 19 (12.580%) in entertainment, 13 (8.610%) in chemical, 11 (7.280%) in information and communications, and the rest (eight firms, 5.300%) in other industries (i.e., healthcare services, education, and professional services). Non-response bias was assessed by verifying that early and late respondents did not differ in their responses. We considered as early respondents any of the firms that responded to the questionnaire in the first four weeks. All possible t-test comparisons between the means of the two groups of respondents showed nonsignificant differences. On average, the total revenues of the sample firms in 2016 were 121.080 million Euros, and they had about 677 employees.

The questionnaire was designed by adapting scales from prior literature and pretested with seven IT/business executives. As prior literature had not developed and studied a scale for knowledge desorptive capacity, we carefully developed a new scale. In fact, this is one of the potential contributions of this paper. We employed a key knowledgeable informant per firm to answer the questions included in the questionnaire (Table A1 in the appendix). Questionnaires were completed

by senior marketing executives (Chief Marketing Officer, Marketing Vice President, Marketing Manager, and Community Manager) (50.330%), IT executives (Chief Information Officer, IT Vice President, and IT Manager) (23.180%), and other business executives (New Product Development Executive, Chief Executive Officer, Operations Vice President, Corporate Development Officer, and Human Resource Manager) (26.500%). We also asked the key informants for a self-evaluation of their degree of knowledge in answering the survey. The item "How knowledgeable did you feel in answering all the questions included in this questionnaire?" (1: Very low, 5: Very high) was included at the end of the questionnaire (Tanriverdi 2005). The average value for this item was 3.830 (S.D.: 0.810), which suggests that the key informants had a high level of competence to answer the questions included in the survey.

Before performing the empirical analysis, we checked the minimum sample size required to test the proposed research model. Assuming an anticipated medium effect size, a statistical power level of 0.800, an alpha of 0.05, and nine indicators (i.e., the largest number of structural paths directed to firm performance in our mediation model), the minimum required sample size to test the statistical significance of the relationships of the research model is 114 (Nitzl 2016). As our sample size is 151, we have an acceptable sample size to test the proposed research model.

We use survey data to measure IT integration capability, knowledge absorptive capacity, knowledge desorptive capacity, firm performance, firm age (control variable), IT investment (control variable), innovation investment (control variable), and quality management investment (control variable). Firm size and industry (control variables) were measured with archival data collected from Actualidad Economica database in 2015.

3.2. Measures

Constructs can be operationalized as emergent variables (i.e., composite model) or latent variables (i.e., factor model) (Benitez et al. 2020b). Latent variables are variables that are not directly observed but inferred through a measurement model from other variables that are observed (directly measured) (Borsboom et al. 2003). These types of variables can be operationalized as reflective and causal-formative (Henseler 2017a). Latent variables are usually used in behavioral research to operationalized concepts such as attitudes or personality traits (Henseler 2015). The causal-formative measurement model changes the direction of causality between the indicators and the construct. In this type of measurement model, contrary to the reflective measurement model, indicators cause the latent variable. On the other hand, composite modeling is the usual way to

model artifacts. Composites are applied to model abstractions of artifacts as a combination of ingredients where the indicators make up the construct (they do not cause the artifact) (Henseler 2015, 2017a, Benitez et al. 2020b). Artifacts are usually objects that are created by managers, staff or firm, representing emergent, strong, complex, and "firm-made" concepts (Benitez et al. 2018a, 2018d, 2020b). Based on these distinctions, we conceptualized and operationalized all the constructs included in the research model as emergent variables, thus generating a composite model.

3.2.1. IT integration capability: IT integration capability was measured as a composite first-order construct composed of five items by adapting the scale from Setia and Patel (2013). This scale evaluates in a five-point Likert scale the extent to which the firm's integration of IT systems facilitates integrated access and sharing of data with external partners.

3.2.2. Knowledge absorptive capacity: Knowledge absorptive capacity was measured as a second-order composite construct composed by four first-order dimensions: knowledge acquisition, knowledge assimilation, knowledge transformation, and knowledge exploitation (Zahra and George 2002, Pavlou and El Sawy 2006, Liu et al. 2013). We used a well-established and validated scale by adapting the scales from Pavlou and El Sawy (2006), Liu et al. (2013), and Setia and Patel (2013). Knowledge acquisition evaluates in a five-item scale the ability to identify external knowledge that could be relevant to the firm (Pavlou and El Sawy 2006, Liu et al. 2013, Setia and Patel 2013). Knowledge assimilation measures in a three-item scale the ability to understand new knowledge (Pavlou and El Sawy 2006, Liu et al. 2013). Knowledge transformation evaluates in a four-item scale the firm's ability to combine new and existing knowledge (Liu et al. 2013, Setia and Patel 2013). Knowledge exploitation measures in a four-item scale the firm's ability to use external knowledge to achieve business' goals (Liu et al. 2013, Setia and Patel 2013). The four dimensions of knowledge absorptive capacity are specified as composite at first-order level.

3.2.3. Knowledge desorptive capacity: Knowledge desorptive capacity is a new developed scale that measures the firm's ability to identify and transfer superficial knowledge to external partners (e.g., suppliers, customers, public institutions, competitors, etc.) (Lichtenthaler and Lichtenthaler 2009, Lichtenthaler and Lichtenthaler 2010). We generated the items based on prior theoretical literature (Lichtenthaler and Lichtenthaler 2009, 2010) that proposes desorptive capacity as composed by two key ingredients (i.e., identification and transfer of knowledge). The measurement was driven by theory and some cautions were taken into consideration to ensure content validity.

We reviewed the seminal theoretical desorptive capacity literature to generate an initial pool of items. All items were measured on a scale from 1 to 5 (1: Strongly disagree, 5: Strongly agree). The list of items was sent to four scholars to verify whether they measured what they were supposed to measure. Valuable comments were used to refine the list of items and a pretest with seven IT/business executives was performed to ensure validity and reliability. As a result, we conceptualize the construct of knowledge desorptive capacity as a second-order composite construct composed by two first-order constructs: knowledge identification (three items) and knowledge transfer (five items). Knowledge identification measures the firm's ability to recognize and gather external knowledge that could be of interest for external organizations (e.g., suppliers, customers, public institutions, competitors), while knowledge transfer measures the firm's ability to transfer superficial knowledge to external agents. The two dimensions were specified as composite at first-order level.

3.2.4. Firm performance: Firm performance was measured with five items in terms of innovation, marketing, and financial facets in the last two years by adapting the scales of Pavlou and El Sawy (2006) and Kim and Atuahene-Gima (2010).

3.2.5. Control variables on firm performance: Differences in firm performance can be attributed to differences in the portfolio of resources possessed by the firm, firm age, industry, total IT investment (Benitez and Walczuch 2012), investment in innovation activities, and the implementation of quality management programs (Benitez et al. 2018b). We thus controlled for the effect of firm size, firm age, industry, IT investment, innovation investment, and quality management investment on firm performance as they can directly affect firm performance. We also controlled for these variables to check whether the impact of IT integration on firm performance, and the effect of knowledge absorptive and knowledge desorptive capacities on firm performance are kept after including these control variables. Firm size was measured by the natural logarithm of the number of employees in 2016 with information collected from Actualidad Economica database (Mithas et al. 2011, Benitez and Walczuch 2012). Firm age was measured through the natural logarithm of the number of years the firm has been in the market in April-May 2016 (Mithas et al. 2011, Benitez et al. 2018b) by including a single-item question in the questionnaire about the number of years the firm has been in the market. Interindustry differences can also have an impact on the performance of the firm. We thus controlled for industry by measuring industry as a composite construct as follows. We classified industries in seven groups and identified the most

important industry as the reference group (Benitez et al. 2018a, 2020b). This group of reference was consumer goods. Then, we created for each observation six dummy indicators (industry group) giving the value 0 if it does not pertain to this industry, and 1 if it does. Thus, industry was computed as a first-order composite construct composed by six indicators, that is, six group of industries (Henseler et al. 2016, Benitez et al. 2020b). We measured IT investment and innovation investment by asking each company the degree of annual IT investment and innovation investment on total turnover in the focal firm (1: Very low, 5: Very high). Quality management investment was measured with a single-item question that refers to the degree of implementation of quality management systems into the firm (1: Low implementation degree, 5: High implementation degree) (Benitez et al. 2018b).

3.3. Prevention and the test of common method variance

We also prevent and conduct the test of potential common method variance, although composite measures are unlikely to suffer from this bias (Ronkko and Ylitalo 2011). First, we tried to prevent the appearance of common method variance in the research design. To do so, we guaranteed confidentiality and anonymity in the survey administration, respondents were not allowed to come back to prior questions, questions were not tagged, and were not given in the order hypothesized in the model (Podsakoff et al. 2003). Second, we checked the correlation matrix to prevent high correlation among key variables ($r > 0.90$) (Bagozzi et al. 1991). The highest correlation is 0.659.

Third, we checked variance inflation factor (VIF) values at construct level, given that VIF larger than 3.3 at construct level may alert about potential common method variance (Kock and Lynn 2012). We estimated the VIF values at construct level by performing a full collinearity test. Values range from 1.055 to 1.961 for all constructs included in the model (Table 2). This suggests that it is unlikely that our research model suffers from common method variance (Kock and Lynn 2012). All these tests taken together suggest that potential common method variance does not seem to be a problem in our study.

Table 2: Full collinearity test

Construct	VIF values
IT integration capability	1.757
Knowledge absorptive capacity	1.792
Knowledge desorptive capacity	1.961
Firm performance	1.373
Firm size	1.133
Firm age	1.131
Industry	1.223
IT investment	1.914
Innovation investment	1.881
Quality management investment	1.055

4. Empirical analysis and results

The proposed research model was empirically tested by performing a partial least squares (PLS) path modeling. PLS can test for exact overall model fit, and it is a full-fledged estimator in the family of variance-based structural equation modeling (SEM) (Henseler et al. 2016, Rueda et al. 2017, Benitez et al. 2020b). Using the PLS estimator is appropriate for the following reasons: 1) PLS is suitable to estimate composite models (as our proposed research model) (Henseler et al. 2014, 2016, Rigdon et al. 2014, 2016); 2) PLS is particularly advisable for models that contain multidimensional constructs (as knowledge absorptive capacity and knowledge desorptive capacity in our study) (Hair et al. 2012, Hair et al. 2019); 3) PLS is suitable when using new developed scales, as is the case in this study (knowledge desorptive capacity) (e.g., Chau 1997, Tiwana and Konsynski 2010). Advanced Analysis for Composites (ADANCO) 2.0.1 Professional (http://www.composite-modeling.com/) was the statistical software used to estimate the measurement and structural models (Henseler and Dijkstra 2015). This software for variance-based SEM is able to model different types of constructs (i.e., composites, common factors, and single-indicator constructs) while facilitating both causal and predictive modeling (Rueda et al. 2017). Bootstrapping algorithm with 5000 subsamples was performed to obtain the level of significance of weights and loadings for each item and dimension, and to obtain the level of significance of path coefficients.

4.1. Confirmatory composite analysis

Every construct of the model (at first- and second-order level) was specified as composite. We used the weighting schemes of correlation weights (mode A) and regression weights (mode B) to estimate the research model. Both mode A and mode B create composite proxies (Becker et al. 2013, Sarstedt et al. 2016). Correlation weights ignore collinearity among predictors; therefore it generates better estimations when there is a strong correlation between indicators (Becker et al. 2013, Rigdon 2016). A composite-formative does not necessarily need to be estimated on mode B as there are certain conditions (e.g., multicollinearity) under which using mode A generates better weight estimations (Becker et al., 2013). Therefore, we used mode B for composites with noncorrelated indicators and mode A for composites with correlated indicators or unexpected signs in weights (Benitez et al. 2020b).

We performed a confirmatory composite analysis, which checks the adequacy of the measurement structure by comparing the empirical correlation matrix and the model-implied correlation matrix (Henseler et al. 2014, Benitez et al. 2018b, 2020b). It provides an overall model fit for the measurement structure at first- and second-order level by estimating the standardized root mean squared residual (SRMR), unweighted least squares discrepancy (d_{ULS}), and geodesic discrepancy (d_G) (Henseler et al. 2014, 2016). SRMR is a proxy of the discrepancy between the empirical and the model-implied correlation matrix. The saturated model has good overall fit when SRMR is below 0.800. d_{ULS} and d_G are exact measures of the overall model fit. The lower d_{ULS} and d_G are, the better the model fit (Benitez et al. 2018a). d_{ULS} and d_G values below the 99%-quantile of the bootstrap discrepancy shows acceptable fit between the model and the data (Henseler 2017b, Benitez et al. 2020b). Table 3 shows results of the confirmatory composite analysis, which with 1% of probability gives support to the structure of our measures. Then, we proceed with the evaluation of the measurement model.

Table 3: Results of the confirmatory composite analysis

Discrepancy	First-order constructs			Second-order constructs		
	Value	HI_{99}	Conclusion	Value	HI_{99}	Conclusion
SRMR	0.064	0.064	Supported	0.023	0.050	Supported
d_{ULS}	2.450	2.499	Supported	0.011	0.052	Supported
d_G	1.037	1.526	Supported	0.010	0.032	Supported

4.2. Measurement model evaluation

As knowledge absorptive capacity and knowledge desorptive capacity are two second-order constructs, we estimated the research model with the two-step approach (Chin 2010). From the first step, latent variables' scores of the dimensions of knowledge absorptive capacity and knowledge desorptive capacity are obtained by freely correlating the first-order constructs and the dimensions of the second-order constructs (i.e., knowledge acquisition, knowledge assimilation, knowledge transformation, knowledge exploitation, knowledge identification, and knowledge transfer). We estimated the research model in the second step by using the latent variables' scores as the measures of the constructs knowledge absorptive capacity and knowledge desorptive capacity (Chin 2010).

We validated composite constructs by evaluating content validity, multicollinearity, and the significance of weights and loadings (Cenfetelli and Bassellier 2009, Benitez et al. 2018b). First, we ensured content validity by using previously validated scales whenever possible (e.g., Pavlou and El Sawy 2006, Chen et al. 2017). This study develops a new scale of knowledge desorptive capacity using the information we extracted from seven interviews we did with IT/business executives as well as the preliminary conceptual foundations proposed in prior research (Lichtenthaler and Lichtenthaler 2009, 2010).

We also evaluated multicollinearity and the significance of weights and loadings at first- and second-order levels. Multicollinearity may become a serious problem in the data if VIFs of indicators and dimensions are greater than 3.3 for constructs estimated in mode B (Diamantopoulos and Siguaw 2006). VIFs values for constructs estimated in mode B range from 1.545 to 2.626 at first-order level and range from 1.129 to 1.986 at second-order level, below the threshold of 3.3. We checked for the level of significance of indicator/dimension weights and loading. Composite indicators/dimensions can be retained as dropping indicators/dimensions may alter the composite's meaning (Henseler 2017a). Every first- and second-order loadings were significant at 0.001 level. This analysis suggests good measurement properties. Table A1 (in the appendix) shows the measurement model evaluation. Next, we proceed with the evaluation of the structural model.

4.3. Structural model evaluation

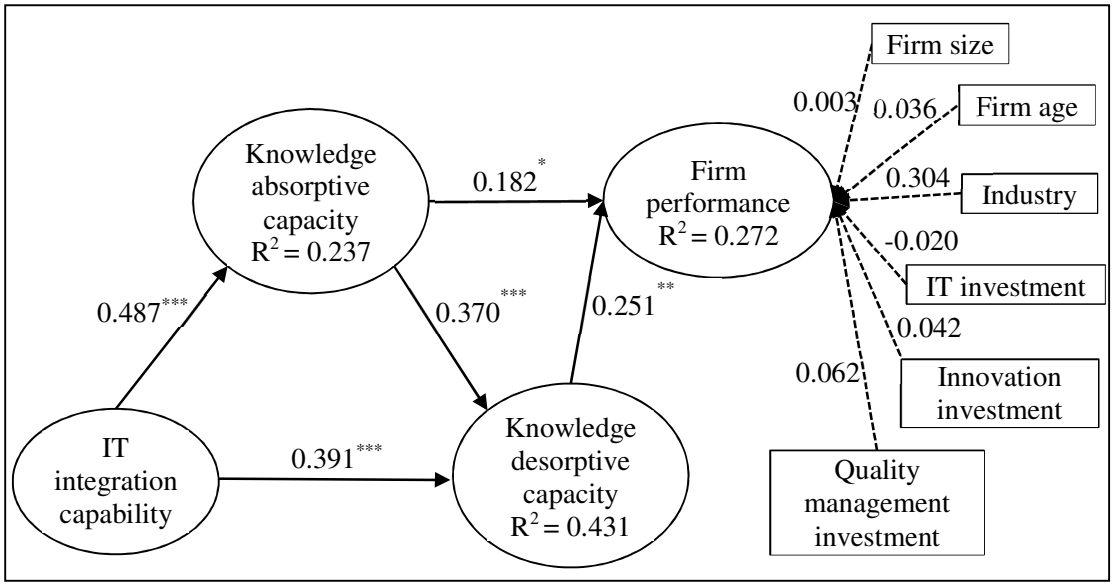
4.3.1. Overall fit of the estimated model: As in the confirmatory composite analysis, the goodness of model fit for the structural model (estimated model) was evaluated by examining the SRMR, d_{ULS}, and d_G (Benitez et al. 2020b). The SRMR value for the base model (i.e., excluding the direct effects of the mediation analysis) is 0.065, and discrepancy values are below the 95%-quantile of

the bootstrap discrepancies, which suggests our base research model should not be rejected based on the alpha level of 0.05. Overall, the proposed research model shows good structural model fit, which indicates the research model has the potential to be a good theory to explain how IT integration capability influences firm's knowledge absorption and desorption. After that, we can proceed with the evaluation of the structural model.

4.3.2. Evaluation of the structural model: We evaluated path coefficients, the level of significance, R^2, adjusted R^2, and f^2. We estimated two models: 1) the base model, which only includes the hypothesized relationships; and 2) the mediation model, where we add to the base model the direct effect of IT integration capability on firm performance. In the base model, we found support for hypotheses H1, H2, H3, H4, and H5, indicating that IT integration capability facilitates the development of a knowledge absorptive capacity (H1) ($\beta = 0.487$, $p_{one\text{-}tailed} < 0.001$), and knowledge desorptive capacity (H2) ($\beta = 0.391$, $p_{one\text{-}tailed} < 0.001$) to improve firm performance (H4) ($\beta = 0.182$, $p_{one\text{-}tailed} < 0.01$) and (H5) ($\beta = 0.251$, $p_{one\text{-}tailed} < 0.05$). H3 is also supported, indicating that knowledge absorptive capacity facilitates the development of knowledge desorptive capacity (H3) ($\beta = 0.370$, $p_{one\text{-}tailed} < 0.001$). The effect of firm size, firm age, industry, IT investment, innovation investment, and quality management investment (control variables) on firm performance was not significant. However, the inclusion of these control variables gives additional credibility to the empirical analysis as it rechecks whether the effects of IT integration capability, knowledge absorptive capacity, and knowledge desorptive capacity on firm performance are sustained after controlling for these control variables.

The R^2 values range from 0.237 to 0.431, which suggests a good explanatory power of the endogenous variables. The adjusted R^2 values range from 0.231 to 0.423. The effect size value indicates the relative size of including each additional relationship to the model (Benitez et al. 2020b). f^2 values of the hypothesized relationships range from 0.028 to 0.311, indicating weak-medium to large effect sizes in the research model (Cohen 1988, Benitez et al. 2020b). Figure 2 and Table 4 present the results of the test of hypotheses.

Figure 2: Results of the PLS estimation



Note: †p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001, one-tailed test for the hypothesized relationships, two-tailed test for the control variables.

Table 4: Evaluation of the structural model

Beta coefficient	Base model	Mediation model
IT integration capability → Knowledge absorptive capacity (H1)	0.487*** (6.378)[5] (0.000) [0.354, 0.613]	0.488*** (6.405) (0.000) [0.359, 0.614]
IT integration capability → Knowledge desorptive capacity (H2)	0.391*** (5.150) (0.000) [0.262, 0.512]	0.392*** (5.165) (0.000) [0.260, 0.510]
Knowledge absorptive capacity → Knowledge desorptive capacity (H3)	0.370*** (6.071) (0.000) [0.273, 0.470]	0.369*** (6.092) (0.000) [0.272, 0.469]
Knowledge absorptive capacity → Firm performance (H4)	0.182* (1.724)	0.192* (1.844)

[5] This value refers to the t-value. The value that appears below refers to the p-value.

	(0.042) [-0.001, 0.354]	(0.033) [0.011, 0.360]
Knowledge desorptive capacity → Firm performance (H5)	0.251** (2.561) (0.005) [0.089, 0.411]	0.266* (2.231) (0.013) [0.070, 0.455]
IT integration capability → Firm performance		-0.039 (-0.334) (0.739) [-0.264, 0.194]
Control variables		
Firm size → Firm performance (control variable)	0.003 (0.044) (0.965) [-0.124, 0.142]	0.001 (0.012) (0.990) [-0.131, 0.140]
Firm age → Firm performance (control variable)	0.036 (0.476) (0.622) [-0.101, 0.179]	0.029 (0.404) (0.686) [-0.107, 0.177]
Industry → Firm performance (control variable)	0.305 (0.493) (0.368) [-0.100, 0.182]	0.300 (0.897) (0.370) [-0.467, 0.451]
IT investment → Firm performance (control variable)	-0.020 (-0.204) (0.839) [-0.219, 0.175]	-0.012 (-0.122) (0.903) [-0.211, 0.181]
Innovation investment → Firm performance (control variable)	0.042 (0.455) (0.649) [-0.139, 0.221]	0.039 (0.425) (0.671) [-0.142, 0.220]
Quality management investment → Firm performance (control variable)	0.062 (0.909) (0.364)	0.065 (0.935) (0.350)

	[-0.077, 0.196]		[-0.075, 0.199]	
R^2	**R^2**	**Adjusted R^2**	**R^2**	**Adjusted R^2**
Knowledge absorptive capacity	0.237	0.232	0.234	0.233
Knowledge desorptive capacity	0.431	0.423	0.431	0.423
Firm performance	0.272	0.231	0.273	0.226
Overall model fit of the estimated model	**Value**	**HI_{95}**	**Value**	**HI_{95}**
SRMR	0.065	0.069	0.065	0.068
d_{ULS}	1.619	1.793	1.609	1.734
d_G	0.451	0.600	0.450	0.595
f^2				
IT integration capability → Knowledge absorptive capacity (H1)	0.311		0.312	
IT integration capability → Knowledge desorptive capacity (H2)	0.205		0.206	
Knowledge absorptive capacity → Knowledge desorptive capacity (H3)	0.183		0.183	
Knowledge absorptive capacity → Firm performance (H4)	0.028		0.029	
Knowledge desorptive capacity → Firm performance (H5)	0.054		0.052	
Firm size → Firm performance (control variable)	0.000		0.000	
Firm age → Firm performance (control variable)	0.001		0.001	
Industry → Firm performance (control variable)	0.117		0.112	
IT investment → Firm performance (control variable)	0.000		0.000	
Innovation investment → Firm performance (control variable)	0.001		0.001	
Quality management investment → Firm performance (control variable)	0.005		0.006	

Note: $^{\dagger}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$, one-tailed test for hypothesized relationships and two-tailed test for the other relationships.

4.3.3. Post-hoc mediation analysis: To reanalyze the mediating role of knowledge absorptive and knowledge desorptive capacities in the proposed research model, we performed a post-hoc mediation analysis. We evaluated the indirect effects involved in the proposed research model by adding a link[6] from IT integration capability to firm performance (Felipe et al. forthcoming). The indirect effect is significant (0.246, $p_{one\text{-}tailed} < 0.001$), while the direct effect is not. The support to all the hypothesized relationships is kept in the mediation model, which strengths the results of the test of hypotheses (Zhao et al. 2010). Results suggest an indirect-only mediation between IT

[6] The beta coefficient between IT integration capability and firm performance (-0.039), and the correlation between both variables (0.201) have different sign, which reflects random fluctuations around zero (Falk and Miller 1992).

integration capability and firm performance. This mediation analysis shows that IT integration capability affects firm performance through knowledge absorptive capacity and knowledge desorptive capacity.

There are multiple mediators on this indirect effect (i.e., knowledge absorptive and knowledge desorptive capacities); therefore, a multiple mediation analysis can be used to clarify the effect of each variable on the mediation (Cepeda et al. 2017). Results indicate that there is indirect effect through knowledge absorptive capacity (β = 0.094, CI[7] [0.006, 0.181]) and knowledge desorptive capacity (β = 0.104, CI [0.024, 0.201]). The indirect effect of IT integration capability on firm performance through knowledge absorptive capacity [variance accounted for (VAF) = 0.453)] and through knowledge desorptive capacity (VAF = 0.504) demonstrates the great majority of the total indirect effect (VAF = 1.189). Additionally, we compared the two indirect effects (through knowledge absorptive capacity and through knowledge desorptive capacity) in a comparison analysis (Table 7). There are no significant differences between the two effects. This analysis suggests that the effects of knowledge absorptive capacity and knowledge desorptive capacity support the mediation equally. Tables 5, 6, and 7 provide additional details of the mediation analysis.

Table 5: Mediation analysis

Relationship	Direct effect	Indirect effect	Total effect
IT integration capability → Firm performance	-0.039 (-0.334) (0.739) [-0.264, 0.194]	0.246** (3.227) (0.001) [0.130, 0.367]	0.207* (2.488) (0.006) [0.068, 0.343]

Note: †p < 0.10, *p < 0.05, **p < 0.01, ***p < 0.001, one-tailed test for the indirect and total effect, two-tailed test for the direct effect.

[7] CI: Confidence interval. The beta/effect is significant when zero is not included in the CI.

Table 6: Multiple mediation effects

	Coefficient	Bootstrap 90% CI				
		Percentile		Biased corrected (BC)		
Direct effects						
a1	0.488	0.357	0.612	0.359	0.614	
a2	0.392	0.257	0.507	0.260	0.510	
a3	0.369	0.276	0.473	0.272	0.469	
b1	0.192	0.009	0.358	0.011	0.360	
b2	0.266	0.071	0.456	0.070	0.455	
Indirect effects						
		Percentile		**BC**		**VAF**
a1xb1	0.094	0.005	0.179	0.006	0.181	0.453
a2xb2	0.104	0.024	0.200	0.024	0.201	0.504
a1xa3xb2	0.048	0.012	0.092	0.011	0.092	0.232
Total indirect effect	0.246	0.129	0.366	0.130	0.367	1.189

Note: c': IT integration capability → Firm performance; a1xb1: IT integration capability → Knowledge absorptive capacity → Firm performance; a2xb2: IT integration capability → Knowledge desorptive capacity → Firm performance; a1xa3xb2: IT integration capability → Knowledge absorptive capacity → Knowledge desorptive capacity → Firm performance.

Table 7: Indirect effects comparison

	Coefficient	Bootstrap 95% CI			
Differential effect		**Percentile**		**BC**	
M1 - M2 = a1xb1 - a2xb2	-0.011	-0.192	0.153	-0.188	0.157

4.3.4. Test of robustness: Our PLS estimation of the proposed research model can be complemented with a test of robustness to examine alternative relationships and conceptual models. We checked for the robustness of the proposed research theory by considering an alternative model in which knowledge desorptive capacity influences knowledge absorptive capacity but every other relationship remains the same. Results of this alternative model yield similar results to those obtained in the proposed model. The alternative model indicates that knowledge desorptive capacity is positively related to knowledge absorptive capacity ($\beta = 0.419^{***}$). This result indicates that it is also rational to think that firms may want to identify and transfer secondary knowledge

first, and then, absorb core knowledge from the external firm as a knowledge management strategy. This phenomenon can be explained by a situation in which the firm has to transfer some superficial knowledge to be able to obtain in return some core knowledge (again, pure opportunistic behavior). Table A3 shows the details of this test of robustness.

That being said, we argue and propose in the proposed research model that companies with a leading IT integration capability should have developed a knowledge absorptive capacity prior to developing a knowledge desorptive capacity. Companies can develop the proficiency to identify superficial knowledge that can be useful and transferable to external partners once they have been created and stored in a substantial core and superficial knowledge base. The selection of superficial knowledge from a knowledge base also requires experience and a solid knowledge absorptive capacity. Anyway, this conceptual debate can be a "chicken-egg problem" theoretically. Statistically, as our proposed research model (the model of Figure 2) does not have a statistically worse overall fit for the estimated model than the overall fit of the estimated alternative model (the model of the test of robustness), the alternative model is not preferred to our proposed research model (Benitez et al. 2020b).

Finally, we also estimated a model where knowledge absorptive capacity and knowledge desorptive capacity freely correlate in the proposed research model (i.e., no relationship between knowledge absorptive capacity and knowledge desorptive capacity was included), and a model in which knowledge absorptive and knowledge desorptive capacities shape a third-order construct called knowledge management capability (Tanriverdi 2005). These models yield similar results to those obtained in the proposed model (β IT integration capability → Knowledge management capability = 0.602^{***}, β Knowledge management capability → Firm performance = 0.383^{***})**.** In conclusion, the results of this test of robustness provide additional credibility to the support of our research model and the findings presented in this study.

4.3.5. Importance-performance map analysis: We performed an importance-performance map analysis (IPMA) at construct and dimension level to identify the antecedents that may have a high importance (i.e., those that have a strong total effect) for our key outcome construct (i.e., firm performance) and a high performance (i.e., those companies that perform well) (Ringle and Sarstedt 2016). At construct level, we find knowledge absorptive capacity and knowledge desorptive

capacity in very similar positions. Both constructs have similar performance values[8] and above average importance values. That is, in absolute terms, when knowledge absorptive capacity is increased by one, firm performance will increase by the construct's importance (i.e., 0.314) (ceteris-paribus). In a similar way, when knowledge desorptive capacity is increased by one, firm performance will increase by 0.280 (ceteris-paribus).

At the dimension level, we find that knowledge transfer capability (i.e., one of the dimensions of knowledge desorptive capacity) has high importance value (i.e., above average), while it has the lowest performance value (68.155). That means companies need to improve the performance of knowledge transfer capability given that its importance for firm performance is significant. We also find knowledge acquisition capacity and knowledge exploitation capacity (i.e., two dimensions of knowledge absorptive capacity construct) and knowledge identification capacity (i.e., one dimension of knowledge desorptive capacity construct) in the high performance and high importance values quadrant, which indicates that they have important and significant effect on firm performance. Finally, we find knowledge assimilation capacity and knowledge transformation capacity (i.e., two dimensions of knowledge absorptive capacity) in the quadrant with low importance values and low performance values (i.e., below average), deriving that those variables are not a priority for companies due to the low significant effect on firm performance. Figures 3 and 4 show the IPMA at both constructs and dimension levels.

[8] Given that both knowledge absorptive capacity and knowledge desorptive capacity are located close to the horizontal center line, we should regard these placements cautiously and not as definite (Henseler forthcoming).

Figure 3: IPMA analysis at construct level

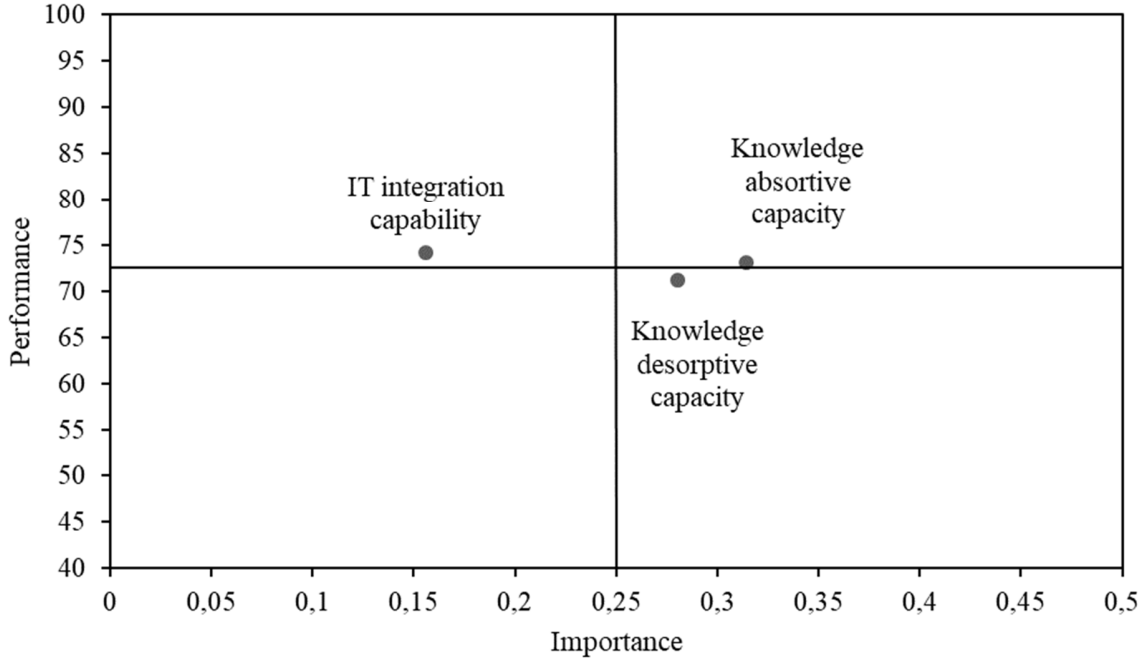
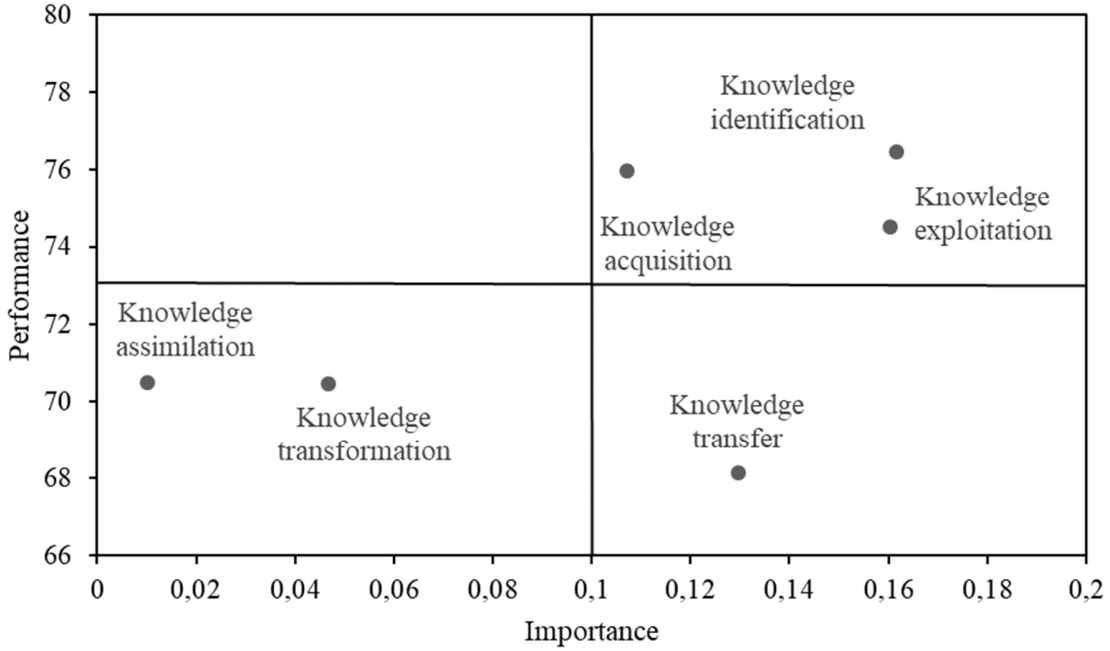


Figure 4: IPMA analysis at dimension level



Note: The IPMA uses the unstandardized total effects to create the x-axis, while it uses the latent variable scores rescaled on a range from 0 to 100 to create the y-axis (Ringle and Sarstedt 2016).

5. Discussion and conclusions

How does the firm's IT integration capability in the supply chain affect knowledge absorption and desorption of the focal firm? This is the cutting edge and idiosyncratic research question this study aims to study theoretically and investigate empirically. Drawn from prior IS research on IT and knowledge management (Tanriverdi 2005, Dong and Yang 2015) and on the IT-enabled organizational capabilities perspective (Mithas et al. 2011, Benitez et al. 2018a, 2018d), we theorized that the firm's ability to integrate its IT systems with the IT systems of external partners (IT integration capability in an interorganizational relationships context) enables the focal firm to absorb core knowledge and desorb superficial knowledge to generate business benefits. The proposed theory was tested on a sample of firms in Spain. The empirical analysis gave support to the proposed theory.

Prior research lacks the overall understanding about how IT matters in the key knowledge management capabilities for the focal firm and its supply chain. Specifically, research has been limited to study how desorptive capacity contributes to supply chain competitiveness (Roldan et al. 2018) or how IT capabilities affect absorptive capacity either directly or indirectly (Liu et al. 2013,

Limaj et al. 2016), lacking to show how firm's IT investments affect the whole picture of knowledge management activities.

How does a firm's IT integration capability affect knowledge management capabilities to create business value? The IT integration capability enables the focal firm the development of knowledge absorptive capacity and knowledge desorptive capacity, which in turn helps the focal firm to improve firm performance. The integration of the IT systems of the focal firm with the IT systems of others organizations of the firm's supply chain facilitates the integration of supply chain information, and access and sharing of order-related data, production-related data, customer-related data, and market-related data as well as the coordination of the business activities between the focal firm and the external organizations. This information integration, data access and sharing, and business activity coordination enables the knowledge acquisition, assimilation, transformation, and exploitation of external core knowledge (knowledge absorption of the focal firm) for commercial ends (Cohen and Levinthal 1990, Zahra and George 2002). Once the focal firm has absorbed sufficient degree of external core knowledge is interested in transferring superficial knowledge to other external organizations to obtain a licensing income, entry into a foreign market, or access to future core knowledge from these external partners. In this sense, we argue that knowledge absorption leads to knowledge desorption. Both knowledge absorption and knowledge desorption improve firm performance and create business value. The investments in IT integration capability are thus converted into business benefits through the absorption and desorption of knowledge, which is consistent with the prior theory building on the IT-enabled organizational capabilities perspective.

This research provides two key contributions to the IS discipline. First, this study introduces the construct of *knowledge desorptive capacity* in the IS research and provides a scale for its measure. Knowledge desorptive capacity is the ability of the firm to identify and transfer its knowledge to external partners (Lichtenthaler and Lichtenthaler 2010). The concept of knowledge desorptive capacity was presented by Lichtenthaler and Lichtenthaler (2009). We develop theoretically this construct by adding the superficial/secondary nature of the knowledge desorbed by firms. We argue that firms should not be interested in desorbing core knowledge. In addition, this construct lacked a set of validated measures. We introduce the construct of *knowledge desorptive capacity* to IS research into a business value of IT conversation, and provide a set of calibrated measures at first-

and second-order level that can be used by future IS scholars. This is the primary contribution of this paper to IS research.

Second, this research provides and demonstrated a theory of IT integration impact on the firm's knowledge absorption and desorption, and their impact on firm performance. Prior IS research has focused on studying the impact of IT on knowledge absorption (e.g., Joshi et al. 2010, Liu et al. 2013), but the focus on the role of IT in knowledge desorption has not been examined. We develop the body of IS research on IT and knowledge management activities at firm level (Tanriverdi 2005, Pavlou and El Sawy 2006) by both theorizing and testing empirically the impact of IT integration capability on both knowledge absorption and desorption. The findings of our study also have core theoretical implications for IS research on business value of IT and the IT-enabled organizational capabilities perspective. Our theory building sets IT integration capability effects on firm performance through the capability development of knowledge absorption and knowledge desorption. In this sense, knowledge absorptive capacity and knowledge desorptive capacity are two intermediate organizational capabilities through which IT affects firm performance. This is the second primary contribution of this research to IS research.

This study has also limitations. First, as business value of IT studies is mostly focused in U.S. and U.K. firms (e.g., Benitez et al. 2018a), and because Spain is a critical market of the European Union with a high volume of firm's IT initiatives, this study was contextualized in large firms in Spain. For this reason, the results should only be generalized to large firms in Spain. Future research should explore whether our findings are also valid in other markets worldwide, and whether this theory is supported in small and medium firms. Second, the key endogenous variable was assessed through a perceptual measure of firm performance. Although our empirical analysis was prevented and checked from potential common method bias, we encourage IS scholars to continue this line of research by measuring business benefits with archival data. Although using two key respondents per firm has been suggested to rigorously execute IS research on business value of IT, this kind of research design is often very difficult to obtain and very costly. Third, in regard to most of the research projects and estimations, our study was developed with assumptions. Based on Gupta and Govindarajan's (2000) work, our study assumes that organizations exhibit an opportunistic behavior because they play "the game of coopetition" with other organizations by trying to absorb core knowledge but only desorbing secondary knowledge. Future IS research could examine if this assumption is correct. We also recognize that the relationship between knowledge absorptive

capacity and knowledge desorptive capacity may suffer from a "chicken-egg problem." However, our empirical analysis and findings are not affected if the opposite effect (Knowledge desorptive capacity → Knowledge absorptive capacity) is included in the model; similarly, the results obtained in this research are not affected when we allow these two constructs to be freely correlated. Future IS research should focus specifically in discovering the preferred sequence companies follow in absorbing and desorbing knowledge.

IS research on knowledge desorption is extraordinarily scarce. In this sense, this topic presents different avenues for future research: First, firms and executives have received high pressure from competitors, employees, and customers to implement digital transformation programs, which represents a good opportunity for companies to absorb and desorb critical knowledge from their innovation ecosystem. Future IS research could examine the role of knowledge absorptive and knowledge desorptive capacities of the focal firm for the successful implementation of the digital transformation programs. We believe this line of IS research will bring very promising research results, theory building, and success to IS scholars. Second, firms may participate in collaboration networks (with competitors and the competitor's allies) to compete better by absorbing core knowledge and desorbing secondary knowledge. However, this implies an opportunistic behavior that can be deployed only for a limited period of time until other organizations discover this opportunistic behavior. We encourage IS scholars to explore how this past opportunistic behavior driven by the simultaneous usage of knowledge absorption and desorption affects the firm's reputation in a collaborative network and future business benefits of the focal firm.

Finally, organizational ambidexterity implies the firm's ability to simultaneously explore and exploit the knowledge (Benitez et al. 2018d) of business opportunities (Benitez et al. 2018b). Knowledge absorptive capacity implies both the acquisition and exploitation of knowledge (Zahra and George 2002), which suggests a certain degree of ambidexterity. At the same time, once firms have absorbed a sufficient degree of external core knowledge, they are interested in desorbing and commercializing with secondary knowledge to better exploit and capitalize their knowledge base and maximize business benefits. The findings that are derived from our research may suggest in a preliminary way that there can exist several levels of organizational ambidexterity in the firm, that is, different degrees of ambidexterity in different types of organizational capabilities, as illustrated in this study in knowledge absorptive capacity and knowledge desorptive capacity. Future IS research should examine this preliminary insight, which seems to be an excellent avenue for future

empirical IS research. All these IS topics promise to come with excellent research questions, challenging research designs, and potentially interesting discussions for the IS research community.

Worldwide IT investment is projected to total $3.8 trillion in 2019 and a significant percentage of this worldwide investment is firm's IT investments at the supply chain level. As companies and top IT executives need to motivate and show the return from their IT investments, this study provides three very useful lessons to IT executives. First, firms can capitalize their investments in IT systems integration in the supply chain because it facilitates the focal firm to absorb core knowledge and desorb secondary knowledge from other organizations to generate business benefits. In this sense, assuming an opportunistic behavior of the focal firm in its knowledge transfer activities, we show how firms can create business value from IT integration through knowledge absorption and desorption. Second, this study also focuses and shows IT executives how critical it is to purposely design first the firm's absorption activities of core knowledge, and therefore focusing on the firm's desorption activities of secondary knowledge. Finally, this study also provides IT executives the guidelines and measures to evaluate their degree of knowledge absorptive capacity by providing a set of calibrated fine-grained measures of knowledge absorptive capacity.

As final concluding remarks, this research examines how the firm's IT integration capability in the supply chain affects knowledge absorption and desorption. We theorized that the IT integration capability enables the focal firm to absorb core knowledge and desorb secondary knowledge, which in turn improves firm performance. Our proposed research theory assumes an opportunistic behavior among companies that try to absorb primary knowledge but transfer secondary knowledge. We tested the proposed theory with a sample of large firms in Spain. After preventing and checking for common method variance, and testing several alternative research models, the empirical analysis gives support to our theory. This paper develops IS research on business value of IT by introducing the construct of *knowledge desorptive capacity* (and a set of calibrated measures), and by providing and testing a theory on the role of IT integration in knowledge absorption and knowledge desorption. In this sense, IT does matter because it creates business value. It is a great time to be an IS scholar but a challenging/changing/disruptive time to be an IT executive. Quo Vadis?

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7. Appendix

Table A1: Detailed information on survey items

Construct/indicator: Except where otherwise indicated below, the possible range for measures was from 1 to 5 (1: Strongly disagree, 5: Strongly agree)	**VIF**	**Weight**	**Loading**
IT integration capability (composite, mode A)			
Our IT systems enable us integrated access and sharing of all order-related data (e.g., order status, handling requirements, etc.)	1.576	0.203***	0.716***
Our IT systems enable us integrated access and sharing of all production-related data (e.g., resource availability, quality, etc.)	1.989	0.255***	0.820***
Our IT systems enable us integrated access and sharing of all customer-related data (e.g., service contracts, feedback, etc.)	2.187	0.193***	0.767***
Our IT systems enable us integrated access and sharing of all market-related data (e.g., promotion details, future forecasts, etc.)	2.839	0.297***	0.875***
To what extent do your IT systems facilitate coordinated activities with external agents (e.g., suppliers, customers, other organizations)? (1: Very low, 5: Very high)	1.776	0.300***	0.793***
Knowledge absorptive capacity (second-order construct, composite, mode A)			
Knowledge acquisition (composite, mode A)	1.709	0.289***	0.197***
We are effective in developing new knowledge or insights that have the potential to influence new product development	1.272	0.207***	0.606***
Our employees are engaged in cross-functional teams	1.772	0.211***	0.758***

We are able to organize special meetings with suppliers, customers, or third parties to acquire new knowledge on process, product, logistics and distribution related to innovation	2.618	0.240***	0.853***
We are able to identify and acquire internal (i.e., within the firm) and external (e.g., market) knowledge	2.434	0.307***	0.856***
We are successful in learning new things	1.501	0.322***	0.763***
Knowledge assimilation (composite, mode A)	1.697	0.298***	0.787***
We quickly analyze and interpret changing market demands	2.674	0.342***	0.901***
We have adequate routines to analyze the information and knowledge obtained	3.317	0.352***	0.926***
We have adequate routines to assimilate new information and knowledge	3.138	0.394***	0.929***
Knowledge transformation (composite, mode A)	2.455	0.326***	0.881***
We are effective in transforming existing information into new knowledge	3.802	0.311***	0.880***
We can successfully integrate the new information and knowledge acquired with our existing knowledge	4.200	0.327***	0.912***
Our firm quickly recognizes the usefulness of new external knowledge to existing knowledge	1.953	0.269***	0.823***
Our firm periodically meets to discuss consequences of market trends and new product development	1.460	0.286***	0.720***
Knowledge exploitation (composite, mode B)	1.986	0.301***	0.820***
We can successfully exploit the new integrated information and knowledge into concrete applications	1.573	0.454***	0.848***
Our firm has a clear division of roles and responsibilities	2.626	0.085	0.791***
We are effective in applying knowledge into new products	2.601	0.319*	0.855***
We constantly consider better ways to exploit knowledge	2.917	0.316*	0.872***
Knowledge desorptive capacity (second-order construct, composite, mode B)			
Knowledge identification (composite, mode B)	1.129	0.754***	0.906***
We often scan the environment to identify knowledge that could be relevant to our suppliers	2.143	0.217	0.781***

We often scan the environment to identify knowledge that could be relevant to our customers	1.545	0.638***	0.922***
We often scan the environment to identify knowledge that could be relevant to other organizations (e.g., public institutions and competitors)	2.115	0.302*	0.801***
Knowledge transfer (composite, mode A)	1.129	0.449***	0.704***
We provide sufficient support for an adequate transfer of knowledge to external agents (e.g., suppliers, customers, other organizations)	1.759	0.331***	0.770***
We often transfer recommendations about internal processes to external agents (e.g., suppliers and customers)	1.945	0.223***	0.790***
We often transfer information about our strategies to external agents (e.g., suppliers and customers)	2.764	0.237***	0.815***
We often transfer information about the product or the market to external agents (e.g., suppliers and customers)	3.619	0.206***	0.820***
The transfer of knowledge to external agents (e.g., suppliers, customers, and other organizations) is organized well	3.046	0.240***	0.861***
Firm performance: Rate the extent to which the firm has achieved the following outcomes during the last two years (composite, mode A)			
Product development was clearly superior to competitors in meeting customer's needs	1.329	0.241***	0.623***
Sales relative to objectives	2.673	0.244***	0.869***
Market share relative to objectives	2.460	0.205***	0.823***
Profit margin relative to objectives	4.104	0.263***	0.907***
Return on assets relative to objectives	3.497	0.265***	0.869***

Note: $^{\dagger}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$, two-tailed test.

Table A2: Correlation matrix

Construct	1	2	3	4	5	6	7	8	9	10
1. IT integration capability	1.000									
2. Knowledge absorptive capacity	0.487	1.000								
3. Knowledge desorptive capacity	0.571	0.560	1.000							
4. Firm performance	0.201	0.366	0.382	1.000						
5. Firm size	0.114	0.179	0.210	0.030	1.000					
6. Firm age	-0.226	0.043	-0.168	-0.004	-0.014	1.000				
7. Industry	-0.028	0.112	0.104	0.344	-0.186	0.008	1.000			
8. IT investment	0.312	0.306	0.248	0.122	0.182	-0.039	-0.007	1.000		
9. Innovation investment	0.241	0.294	0.198	0.120	0.140	-0.101	-0.054	0.659	1.000	
10. Quality management investment	0.082	0.013	-0.020	0.040	-0.056	-0.066	-0.074	-0.003	0.118	1.000

Table A3: Results of the test of robustness

Beta coefficient	Base model	Mediation model
IT integration capability → Knowledge absorptive capacity (H1)	0.248** (2.681) (0.004) [0.090, 0.398]	0.248** (2.696) (0.004) [0.093, 0.400]
IT integration capability → Knowledge desorptive capacity (H2)	0.571*** (9.847) (0.000) [0.465, 0.665]	0.572*** (9.871) (0.000) [0.465, 0.664]
Knowledge desorptive capacity → Knowledge absorptive capacity (H3)	0.419*** (6.380) (0.000) [0.310, 0.528]	0.418*** (6.378) (0.000) [0.308, 0.529]
Knowledge absorptive capacity → Firm performance (H4)	0.182* (1.724) (0.042)	0.192* (1.844) (0.033)

	[-0.003, 0.353]	[0.020, 0.359]
Knowledge desorptive capacity → Firm performance (H5)	0.251** (2.561) (0.005) [0.090, 0.411]	0.266* (2.231) (0.013) [0.065, 0.458]
IT integration capability → Firm performance		-0.039 (-0.334) (0.739) [-0.264, 0.194]
Control variables		
Firm size → Firm performance (control variable)	0.003 (0.044) (0.965) [-0.130, 0.139]	0.001 (0.012) (0.990) [-0.131, 0.140]
Firm age → Firm performance (control variable)	0.036 (0.493) (0.622) [-0.100, 0.182]	0.029 (0.404) (0.686) [-0.107, 0.177]
Industry → Firm performance (control variable)	0.304 (0.900) (0.368) [-0.475, 0.459]	0.300 (0.897) (0.370) [-0.467, 0.451]
IT investment → Firm performance (control variable)	-0.020 (-0.204) (0.839) [-0.219, 0.175]	-0.012 (-0.122) (0.903) [-0.211, 0.181]
Innovation investment → Firm performance (control variable)	0.042 (0.455) (0.649) [-0.139, 0.221]	0.039 (0.365) (0.671) [-0.142, 0.220]
Quality management investment → Firm performance (control variable)	0.062 (0.909) (0.364) [-0.078, 0.196]	0.065 (0.935) (0.350) [-0.075, 0.199]

R^2	R^2	Adjusted R^2	R^2	Adjusted R^2
Knowledge absorptive capacity	0.355	0.347	0.356	0.347
Knowledge desorptive capacity	0.327	0.322	0.327	0.323
Firm performance	0.272	0.231	0.273	0.226
Overall model fit of the estimated model	**Value**	**HI_{95}**	**Value**	**HI_{95}**
SRMR	0.065	0.069	0.065	0.068
d_{ULS}	1.619	1.794	1.610	1.734
d_G	0.451	0.599	0.450	0.595
f^2				
IT integration capability → Knowledge absorptive capacity (H1)	0.064		0.064	
IT integration capability → Knowledge desorptive capacity (H2)	0.485		0.486	
Knowledge desorptive capacity → Knowledge absorptive capacity (H3)	0.183		0.183	
Knowledge absorptive capacity → Firm performance (H4)	0.028		0.029	
Knowledge desorptive capacity → Firm performance (H5)	0.054		0.052	
Firm size → Firm performance (control variable)	0.000		0.000	
Firm age → Firm performance (control variable)	0.002		0.001	
Industry → Firm performance (control variable)	0.117		0.112	
IT investment → Firm performance (control variable)	0.000		0.000	
Innovation investment → Firm performance (control variable)	0.001		0.001	
Quality management investment → Firm performance (control variable)	0.005		0.006	

Note: $^{\dagger}p < 0.10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$, one-tailed test for hypothesized alternative relationships and two-tailed test for other relationships.