

■ Research Article

Knowledge Processes, Absorptive Capacity and Innovation: A Mediation Analysis

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The present research aims to explore the role of knowledge creation and absorptive capacity as mediating variables between knowledge acquisition, knowledge sharing, and companies' organizational innovation. A theoretical model supporting the hypothesized relationships is developed, and then research hypotheses are tested with a sample of 111 industrial organizations, using partial least squares structural equation modeling. The results show that knowledge creation positively influences innovation and partially mediates the relationship between intra-firm knowledge sharing and innovation. Knowledge acquisition from external partners is not enough to promote innovation results but significantly reinforces absorptive capacity as well as knowledge sharing. Companies' absorptive capacity fosters the creation of knowledge, but does not significantly influence organizational innovation. The small sample size limits generalization of the present findings. Further research should explore the complementary role of knowledge creation and absorptive capacity in both small and medium-sized enterprises and large companies. Knowledge management practitioners should facilitate a knowledge sharing environment, where new ideas and solutions can be developed, and consequently innovation outcomes are likely to occur. This paper follows recent approaches to mediation analysis and covers advanced topics in partial least squares structural equation modeling literature, providing empirical examples of the application of hierarchical component models and mediation analysis using bootstrap. Copyright © 2016 John Wiley & Sons, Ltd.

INTRODUCTION

Organizations in general and particularly small and medium-sized enterprises facing constantly changing environments seek to innovate in order to survive and gain competitive advantage (Purcarea *et al.*, 2013). To do so, they need to manage knowledge required for innovation, that is, the development of new products, production processes, administrative changes, and marketing improvements (Weerawardena, 2003). The literature has identified several knowledge management processes (KMP) such as creation (Popadiuk and Choo, 2006), acquisition (Martinez-Canas *et al.*, 2012), and sharing (Liao *et al.*, 2007) as precursors of innovation outcomes. Furthermore, the organization's capacity

to identify, acquire, and commercially exploit external knowledge, that is, its absorptive capacity (ACAP) (Cohen and Levinthal, 1990), has also been studied considering its impact on innovation (e.g., Murovec and Prodan, 2009; Gebauer *et al.*, 2012).

Innovation is a very broad research topic, and different types of innovation are frequently identified, as well as different stages of the innovation process and diverse levels of analysis (Gopalakrishnan and Damanpour, 1997). Focusing on the knowledge management field, knowledge is considered a knowledge-based outcome, that is, innovation as new, duplicable, and useful knowledge (Quintane *et al.*, 2011). However, researchers frequently consider innovation outputs as new concrete products, services, managerial practices, and marketing strategies (Weerawardena, 2003; Popadiuk and Choo, 2006; Andreeva and Kianto, 2011; Ritala *et al.*, 2015).

However, according to recent contributions in the field (cf. Costa and Monteiro, 2014), only a few papers have previously addressed the relationship

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between KMP, absorptive capacity, and innovation (Chou, 2005; Liao *et al.*, 2007, 2010; Kotabe *et al.*, 2011; Maes and Sels, 2014; Su *et al.*, 2013). Therefore, this paper follows a knowledge-based view of the firm, in which knowledge is considered the most valuable resource to achieve a sustained competitive advantage (Kogut and Zander, 1992; Grant, 1996, 2006), and investigates the relationship between absorptive capacity, knowledge processes, and innovation, being guided by the following questions: (1) Do knowledge processes positively impact on organizational innovation? (2) Is absorptive capacity playing a mediating role between knowledge acquisition, knowledge sharing, and organizational innovation? (3) Is internal knowledge creation reinforcing innovation, and mediating the effect of other knowledge processes?

By answering these questions, this paper contributes to knowledge management, dynamic capabilities, and innovation research and practice, showing that innovation can be diversely influenced by knowledge and organizational capabilities and routines.

The remainder of the paper is organized as follows: Section on Literature Review and Hypotheses presents the literature review and research hypotheses; Section on Methodology shows the methodology of the research; Section on Results states the results of the measurement and structural model and the test of the research hypotheses; and Section on Discussion presents the discussion of the results, conclusions, limitations, and further research challenges.

LITERATURE REVIEW AND HYPOTHESES

Some research has recently explored the relationship between knowledge management and innovation, both empirically (e.g., Alegre *et al.*, 2011; Andreeva and Kianto, 2011; Lee *et al.*, 2013) and theoretically (e.g., Xu *et al.*, 2010; Quintane *et al.*, 2011). Moreover, the literature on knowledge management and innovation “share related underlying concepts” with absorptive capacity (Sun and Anderson, 2010, p. 147), a routine-based capability (Zahra and George,

2002; Sun, 2010). However, this relationship has been little explored with a few exceptions (e.g., Liao *et al.*, 2007, 2010; Su *et al.*, 2013) that focus on only one knowledge process. Thus, this paper aims to theoretically and empirically explore the relationship between the knowledge processes of acquisition, sharing, and creation with companies’ absorptive capacity and their organizational innovation intensity. The authors argue theoretically that knowledge creation and absorptive capacity mediate the relationship between knowledge acquisition and innovation, as well as between knowledge sharing and innovation. Companies’ absorptive capacity is expected to foster knowledge creation and innovation. Figure 1, at the end of the present section, presents the theoretical model.

Knowledge acquisition and innovation

External knowledge search and acquisition represents an important process for every organization, especially when internal resources are scarce and innovation is an imperative (Maes and Sels, 2014). Several papers investigate the relationship between knowledge acquisition and innovation (e.g., Zhou and Li, 2012; Pattinson and Preece, 2014; Segarra-Cipres *et al.*, 2014), concluding that the acquisition of external knowledge promotes different innovation types such as administrative and technical innovation (Chen and Huang, 2009), product/service innovation (Marvel, 2012), product innovation (Maurer, 2010), and new product performance (Molina-Morales *et al.*, 2014). Thus, the authors formulate the following hypothesis:

H1a: Knowledge acquisition positively impacts on organizational innovation.

Relationship between knowledge acquisition, absorptive capacity and innovation

Research on knowledge acquisition, absorptive capacity and innovation has found that knowledge acquisition positively impacts on innovation, and the relationship is either moderated (Kotabe *et al.*,

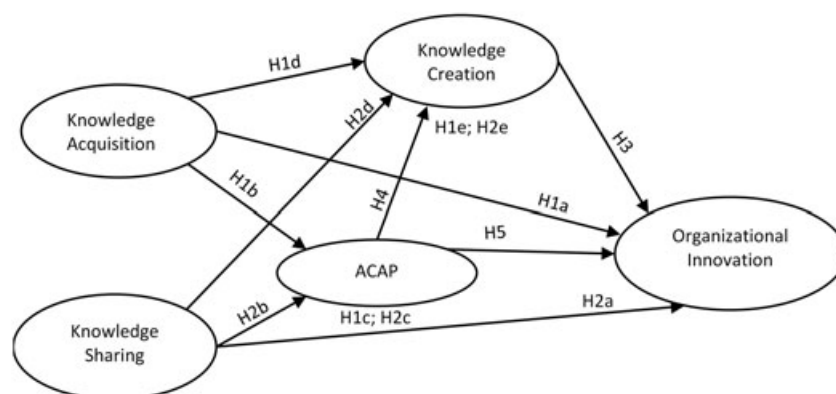


Figure 1 Theoretical Model. ACAP, absorptive capacity.

2011) or fully mediated (Liao *et al.*, 2010) by absorptive capacity. In fact, external knowledge acquisition broadens the knowledge base, reinforcing firms' capacity to identify and successfully assimilate, transform, and apply new knowledge, that is, their absorptive capacity. Therefore, the authors formulate the following research hypothesis:

H1b: Knowledge acquisition positively impacts on absorptive capacity.

Considering that knowledge acquisition can directly impact on innovation results, but that when absorptive capacity is considered in the equation, the effect of acquisition tends to change, we formulate the following hypothesis:

H1c: Absorptive capacity mediates the relationship between knowledge acquisition and innovation.

Relationship between knowledge acquisition, knowledge creation and innovation

Knowledge acquisition seems to directly influence new knowledge creation (Zheng *et al.*, 2011), which in turn promotes organizational innovation (Zhang *et al.*, 2010; Andreeva and Kianto, 2011). Therefore, some papers found that mere acquisition was not enough to stimulate innovation (Zhang *et al.*, 2010; Andreeva and Kianto, 2011; Lee *et al.*, 2013; Aboelmaged, 2014), or that its effect on innovation depends on the characteristics of the recipient firm's knowledge base (Zhou and Li, 2012). Hence, internal knowledge creation plays a mediating role between acquisition of new external knowledge and innovation (Zhang *et al.*, 2010; Andreeva and Kianto, 2011). The following hypotheses are then formulated:

H1d: Knowledge acquisition positively impacts on knowledge creation.

H1e: Knowledge creation mediates the relationship between knowledge acquisition and innovation

Knowledge sharing and innovation

The knowledge management literature consistently recognizes knowledge sharing as a key process (e.g., Heisig, 2009; Hislop, 2009), and theoretically and empirically relates knowledge sharing to innovation outcomes (Xu *et al.*, 2010; Saenz *et al.*, 2012; Wang and Wang, 2012; Lee *et al.*, 2013). In fact, when knowledge is actively shared, different innovation outcomes such as radical innovation (Maes and Sels, 2014), product innovation (Camelo-Ordaz *et al.*, 2011), administrative and technical innovation (Chen and Huang, 2009; Huang and Li, 2009), organizational innovation (Aboelmaged, 2014), and team innovation (Hu and Randel, 2014) take place in organizations. Therefore, the literature allows the authors to hypothesize that

H2a: knowledge sharing positively impacts on organizational innovation.

Relationship between knowledge sharing, absorptive capacity, and innovation

When knowledge is shared within organizations, individual and group knowledge turns into organizational knowledge, and knowledge can effectively be managed (van den Hooff and de Leeuw van Weenen, 2004). Previous research, exploring the relationship between knowledge sharing and absorptive capacity concludes that knowledge sharing promotes absorptive capacity, considering the three learning processes of exploratory, transformative, and exploitative learning, and especially influences the intermediate process of transformative learning (Maes and Sels, 2014). Knowledge sharing also shows its positive influence on ACAP, as conceptualized by Minbaeva *et al.* (2003) in Liao *et al.*'s (2007) research. As stated by Zahra and George (2002), relevant knowledge needs to be shared to build mutual understanding, and this is a pre-requisite for exploitation. Lane *et al.* (2006, p. 838) also stated that ACAP "depends on the organization's ability to share knowledge and communicate internally". Thus, knowledge sharing seems to underpin different ACAP phases (Todorova and Durisin, 2007), and it is expected that the sharing of knowledge will strengthen firms' absorptive capacity. Following previous literature, the authors state that

H2b: Knowledge sharing positively impacts on absorptive capacity.

Previous research findings substantiate that knowledge sharing influences innovation through firms' absorptive capacity, that is, when a knowledge sharing culture exists, absorptive capacity is reinforced, and knowledge is translated into innovations (Liao *et al.*, 2007). The authors formulate the following hypothesis:

H2c: Absorptive capacity mediates the relationship between knowledge sharing and innovation.

Relationship between knowledge sharing, knowledge creation, and innovation

The knowledge management literature recognizes the relevance of sharing knowledge for new knowledge creation and innovation (Nonaka, 1991; Xu *et al.*, 2010; Camelo-Ordaz *et al.*, 2011). Empirical studies show that knowledge sharing positively influences technical and administrative innovation (Aboelmaged, 2014), as well as innovation capability (Kumar and Rose, 2012). Moreover, empirical research has found that knowledge creation mediates the relationship between intra-firm knowledge sharing and innovation (Andreeva and Kianto, 2011). Therefore, the authors hypothesize that

H2d: Knowledge sharing positively impacts on knowledge creation

H2e: Knowledge creation mediates the relationship between knowledge sharing and innovation.

Knowledge creation and innovation

The creation of new knowledge is closely linked to the concept of innovation. However, as stated by Andreeva and Kianto (2011), knowledge creation refers to the process through which ideas and solutions are developed within organizations, and innovation refers to the results of the application of the new knowledge. Conceptual papers have also explored the links between the knowledge creation theory (Nonaka, 1991) and the innovation process (e.g., Popadiuk and Choo, 2006; Esterhuizen *et al.*, 2012). Current empirical research reinforces the positive and significant relationship between knowledge creation and product and process innovation (Smith *et al.*, 2005), product and market performance (Lai *et al.*, 2014), and organizational innovation performance (Andreeva and Kianto, 2011). Therefore, the authors hypothesize that

H3: Knowledge creation positively impacts on organizational innovation.

Absorptive capacity and knowledge creation

The literature on knowledge creation and absorptive capacity reveals mixed results. On one hand, some studies show that new knowledge creation can be an outcome of the firm's absorptive capacity (Chou, 2005; Matusik, 2005; Sun, 2010), because absorptive capacity acts as an accelerator of new knowledge creation (Zelaya-Zamora and Senoo, 2013). On the other hand, some authors found that both can create a synergistic effect, reinforcing each other and supporting innovation (Su *et al.*, 2013). In fact, absorptive capacity overall—and the transformation phase in particular—seems to underpin the creation of new knowledge (Sun, 2010), resulting from the combination of firms' knowledge base with the external knowledge already acquired and assimilated. However, some firms with lower absorptive capacity can rely on internal knowledge creation to foster innovation outcomes.

H4: Absorptive capacity positively influences knowledge creation.

Absorptive capacity and innovation

It is widely accepted that firms need external knowledge to innovate (Ferrerias-Méndez *et al.*, 2015). However, more than recognizing the benefits

of access to externally developed knowledge, it is important to provide evidence that firms take advantage of such knowledge, for example, in the form of innovations (Fabrizio, 2009). Several papers have recently contributed to this understanding by empirically linking ACAP with innovation outcomes (Fosfuri and Tribo, 2008; Chen *et al.*, 2009; Murovec and Prodan, 2009; Su *et al.*, 2013; Ebers and Maurer, 2014; Moilanen *et al.*, 2014; Ferreras-Méndez *et al.*, 2015). In general, researchers found that absorptive capacity positively affects innovation performance (Chen *et al.*, 2009; Moilanen *et al.*, 2014), product and process innovation (Murovec and Prodan, 2009), and product innovativeness (Su *et al.*, 2013). Following current research, the authors formulate the following research hypothesis:

H5: Absorptive capacity positively influences organizational innovation intensity.

METHODOLOGY

Data collection and sample

Data was collected with an online survey. Companies were emailed with a cover letter stating the goals of the study and containing a link to the online questionnaire. The population of this study comprises Portuguese companies with more than 10 employees that are connected with industry in multiple sectors of activity, namely footwear, textile, moulds, metallurgy, information technologies, automotive components, plastics, chemicals, paper and cardboard, and ceramics. These industries were selected considering the important role that they ascribe to innovation. Moreover, they represent, simultaneously, some of the most mature and cutting-edge industries in Portugal.

First, companies' email addresses were collected from industry associations' websites (e.g., APICCAPS; ATP; CEFAMOL; ANEME). Overall, 1739 email addresses were collected. 188 emails were automatically returned, and 111 valid answers were obtained out of the 1551 valid emails, giving a response rate of 7.16%.

Key informants were companies' Chief Executive Officers (CEO), top managers, middle managers, and human resources professionals (86.5%), and also production managers, Research and Development (R&D) directors or other professionals (13.5%) who were aware of the organizational processes under study. Respondents are mainly qualified workers, with 79.3% holding a degree or higher. On average, respondents have worked in the firm for 13 years and 6 months, and companies began activities 33 years ago.

Companies were small (52.3%) and medium-sized enterprises (41.4%) with only seven companies having more than 250 employees. Twenty-eight firms (25.2%) have an internal R&D unit.

Measures

The authors requested permission to use previously developed measures (Weerawardena, 2003; Andreeva and Kianto, 2011; Flatten *et al.*, 2011a, 2011b) and followed guidelines for translation and cross-cultural adaptation (Brislin, 1986; Beaton *et al.*, 2000; Gjersing *et al.*, 2010) in order to adapt the measures from English to European Portuguese.

The online questionnaire comprises the following measures:

Absorptive Capacity: absorptive capacity is measured with the scale developed by Flatten *et al.* (2011a, 2011b) Following Zahra and George's (2002) model, several authors have recently used this measure (e.g., Flatten *et al.*, 2011a, 2011b; Aljanabi *et al.*, 2014), and its reliability has been tested in different cultural contexts (Flatten *et al.*, 2014).

Three items (e.g., "Our management motivates the employees to use information sources within our industry") assess the acquisition dimension, that is, the use of external sources to obtain information. Assimilation, "the firm's routines and processes that allow it to analyze, process, interpret, and understand" (Zahra and George, 2002, p.189) external information, is measured with four items (e.g., "Our management emphasizes cross-departmental support to solve problems"). Knowledge processing in the organizations surveyed was assessed with four items that represent the transformation dimension (e.g., "Our employees successfully link existing knowledge with new insights"). The commercial exploitation of new knowledge was measured by three statements (e.g., "Our company has the ability to work more effectively by adopting new technologies"). All 14 items are measured with a 7-point Likert-type scale ($CR = 0.947$; $\alpha = 0.939$; average variance extracted (AVE) = 0.563).

Knowledge Management Processes were assessed using three independent scales, translated from the work of Andreeva and Kianto (2011), and measured by a 6-point semantic differential scale with a seventh "I don't know" option.

Knowledge sharing: The intra-organizational knowledge sharing scale, with five items, aims "to evaluate both vertical and horizontal knowledge sharing within the organization" (Andreeva and Kianto, 2011, p. 1023). A sample item was "In our organization information and knowledge are actively shared within the units". The scale shows good validity in the present study ($CR = 0.938$; $\alpha = 0.917$; $AVE = 0.752$).

Knowledge acquisition: with three items, the knowledge acquisition scale provides information about companies' interactions with the external environment. A sample item was "Our organisation

regularly captures knowledge of our competitors". The scale presents good validity in our sample ($CR = 0.847$; $\alpha = 0.730$; $AVE = 0.649$).

Knowledge creation: measured with four items (e.g., "Our organisation frequently comes up with new ideas about our products and/or services"). The knowledge creation scale evaluates the frequency of new idea development considering organizations' different activities ($CR = 0.921$; $\alpha = 0.886$; $AVE = 0.746$).

Organizational innovation intensity: Incorporating different innovation types (product, process, managerial, and marketing), organizational innovation intensity was measured with four items, adapted from Weerawardena (2003). The 5-point scale ranges from "1 = limited" to "5 = extensive" ($CR = 0.821$; $\alpha = 0.717$; $AVE = 0.536$).

Control Variables: Considering the dependent and independent variables, the authors followed research guidelines (e.g., Atinc *et al.*, 2012) and introduced several variables to control for firm and respondent factors. *Firm size:* several authors argue that firm size can positively influence innovation, as larger firms have more access to resources (Zheng *et al.*, 2011). However, Damanpour (2010), analyzing 20 studies on size and innovation, does not find substantial differences. Firm size was measured considering the number of employees. *Firm age:* measured by asking respondents the year of company's foundation (Huang and Li, 2009; Li *et al.*, 2010), this control variable was introduced considering previous research which states that firm age tends to be inversely related to innovation (Hansen, 1992; Huergo and Jaumandreu, 2004). *Firm revenue:* considering the previous year's revenue in millions of euros. *Research and Development:* a variable that is equal to 1 if the firm reports having a formal R&D department or 0 if it does not. *Exporting:* adapted from Moilanen, Østbye and Woll (2014), this variable measures the percentage of the previous year's sales which was to foreign countries, if applicable.

Statistical method

Partial least squares structural equation modeling using SMARTPLS 2.0.M3 (SmartPLS, Hamburg, Germany) (Ringle *et al.*, 2005) was used considering the sample size and the research model complexity. Additionally, the PLS algorithm does not make any assumptions about data normality (Hair *et al.*, 2014). First, the measurement model (or outer model) was evaluated, and then the author estimated the structural model (or inner model) to test the hypotheses, following the two-stage approach (Ringle *et al.*, 2012). To represent the absorptive capacity construct, and its four dimensions, the authors followed

a repeated indicators approach, suitable for the representation of reflective-reflective type higher-order components (Wetzels *et al.*, 2009; Wilson, 2010; Ringle *et al.*, 2012). The absorptive capacity indicators are suitable for this analysis because the items are similarly distributed through the four dimensions. Hence, items were assigned to each dimension and a higher order construct was created, incorporating all the items. Then, the authors ran the PLS algorithm and saved the latent variable scores (LVS), creating a new database. Further analysis was performed with the LVS of the low order components as manifest variables.

RESULTS

Common method variance (CMV) concerns appear in the business research literature (Chang *et al.*, 2010; Podsakoff *et al.*, 2003). In the present study, we undertook several steps to minimize this potential bias, because self-reported data was collected from a single source. First, data was collected using different measurement scales (cf. Section on Measures). Moreover, the online survey does not allow

the respondent to skip the scales and thus relate dependent and independent variables. We perform a post-hoc analysis, assessing possible CMV with Harman's single factor test. The analysis shows a 7-factor solution with eigenvalues greater than 1 and a first component that explains 44.4% of the variance. Because the first component does not account for the majority of the variance, and a single factor solution did not emerge from the data, CMV was not found to be an issue.

Measurement model

Convergent validity: the indicators' outer loadings are higher than the recommended 0.708, with the exception of the item "innov5" (cf. Table 1). However, AVE is above the 0.50 threshold showing the convergent validity of the items, and the composite reliability of all factors exceeds the 0.70 recommendation. Table 1 presents the indicators' loadings, construct reliability, and convergent validity.

Discriminant validity: we assess constructs' discriminant validity with the Fornell–Larcker criterion (Fornell and Larcker, 1981). Table 2 shows that the

Table 1 Individual reliability, composite reliability and average variance extracted for the first and second-order constructs

Factor	Items	Loadings	Composite reliability	Cronbach's alpha	Ave
ACAP (second order reflective-reflective)			0.947	0.939	0.563
Acquisition	acap1.1	0.895	0.934	0.894	0.824
	acap1.2	0.938			
	acap1.3	0.890			
Assimilation	acap2.1	0.902	0.940	0.915	0.796
	acap2.2	0.912			
	acap2.3	0.882			
	acap2.4	0.873			
Transformation	acap3.1	0.876	0.956	0.938	0.845
	acap3.2	0.958			
	acap3.3	0.950			
	acap3.4	0.890			
Application	acap4.1	0.835	0.902	0.836	0.755
	acap4.2	0.931			
	acap4.3	0.837			
Knowledge acquisition	Kaquisition1	0.771	0.847	0.730	0.649
	Kaquisition2	0.808			
	Kaquisition3	0.836			
Knowledge creation	KCreation1	0.801	0.921	0.886	0.746
	KCreation2	0.906			
	KCreation3	0.874			
	KCreation4	0.871			
Knowledge sharing	KSharing1	0.919	0.938	0.917	0.752
	KSharing2	0.895			
	KSharing3	0.892			
	KSharing4	0.734			
	KSharing5	0.884			
Organizational innovation	Innov1	0.760	0.821	0.717	0.536
	Innov3	0.821			
	Innov5	0.626			
	Innov7	0.708			

ACAP, absorptive capacity.

Table 2 Constructs discriminant validity assessment

	1	2	3	4	5	6	7	8	9	10
1. ACAP	0.751									
2. Knowledge creation	0.647	0.864								
3. Knowledge acquisition	0.495	0.438	0.806							
4. Knowledge sharing	0.738	0.755	0.524	0.867						
5. Organizational innovation	0.460	0.454	0.358	0.405	0.732					
6. R&D	0.263	0.182	0.201	0.157	0.244	-				
7. Revenue	0.090	0.039	0.212	0.030	0.115	0.193	-			
8. Size	0.213	0.172	0.225	0.130	0.186	0.300	0.703	-		
9. Age	0.032	-0.101	-0.143	-0.178	-0.014	-0.227	-0.352	-0.315	-	
10. Export	0.227	0.154	0.162	0.170	0.293	0.133	0.140	0.316	-0.032	-
Mean	5.230	4.740	4.341	4.775	3.164	0.252	1.870	1.541	1982.243	2.582
SD	1.006	0.945	1.025	0.936	0.756	0.436	0.821	0.615	24.981	1.461

ACAP, absorptive capacity; Av., Average score of all item included in the construct/variable; R&D, Research and Development; SD, standard deviation.

correlations between the constructs are less than 0.80 and less than the squared root of the AVE, revealing the distinctiveness of the constructs and thus discriminant validity. Cross loadings between constructs were also analyzed, showing that loadings were always higher on the intended factor.

Multicollinearity assessment: Using LVS from Smart PLS, the authors ran a regression model using SPSS (IBM Corporation, NY, USA). The highest variance inflation factor (VIF) value is 3.2 with tolerance values above 0.309. Therefore, variance inflation factor values are below the recommended cut-off value of 5.0, and correlations between constructs are far below 0.90, showing that multicollinearity is not present in the data (Hair *et al.*, 2010, 2014).

Structural model

Having previously assessed the appropriateness of the measurement model, the authors use the R^2 values as a measure of predictive power and Q^2 (Geisser, 1974; Stone, 1974) as a measure of predictive relevance. Latent variables scores from the PLS algorithm were used as indicators of the constructs to test the hypotheses. The bootstrap procedure was performed with 5000 sub-samples and 111 cases

according to recommendations in the literature to assess the significance of path coefficients (β) (Hayes, 2009; Hair *et al.*, 2014). The test of mediation hypotheses relies on the bootstrap procedure and follows recent contributions on the topic (Preacher and Hayes, 2004; Preacher *et al.*, 2007; Hayes, 2009; Zhao *et al.*, 2010).

To empirically test the research hypotheses, four models were created, considering that the full model has two mediators, and a relationship between the mediators (cf. Klarner *et al.*, 2013). Table A1 (Appendix A) shows a comparison between the four models. Model 1 considers the independent variables of knowledge acquisition and sharing and the dependent variable of innovation (Table 3). Thus, when considering the model without the mediators, knowledge acquisition has a non-significant effect on innovation ($\beta=0.147$, $t=1.157$). The effect of knowledge sharing on organizational innovation has a significant ($p<0.05$) value of 0.209 ($t=2.480$). Thus, hypothesis H1a is not substantiated by the data and hypothesis H2a is supported. The R^2 coefficient is 0.271, which means that 27% of the organizational innovation variance is explained by the combined effect of the exogenous variables. With a Q^2 value larger than 0 ($Q^2=0.288$), the authors confirm that the model has predictive relevance (Hair *et al.*, 2014). Control

Table 3 Structural Model Assessment (Model 1, without mediators)

Path	Path coefficient (β)	T statistics(t)	p-value
Knowledge acquisition \rightarrow Innovation	0.147	1.157	0.247
Knowledge sharing \rightarrow Innovation	0.290	2.480*	0.013
Age \rightarrow Innovation	0.123	1.085	0.278
Export \rightarrow Innovation	0.193	1.931	0.054
R&D \rightarrow Innovation	0.158	1.781	0.075
Revenue \rightarrow Innovation	0.055	0.456	0.648
Size \rightarrow Innovation	0.006	0.061	0.951

* $p < 0.05$

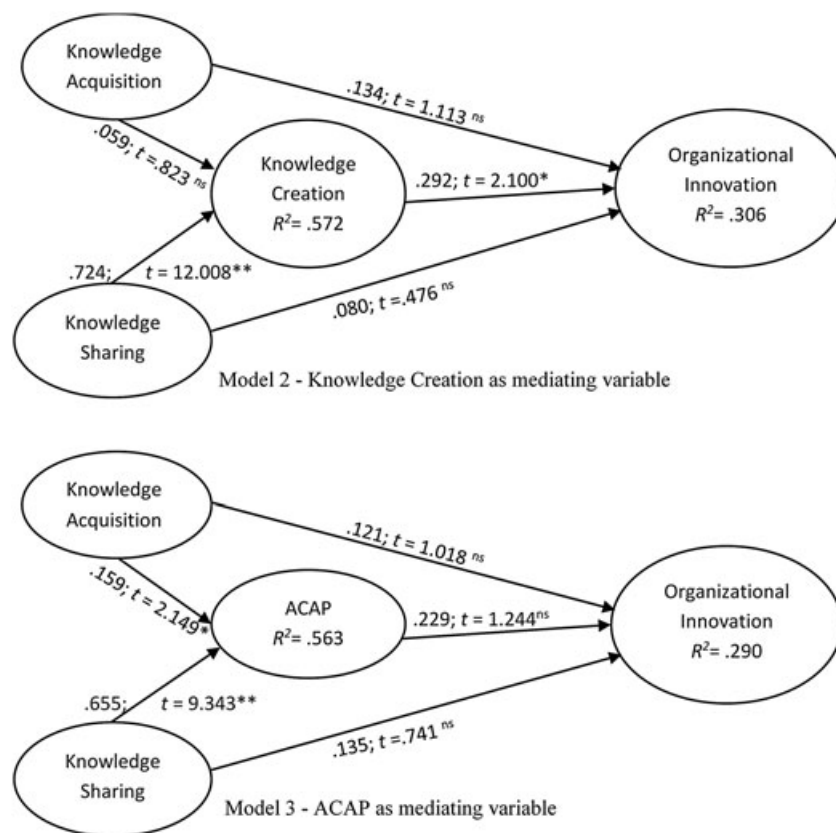
R&D, Research and Development.

variables have no significant relationship with organizational innovation, at a confidence interval of 95%. However, the results suggest, with a 90% confidence interval, that exporting plays a significant role in organizational innovation ($\beta = 0.193$, $p = 0.054$), as well as the formal existence of an internal R&D department ($\beta = 0.158$, $p = 0.075$).

Next, in Models 2 and 3 (Figure 2), we separately consider the effect of knowledge creation and absorptive capacity as mediating variables, respectively (Hypotheses H1b, H1c, H1d, H2b, H2c, and H2d). Model 2 shows that knowledge sharing strongly supports knowledge creation ($\beta = 0.724$; $t = 12.008$, $p < 0.01$), providing empirical evidence to substantiate H2d. However, knowledge acquisition has a non-significant relationship with knowledge creation ($\beta = 0.059$). The direct effect of knowledge sharing on innovation vanishes when we control for the effect of knowledge creation. The direct effect decreases from 0.209 (without the mediator) to a non-significant 0.080 (with the mediator). Therefore, the results provide empirical support to H2e, which states that knowledge creation mediates the relationship between knowledge sharing and innovation, with a significant ($p < 0.05$) indirect effect of 0.211 ($t = 2.080$). Considering that the indirect effect

is significant and the direct effect is non-significant, the results support an indirect-only mediation type (cf. Zhao *et al.*, 2010). However, with a variance accounted for of 72.5%, only partial mediation is supported (Helm *et al.*, 2010; Hair *et al.*, 2014). This result shows that 72.5% of knowledge sharing's effect on innovation is explained via knowledge creation. The relationship between knowledge creation and organizational innovation has a significant value of 0.292 ($t = 2.100$, $p = 0.036$), supporting H3. To assess the effect size of knowledge creation on innovation, the f^2 effect size was calculated, considering the R^2 values of Model 1 (i.e., R^2_{excluded}) and Model 2 (i.e., R^2_{included}). With an f^2 value of 0.05, the introduction of knowledge creation produces a small effect.

Model 3, with ACAP as a mediating variable, shows that both acquisition ($\beta = 0.159$; $t = 2.149$, $p < 0.05$) and sharing ($\beta = 0.655$; $t = 9.343$, $p < 0.01$) reinforce absorptive capacity, thus substantiating hypotheses 1b and 2b, respectively. However, ACAP's relationship with innovation is not significant, despite the positive tendency ($\beta = 0.229$; $t = 1.244$, $p = 0.214$). Thus, no support was found for H5. When controlling the effect of ACAP, knowledge sharing's direct relationship with



Note: The representation of the structural models excludes the control variables for simplification purposes.

* $p < .05$; ** $p < .01$; ns = non-significant.

Figure 2 Models 2 and 3 structural model representation. Note: The models representation excludes the control variables for simplification purposes. * $p < 0.05$; ** $p < 0.01$; ns = non-significant; ACAP, absorptive capacity.

innovation is no longer significant ($\beta=0.135$; $t=0.741$), as well as the indirect effect ($\beta=0.150$; $t=1.219$). However, the total effect remains significant with a value of 0.285 ($p=0.016$). The indirect effect of knowledge acquisition on innovation is non-significant ($\beta=0.036$), and thus no support was found for the mediating effect of ACAP between knowledge acquisition and innovation (hypothesis H1c). With an f^2 effect size of 0.03, the introduction of ACAP represents a small effect.

Lastly, Model 4 (Figure 3) incorporates the two mediators (knowledge creation and ACAP), as well as the hypothesized relationship between ACAP and knowledge creation. The relationship between ACAP and knowledge creation is significant ($t=2.392$, $p=0.017$) with a path coefficient of 0.192. This result supports hypothesis H4. The mediating effect of knowledge creation between knowledge sharing and innovation remains significant as well as the relationship between knowledge creation and innovation (on the threshold of statistical significance).

DISCUSSION

The present study aims to analyze the mediating role that knowledge creation and absorptive capacity play between external knowledge acquisition, intra-firm knowledge sharing, and organizational innovation. Therefore, it contributes to the increasing body of research that relates knowledge processes to absorptive capacity, in order to understand their critical role in innovation.

The results show that the creation of new knowledge within the firm positively impacts organizational innovation. Additionally, companies' absorptive capacity and intra-firm knowledge sharing significantly reinforce knowledge creation. However, for the respondent firms, the acquisition

of external knowledge and their knowledge absorptive capacity do not influence organizational innovation, either directly or indirectly. These results are in line with the findings of Aboelmaged (2014), that knowledge acquisition is not enough to promote innovation. On the other hand, when knowledge is shared within organizations, organizational innovation is significantly reinforced, via the creation of new knowledge, which is consistent with previous findings on the mediating effect of knowledge creation between knowledge sharing and innovation (Andreeva and Kianto, 2011). Knowledge sharing also leverages the absorptive capacity of the respondent firms, reinforcing previous claims and findings from the literature (Maes and Sels, 2014; Zahra and George, 2002). The acquisition of external knowledge, while having no impact on knowledge creation or innovation, strengthens companies' absorptive capacity, consistent with previous findings (Liao *et al.*, 2010).

This result suggests that the respondent firms rely on internal knowledge sharing and creation to develop new products, production processes, marketing strategies, and management practices. Although the respondent companies report high absorptive capacity (considering a mean of 5.23 on a 1–7 scale), they are not taking direct advantage of this capacity for innovation purposes, which suggests a poor knowledge integration capacity and/or very sparse networks, with a low knowledge overlap between the organizations' knowledge base.

Considering the implications of the present findings, it is important to emphasize the role of knowledge creation as the main driver of companies' innovation. Therefore, knowledge management practitioners should promote an organizational climate where knowledge can be shared and, even more importantly, created. Even considering that our findings suggest a prominence of internal processes (sharing and creation) leading to innovation,

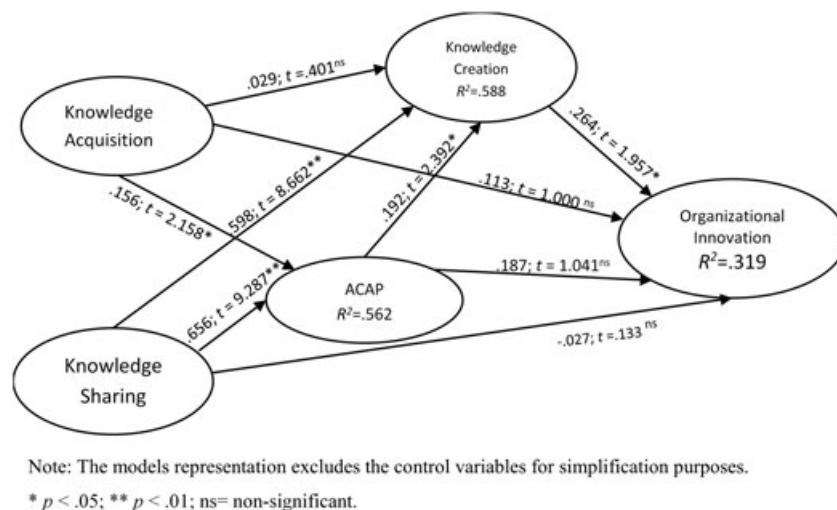


Figure 3 Structural model representation of Model 4. Note: The representation of the structural models excludes the control variables for simplification purposes. * $p < 0.05$; ** $p < 0.01$; ns = non-significant; ACAP, absorptive capacity.

the external acquisition of knowledge should not be neglected because this knowledge reinforces companies' absorptive capacity.

Limitations of the present study include the small sample size and consequently limited generalization of the research findings. Moreover, with a single method for data collection, as well as a single respondent from each organization, the threat of common method variance is a limitation, despite the pre-hoc and post-hoc analysis.

Future research should continue to explore the relationship between KMP, ACAP, and innovation, considering previous theoretical models (Liao *et al.*, 2007; Sun, 2010; Maes and Sels, 2014). Because the inclusion of three knowledge processes in the present research is not exhaustive, further research should consider other processes such as knowledge storage, codification, application, and refinement (cf., Xu *et al.*, 2010), which can play a role in companies' innovation. The complementary/competitive role of knowledge creation and absorptive capacity in innovation should be explored in both small and medium-sized enterprises and large companies.

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APPENDIX

Table A1 Structural models assessment

Endogenous constructs		R ²	Q ²	R ²	Q ²	R ²	Q ²	R ²	Q ²
Control variables	Innovation	0.271	0.288	0.306	0.330	0.290	0.309	0.319	0.340
	Knowledge creation			0.572	0.569			0.588	0.586
	ACAP					0.563	0.393	0.562	0.392
		Model 1		Model 2		Model 3		Model 4	
	Path	$\beta(t)$		$\beta(t)$		$\beta(t)$		$\beta(t)$	
	Age → Innovation	0.123(1.085)		0.105(0.986)		0.067(0.644)		0.062(0.594)	
	Export → Innovation	0.193(1.931)		0.196(1.962)*		0.179(1.754)		0.185(1.818)	
	R&D → Innovation	0.158(1.781)		0.144(1.559)		0.123(1.288)		0.117(1.211)	
	Revenue → Innovation	0.055(0.456)		0.074(0.635)		0.047(0.403)		0.066(0.575)	
	Size → Innovation	0.006(0.061)		−0.029(0.262)		−0.013(0.120)		−0.041(0.379)	
	K_Acquisition → Innovation	0.147(1.157)		0.134(1.113)		0.121(1.018)		0.113(1.000)	
	K_Sharing → Innovation	0.290(2.480)*		0.080(0.476)		0.135(0.741)		−0.027(0.133)	
	K_Acquisition → K_creation			0.059(0.823)				0.029(0.401)	
	K_Sharing → K_creation			0.724(12.008)**				0.598(8.662)**	
	K_Creation → Innovation			0.292(2.100)*				0.264(1.957)*	

* $p < 0.05$; ** $p < 0.01$

ACAP, absorptive capacity; R&D, Research and Development.