ISSN 0798 1015

REVISTA ESPACIOS

HOME Revista ESPACIOS ÍNDICES A LOS AUTORES

Vol. 38 (Nº 36) Año 2017. Pág. 10

Absorptive Capacity (AC): knowledge generation and its evolution from variable to construct

Capacidades de Absorción (CA): generación de conocimiento y su evolución desde la variable hasta el constructo.

Geovanny PERDOMO Charry 1; Nelson LOZADA Barahona 2; Alexander ZÚÑIGA Collazos 3

Recibido: 22/02/2017 • Aprobado: 12/03/2017

Content

ABSTRACT:

The article purpose is to analyze knowledge generation based on the Adsorptive Capacity of firms (AC). This study was done considering the currently existing literature between 2005 and 2014 in recognized journals of technology and innovation as per the Journal Citations Report (JCR) Scimago Journal & Country Rank (SJR). The results show the predominance of studies with quantitative, multidimensional, and interdisciplinary approaches, which look to enhance the analysis levels over theoretical perspectives, the determinants and CA factors, realize construct update and validation with first and second order data, as well as develop and apply measurement scales CA.
Keywords Absorptive capacity, determinants, factors, measurement scales.

RESUMEN:

El propósito del artículo es analizar la generación de conocimiento basada en la Capacidad de Absorción de las empresas (CA). Este estudio analizo la literatura existente entre 2005-2014 de reconocidos journals de tecnología e innovación que hacen parte de Journal Citations Report (JCR) y Scimago Journal & Country Rank (SJR). Los resultados muestran la predominancia de estudios cuantitativos, multidimensionales e interdisciplinarios que buscan mejorar los niveles de análisis sobre perspectivas teóricas, determinantes y factores CA, realizar actualización y validación de constructos con datos de primer y segundo orden, así como desarrollar y aplicar escalas de medida de CA.
Palabras clave: Capacidades de Absorción, determinantes, factores, escalas de medición

1. Introduction

The ways how firms face rapid technological changes, entrepreneurial aggressiveness, and the short lifecycles of technology can be found on their inside as well as in their environment (Camisón and Forés, 2010). Some firms may face changes more rapidly than others due to their capability to recognize, valuate, assimilate, and apply newly acquired external knowledge (Camisón and Forés, 2010; Cepeda-Carrion, Cegarra-Navarro and Jimenez-Jimenez, 2012; Enkel and Heil, 2014; Escribano, Fosfuri and Tribó, 2009; Flatten, Engelen, Zahra and Brettel, 2011; Fosfuri and Tribó, 2008; Jansen, Bosch and Volberda, 2005; Javalgi, Hall and Cavusgil, 2014; Jiménez-Barrionuevo, García-Morales and Molina, 2011; Kostopoulos, Papalexandris, Papachroni and Ioannou, 2010; Leal-Rodríguez, Ariza-Montes, Roldán and Leal-Millán, 2014; Malhotra, Gosain and El Sawand, 2005).

Through this process, firms foster and enhance explicit knowledge through codification and application, improve decision making processes, and develop or modify knowledge bases (Bergh and Lim, 2008). This dynamic behavior is recognized by the literature as Absorptive Capacity – AC –. Thereby, organizations must determine internal and external sources of knowledge in order to maximize their innovating potential. In order to do so, it is necessary to develop the capability of exploring valuable external knowledge, and then transfer it inwardly and exploit it efficiently (Flatten et al., 2011). From Cohen and Levinthal's (1990) studies, a vast amount of academic production has emerged, which has given birth to four research lines: Organizational Learning (Cohen y Levinthal, 1990; Kim, 1998), Knowledge Management (Szulanski, 1996), Strategic Lines (Lane y Lubatkin, 1998), and Innovation Management (Mowery y Oxley, 1995; Veugelers, 1997).

Our literature review in this field shows that Cohen and Levinthal (1990) were pioneers in the introduction of AC as a complex process (Lane and Lubatkin, 1998; Todorova and Durisin, 2007), which becomes a unidimensional variable at the moment of measurement, and whose most common measurement mechanism focuses on R&D (Tsai, 2001). Subsequent studies have enhanced the concept of AC at organizational level in order to cover the richness of the construct (Jiménez-Barrionuevo et al., 2011; Zahra y George, 2002). According to the above, this article will start by addressing the several definitions or variations given to the construct throughout time. Secondly, such conceptualization will permit us to identify a consequent topic of interest, in which different authors have established several analysis levels, from which the construct has grown and emerged. Although it is clear that the concept can be applied to different levels, we will deepen into the ones of overt research interest and provide reliable analysis sets.

Thirdly, we will review the internal and external factors of the organization, which in turn have give origin to the determinants addressed by the literature. In fourth place, we will analyze the main measurements of AC taking into account, on the one hand, its phases and dimensions as per the literature review, and the dimensions developed by Zahra and George (2002) on the other. We also intend to feature some specific approaches and theoretical perspectives such as strategy formulation, innovation, cooperation management, and organizational learning. Finally, taking into account that AC is not considered as a mere determinant but as a moderating and contributing variable, we present the conclusions and possible future research horizons.

The selection of articles for the present study includes journals with a recognized impact factor in the JCR, and covers a 10-year period, from 2005 up to 2014. This review covers around 50 studies belonging to Organizational, Innovation, and Technology Management journals. We considered article search keywords such as absorptive capacity, capabilities, knowledge management, technological absorptive capacity, among other concepts of relevance in the field.

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2. Conceptualization of AC

Although the most commonly accepted definition of AC is the one developed by Cohen and Levinthal (1990), which see it as an ability of a firm to identify, assimilate, and apply external knowledge with commercial aims, to Mowery and Oxley (1995) AC is a wide array of abilities necessary for dealing with the tacit element of acquired knowledge. In more general terms, Kim

(1008) established AC as the capacity to learn and solve problems that enable a company to assimilate external knowledge and create new knowledge. With certainty, one of the studies with greatest impact in the field is the one carried out by Zahra and George (2002).

These authors have featured AC as a dynamic ability related to the creation and use of knowledge, in which both processes are oriented to increasing the capacity of a firm to maintain and create comparative advantages, being all this by means of the development of other organizational capabilities or arrays of organizational routines and processes such as marketing, distribution, and production, through which firms acquire, assimilate, transform, and exploit knowledge. Let us present one timeline of changes, or corrections, to the definitions and notions given to the AC construct (See table 1).

Table 1. Conceptualizing Absorptive Capacity.

Decade	Authors	Description
1990	Cohen & Levinthal (1990)	Ability that a firm has to identify, assimilate, and apply external information with commercial ends.
	Mowery & Oxley (1995)	Array of abilities to deal with tacit information transferred and with the need to modify it.
	Kim (1998)	Capacity to learn and solve problems so that the firm assimilates and creates new external knowledge.
	Lane & Lubatkin (1998)	They analyze a firm’s AC in relation to a second one in order to value, assimilate, and apply knowledge.
2000	Zahra y George (2002)	They elaborate a reconceptualization of AC integrating internal as well as external knowledge by means of dimensions grouped into two components.
	Jansen, Van den Bosch, and Volberda (2005)	They take up the dimensions featured by Zahra and George, taking into account three combinatory capacities: coordination, systems, and socialization.
	Malhotra, Gosain, and El Sawy (2005)	Set of routines and organizational processes through which firms acquire, assimilate, transform, and exploit knowledge as a result of capability production.
	Nieto & Quevedo (2005)	They consider Cohen and Levinthal’s work; in order to make the measurement of factors, they study the firm’s communication with the external

		environment, know-how levels, expertise, diversity of the knowledge structure, and knowledge-positioning strategy.
	Lane, Koka, Pathak, Lane, and Thak (2006)	Ability of an organization to use knowledge from the external environment by means of 1) recognition and understanding of newly acquired knowledge, 2) assimilation through transformative learning, and 3) use assimilated knowledge to create new knowledge, as well as achieve commercial results through exploitation learning.
	Todorova & Duirisin (2007)	Firms recognize the value, acquire, transform or assimilate, and exploit knowledge.
	Arbussa & Coenders (2007)	They define two kinds of ACs: the capability to scan the external environment for new technology and the capability to integrate new external knowledge into the innovation processes.
	Fosfuri & Tribó (2008)	They reconceptualize ACs, taking into account potential AC theories. This work features the process that adjoins external knowledge inflow with innovative performance through potential AC.
	Rothaermel & Alexandre (2009)	The strategies favor AC and strengthen the capabilities for knowledge acquisition, transformation, and exploitation.
	Grimpe & Sofka (2009)	They use Cohen and Levinthal's definition for measurements; they confirm that the construct's measurement is not tangible. However, they use the same approach of these authors.
	Escribano, Fosfuri, and Tribó (2009)	They define AC as the individuals' abilities, within the organization, to assimilate, process, and then transform the flow of external knowledge.
2010	Schmidt (2010)	He refers mainly to knowledge exploitation. AC is studied separately. To this author, a firm that is able to exploit knowledge is also able to identify and assimilate new knowledge.
	Spithoven, Clarysse, Knockaert (2011):	To these authors, AC is a process for knowledge accumulation and development

	of new absorption capabilities, in which new routines are adopted and structures as well as organizational cultures are reorganized aiming to future commercialization.
Camisón & Forés (2010)	It is defined as a systematic and dynamic capacity that exists as two sub-groups of absorption capabilities: potential and realized.
Jiménez-Barrionuevo, García-Morales, and Molina (2010)	AC is a capacity developed by a firm based on a set of organizational routines and strategic processes, through which the firm acquires, assimilates, transforms, and exploits acquired knowledge from outside the organization, aiming to creating value. Yet, it is based on the definitions by Zahra and George, and Lane and Lubatkin.
Kostopulos *et al.* (2010)	AC is the capability to recognize the value of external knowledge, assimilate it, and exploit it for commercial ends.
Flatten, Engelen, Zahra, and Brettel (2011)	They work on the basis of Zahra and George's reconceptualization, who make a distinction between potential and realized CA.
Cepeda- Carrion, Cegarra-Navarro, and Jiménez-Jiménez (2012)	They focus on the distinction made by Zahra and George between potential and realized CA.
Engelen, Kube, Schmidt, and Flatten (2014)	They follow the studies developed by Zahra and George.
Enkel & Heil (2014)	They build on the reconceptualization made by Zahra and George.
Leal-Rodríguez, Ariza-Montes, Roldán, and Leal-Millán (2014)	It focuses on the suggestion made by Zahra and George on the four capabilities with two approaches: PACAP and RACAP.

Source: Authors.

Between 2000 and 2010, AC was conceived as a second-order construct with first-order variables such as (1) acquisition, (2) assimilation, (3) transformation, and (4) exploitation of knowledge at multiple levels, dimensions of the organization, and its environment.

3. Variables and dimensions of CA as construct

The state of art feature Cohen and Levinthal (1990) as seminal authors in regard to the new origins and conceptualization of AC. They consolidated a new construct with dimensions of unidimensional, bidimensional, and multidimensional orders. In this way, there is an enhancement of the collective capability to manage and exploit knowledge base, which leads to invigorate the innovating capacity. However, the literature evinces a different approach to AC, which is debated from a Dynamic Capabilities perspective (Helfat, Finkelstein, Mitchell, Peteraf, Singh, Teece, and Winter, 2007; Zollo & Winter, 2002). The origin of dynamic capabilities stems from organizational evolution theories (Nelson & Winter, 1982). These capabilities enable firms to respond to the changes within social and entrepreneurial environments. Thus, Zahra and George' proposal (2002) expand the analysis suggesting four organizational capabilities that support one another to generate AC. This is regarded as a dynamic capacity given its influence on the firm's capabilities to create and deploy the knowledge necessary to construct other organizational capabilities. These capabilities are called "variables" and include acquisition, assimilation, transformation, and exploitation of organizational knowledge. Such dimensions are grouped into two approaches: Potential Absorptive Capacity (PACAP) and Realized Absorptive Capacity (RACAP); both groups hold different strategic values for the firm.

The development, evolution, and adoption of the construct, its variables, approaches, and dimensions as featured by the authors in the field can be seen in the analytical table below (See Table 2).

Table 2. Conceptualizing Absorptive Capacity

Variables	Description	Approaches	Authors	Dimensions
Value **Assimilate** **Apply**	**Value**: The firm accounts for previous, basic knowledge. **Assimilate:** Internalize knowledge from external sources **Apply:** problem-solving capabilities		Cohen & Levinthal (1990) Lane & Lubatkin (1998)	Multidimensional
		Relative AC between organizations.	Lane & Lubatkin (1998)	Multidimensional
Acquire **Apply**	**Acquire:** Evaluate both knowledge usefulness and transfer capabilities between firms. **Apply:** Problem-solving capabilities.		Arbussa & Coenders (2007)	Bidimensional
	Acquire: Evaluate both knowledge usefulness and transfer capabilities between firms. **Assimilate:** Understand external knowledge through organizational routines.	Sub-dimension: Potential.		

Acquire **Assimilate** **Transform** **Exploit**	**Transform:** Link both previous dimensions to combine and accomplish new entrepreneurial opportunities. **Exploit:** Create new routines to generate knowledge, which results in new assets, systems, processes, etc.	Sub-dimension: Realized.	Zahra & George (2002) Jansen *et al* (2005), Volberda, Foss, and Lyles (2010)	Multidimensional

Source: Authors.

From the table above, we can evince that Zahra and George's (2002) work has led other authors (Jansen et al., 2005; Vega et al., 2007), on the one hand, to advance and deepen into studies around the organizational records that affect realized and potential absorptive capacities and, on the other hand, to work separately on both of these two capacities (Forfuri and Tribo, 2008; Gambardella and Giarratana, 2004). Other studies have worked on the effects of PACAP over a firm's openness to new changes of forms of knowledge (Liao, Welsch, and Stoica, 2003) and over innovating performance (Forfuri and Tribo, 2008).

4. Analysis levels of AC

More recently, AC has been analyzed at five levels: individual (Cohen and Levinthal, 1996), business units of group levels (Szulanski, 1996), organizational (Cohen and Levinthal, 1990); inter-organizatinoal (Giuliani, 2003; Giuliani and Bell, 2005); and within the national environment (Criscuolo and Narula, 2008; Dahlman and Nelson, 1995), as can be seen in Table 3.

Table 3. Analysis levels of AC

Level	Description	Authors
Individual	Organizations learn through individuals, because they are the core agents of learning and change. Perceptions and innovating ideas emerge from individuals, not from organizations themselves (Nonaka, Takeuchi, and Uemoto, 1996).	• Cohen & Levinthal (1990). • Deng, Doll, and Cao (2008).
Group	The whole organization is not the object of study, but its sub-systems, departments, or areas as independent, open, and dynamic units.	• María del Carmen Haro-Domínguez, Daniel Arias-Aranda, Francisco Javier Llorens-Montes, and Antonia Ruíz Moreno (2007). • Fabrizio (2009). • Yu-Shan Chen, Ming-Ji James Lin, and Ching-Hsun Chang (2009). • Roberts, Galluch, Dinger, and Grover (2012). • Schleimer and Pedersen (2013).
	This level has drawn great	• Cohen & Levinthal (1990). • Jansen *et al.* (2005). • Tu, Vonderembse, Ragu-Nathan, and Sharkey (2006).

Organizational	attention from researchers. It covers the whole organization including individuals, groups, departments, organizations, and institutions; it considered that that firms can learn from individuals.	• Park, Suh, and Yang, (2007). • Ingmar Björkman, Günter K. Stahl, and Eero Vaara (2007). • Murovec y Prodan (2009). • Camisón & Forés (2010). • Jiménez-Barrionuevo *et al.* (2011). • Biedenbach and Müller (2012). • Robertson, Casali, and Jacobson (2012). • Leal-Rodríguez *et al.* (2014). • Sánchez-Sellero, Rosell-Martínez, and García-Vasquez (2014). • Javalgi *et al.* (2014).
Inter organizacional	Knowledge is acquired from the firm via hiring of new staff or through alliances. This knowledge can be transferred tacitly, which leads an organization to make greater efforts, while knowledge assimilation periods for commercial purposes are also considerable (Van de Bosch et al., 2003).	• Nieto & Quevedo (2005). • Malhotra *et al.* (2005). • Arbussa & Coenders (2007). • Nooteboom, Van Haverbekeb, Duystersc, Gilsing, and Van den Oord (2007). • Fosfuri & Tribo (2008). • Zahra & Hayton (2008). • Schmidt (2010). • Rothaermel & Alexandre (2009). • De Jong & Freel (2010). • Hughes & Wareham (2010). • Spithoven *et al* (2011). • Flatten *et al.* (2011). • Lin, Wu, Chang, Wang, and Lee (2012). • Patel, Terjesen, and Li (2012). • Liu, Ke, Wei, and Hua (2013). • Sciascia, D'Oria, Bruni and Larrañeta (2014). • Hurmelinna-Laukkanen & Olander (2014). • Enkel & Heil (2014). • Chen, Qiao, and Lee (2014). • García-Morales, Bolívar-Ramos, and Martín-Rojas (2014). • Sánchez-Sellero *et al.* (2014).
National Environment (Country)	This analysis goes beyond the firm. In other words, the AC studies (an) industrial sector (s) of a nation, or various countries, in which one territory may benefit from other territory's knowledge.	• Criscuolo & Narula (2008). • Grimpe & Sofka (2009). • Kostopoulos *et al*. (2011). • Castellacci & Natera (2013). • Xia & Roper (2008).

Source: Authors.

5. Main AC factors

To the best of our knowledge, several external and internal factors can be evinced, which display possible determinants that affect AC. This multiplicity is owed to the fact that each author focuses on a different analysis level or, occasionally, to the data sets authors resort to for their analyses (Can den Bosch, 2003). All in all, external and internal factors are addressed for their explanations.

5.1 Internal factors

Internal factors are processes, activities, and procedures controlled by an organization in its management dynamics, which consider aspects as strategy, structure, technology, culture, and individuals. Such factors become the firm's knowledge base (See table 4).

Table 4. Internal factors

Internal factors	Description	Authors
Investment in R&D.	The higher the number of R&D activities, the higher will be the capabilities of staff to acquire and implement external knowledge (Cohen y Levinthal, 1990).	Cohen & Levinthal (1990); Murovec & Prodan (2009).
Knowledge level of the firm.	Previous knowledge is oriented towards individuals' knowledge units, for instance education, experience, training, and available dexterities within the organization. AC is the result of the accumulative nature of knowledge (Kim, 1998).	Cohen & Levinthal (1990); Zahra & George (2002); Lane *et al* (2006); Fosfuri & Tribo (2008).
Combinatory or relation capabilities.	1) Systemic capabilities: They are organizational procedures, policies, or routines that have rooted in the organization.	Van den Bosch, Volberda, and De Boer (1999); Jansen *et al*. (2005).
	2) Coordination capabilities: It suggests that experience within each of the complementary knowledge domains encourage exploratory learning and stimulate innovation.	
	3) Socialization capabilities: These refer to a firm's capacity to produce a shared ideology that promotes cooperation among its members. (Van den Bosch *et al*, 1999).	
Knowledge diversity of the firm	It refers to different perspectives to process newly acquired knowledge, which contributes to new alliances and promotes innovation (Cohen & Levinthal, 1990).	Cohen & Levinthal (1990); Lane & Lubatkin (1998)
Inovation culture	It refers to positive orientation of staff towards change as something natural and desirable. It permits that employees question (themselves) permanently about their own ways to improve performance, solve problems, and offer suggestions; this will contribute to higher innovation and learning capacity, thus leading to higher AC (Lenox & King, 2004)	Zahra & George (2002); Lane et al. (2006)
Strategic orientation.	Up to a certain level, learning capabilities are influenced by the organization's strategic position. Thanks to the strategies, goals, objectives, and actions can be defined for proper development (Miles, Snow, Meyer, and Coleman, 1978; Porter, 1981)	Cohen & Levinthal (1990); Van den Bosch et al. (1999); Lane et al. (2006)

Source: Authors.

In sum, we could affirm that the internal factors determining a firm's AC are centered in three essential elements that, if we consider an optimal knowledge base, articulate and join efforts to identify, assimilate, transform, and exploit knowledge at different levels and environments where the organization unfolds, and ultimately generate dynamic capabilities, not only supported on R&D, but on other capabilities such as commercial and operative ones.

5.2 External factors

External factors refer to the interaction between the agents and the environment in terms of knowledge and information exchange (Nonaka et al., 1996). Information may generate new capabilities that enhance a firm's AC. Although the external factors are necessary, they may deem insufficient to determine a firm's AC, in other words, it is crucial but not exclusive to develop this capacity, as we can see in Table 5.

Table 5. Internal factors

External Factors	Description	Authors
Environmental Turbulence	It refers to a firm's capacity for adaptation to the environment and to the changes in variables such as: consumers' preferences, new consumers, new products, market share size, technology, policies, and regulations. Turbulence generates threats within the environment. Then, it is expected that the organizations participating in these environments wish to continue obtaining competitive advantages, make knowledge acquisition, assimilation, and dissemination capabilities more dynamic on the basis of newly acquired external knowledge (Van den Bosch *et al*, 1999).	Van de Bosch *et al* (1999); Welsch & Stoica, (2003)
Technological opportunities	Scientific and technological knowledge advance at comparatively different speed rates and difficulty levels (Nieto & Quevedo, 2005). A certain growth related to technological opportunities, for instance those linked to the amount of information invested in R&D that reflects competitiveness growth of the firm, leads to a growth in incentives to generate higher AC of those organizations aiming to gain competitive advantages (Cohen and Levinthal, 1990). There is an indirect relationship between technological opportunity and the value of external knowledge. This means that the higher the presence of technological opportunities within sectors leads, the lower their effort to recognize the value of external knowledge.	Cohen y Levinthal, (1990); Nieto y Quevedo, (2005); Lichtenthaler y Lichtenthaler (2009).
Externalities or Spillovers	This refers to a knowledge mass that comes from specific efforts of firms. These firms must not exclusively own this knowledge. Thus, such knowledge must become public and other organizations can gain access to it at no extra cost in order to use it (Nieto y Quevedo, 2005). Partly, this is due to the power of patents in an industry	Cohen & Levinthal (1990); Zahra & George (2002); Nieto & Quevedo (2005); Jansen et al. (2005); Kostopoulos

	(Cohen & Levinthal, 1990).	et al. (2011).
Knowledge features of other Firms.	Tacit knowledge refers to knowledge derived from experience and the processes within organizational routines. It presents difficulties for transmission and codify in systematic and formal ways. When an organization presents higher degrees of tacit knowledge, certain barriers emerge, which make difficult both imitation and transmission processes. Organizations that look to absorb explicit knowledge (easily codifiable) will face acquisition and assimilation more adequately, thus leading to higher AC levels of this type of knowledge (Nonaka *et al,* 1994; Szulanzki, 1996).	Cohen & Levinthal (1990); Lane et al. (2006)
Cultural Diversity	Cultural diversity brings about different challenges since it includes cultural differences in terms of values, beliefs, languages, institutional heritage, business practices, among other variables. Several authors, including Lane and Lubatkin (1998), have pointed out that similarities between two firms in terms of capabilities, structural organization, and compensation practices will facilitate at a great extent knowledge transfer between them.	Lane y Lubatkin (1998); Lane et al. (2001)
Geographical diversity.	This factor represents another challenge for organizations implied AC processes. It involves cost and time increases that both organizations must consider for the establishment of contacts and information exchange. Indeed, telecommunication technologies have nuanced this issue. Yet, there are certain forms of knowledge that require face-to-face interaction and verbal communication (Szulanski, 1996).	(Szulanski, 1996).
Existence of external knowledge mechanisms	Sources of knowledge such as acquisitions, mergers, joint ventures, and inter-organizational relations enable organizations to absorb tacit knowledge more easily (Zahra & George, 2002). However, this works if two aspects are considered: the levels of investment in the internal development of a firm and the external knowledge that is captured (Lei & Hitt, 1995).	(Zahra & George, 2002); Lane & Lubatkin (1998); Arbussá & Coenders (2007); Fosfuri & Tribo (2008); Murovec & Prodan (2009); Escribano *et al.* (2009)
Position in the knowledge network.	This refers to the moves of the firm and the external entities within the value chain including suppliers, clients, competitors, universities, institutes, consulting agencies, among other entities. It is even necessary to consider subsidiaries, industrial communities, and enterprises located in specific geographical areas in which these entities act independently and have know-how flow, which in turn permits to minimize technological uncertainty (Nonaka et al., 1995).	Nonaka *et al* (1995).

Source: Authors.

We believe that it is important to clarify how, regarding externalities and spillovers, some authors as Veugelers (1997) intend to unveil that organizational access to knowledge is not cost-free since higher investment will be required by R&D departments due to the appropriation need for new external knowledge, as well as to the conservation or increase of their competitive advantage. In other words, the higher the externality level of the environment, the higher will be the firm's incentive to invest in its AC.

6. Measurements of AC

The studies reviewed reveal that researchers in their empirical work have implemented two approaches to AC: 1) a unidimensional approach, wherein the capacity is evaluated using a unique and simple measurement by means of proxy-variables whose nature varies from one study to other, or where bidimensional measurements reflect various aspects of the construct (Chen, Lin, and Chang, 2009); and 2) a multidimensional approach, which takes into account the theoretical basis of the construct and is considered to be as an improved alternative to the measurement that has been traditionally used.

We have evinced scarcity in studies following the second approach. This may be due to the difficulty generated by the implementation of a measurement method that helps differentiate the phases of the process (Murovec & Prodan, 2009). In general terms, few empirical studies seem to capture the robustness of the theoretical arguments and the multidimensional nature of the AC construct. Most of the quantitative studies employ non-structural variables or proxy variables, which hardly account for a standard measurement that permits the operational use of the construct. In order to "soften" such complexity, the empirical studies establish the concept as a unidimensional variable, as this variable may revolve around the accumulated knowledge available and link to the results of innovation efforts in the record of organizations. In other words, the most commonly used measurement is related to quantification of R&D expenditures over annual sales (Cohen & Levinthal, 1990; Tsai, 2001), patents, full-time research staff, R&D activities, number of publications, and implementation of new projects.

However, not all firms have an R&D department. Then, it is hard to estimate research expenditures in those firms lacking this department. These segmented measurements hardly reflect the dynamic possibilities of knowledge absorption capabilities and knowledge flow processes (Zahra and George, 2002). Consequently, dealing with this construct in this way would mean undervaluing the richness embedded in it (Jiménez-Barrionuevo et al., 2010).

It has been found that, beyond formal R&D, there exist other activities within organizations that contribute fundamentally to the firms' innovation capacity (Jansen et al, 2005; Vega & Jurado, 2008; Volberda et al., 2009). It is important to follow an approach oriented to a more dynamic capacity in order to support the growth and evolution of the AC construct. This should draw our attention over the structure, the policies, and the organizational processes that affect knowledge transference, exchange, the integration, and the creation of AC (Lane et al., 2006). According to the above, we have found that different multidimensional scales have been proposed in the last years (Comisón y Forés, 2010; Jansen et al, 2005; Jiménez-Barrionuevo et al., 2011, Liao et al, 2003). The proponents of these scales have in common the trend of Zahra and George's (2002) work, who have reconceptualized the construct aiming to contribute to the weakness found in the unidimensional measurements.

In this sense, Jansen et al. (2005) used the distinction between Potential AC and Realized AC to study the organizational antecedents, which are linked to AC components. The measurement proposed by these authors derives from the subcomponents of the Potential AC that could be empirically applied. Based on these contributions, Camisón and Forés (2010) have been able to develop a 16-item AC scale taking into account a firm's antecedents and components. Jiménez-Barrionuevo et al. (2011) measured the concept using internal factors, which resulted in an 18-item scale. Other measurements have been adopted such as the ones related to the HR

department (Murovec and Prodan, 2009; Flatten et al, 2011) and the Quality and Information Management departments, since they constitute the models and systems that the enterprise has designed and implemented in its organizational design (Forés Julián y Camisón Zornoza, 2008). Other authors argue for the organizational structure of the firm, being this functional, divisional, or matrix. This is a departure point for knowledge exploitation, which certainly has to do with the importance of change resistance and awareness (Van den Bosch et al., 1999). Zahra and George (2002) consider external factors such as alliances, joint ventures and acquisitions as other mechanisms to quantify the absorptive capabilities of firms.

Table 6. Quantifying the AC construct

Authors	Constructing AC variables	Dimensions	Methodology
Jansen *et al*. (2005).	Based on the dimensions defined by Zahra and George (2002) and a proposed scale (as proposed by Cohen and Levinthal, 1990), Szulanski's work measured AC as the firm's R&D intensity (which is defined as R&D expenditures divided by annual sales).	Multidimensional	Confirmatory factorial analysis
Nieto & Quevedo (2005)	The authors follow the scale proposed by Szulanski (based on Cohen and Levinthal, 1990). In fact, Szulanski measured AC as the firm's R&D intensity. Furthermore, Fiol and Lyles (1985) had already highlighted the importance of an organization' strategic position.	Multidimensional	Multiple regression model
Arbussà & Coenders (2007)	The construct is formed by a group of variables to measure two types of capabilities: scan and integrate.	Bidimensional	Mixed logit model
Escribano *et al*, (2009).	This is a construct of four dimensions: Internal R&D expenditures, permanent R&D, staff training in R&D, and the scientific staff ratio.	Multidimensional	Modelo Logit
Kostopoulos *et al*, (2011).			Trajectory model
Murovec & Prodan (2009).	Bidimensional construct according to the data source (research and market).	Bidimensional	Structural equations model
Grimpe & Sofjka (2009).	R&D expenditures and employees' experience.	Bidimensional	Tobit regression and Latent class regression analysis
Rothaermel & Alexandre	Following Cohen and Levinthal (1990), Stock, Greis, and Fisher, (2001); (Zahra y	Unidimensional	Regression

(2009)	Hayton, 2008); Efforts, or intensity, in R&D (R&D expenditures divided by annual sales).		model
Camisón & Forés (2010)	Following Zahra and George (2002), these authors define AC as construct with multiple items for each dimension: PACAP and RACAP. They consider R&D expenditures, to measure knowledge acquisition capabilities, and the number of patents, to measure knowledge application capabilities.	Multidimensional	Confirmatory factorial analysis
Liu *et al* (2013)			Confirmatory factorial analysis and Structural Equations Model.

Source: Authors.

7. Conclusion and future research territories

This study addressed relevant aspects of the literature in the field of AC over a period of ten years, between 2005 and 2014, considering the contributions made by the seminal works of Cohen and Levinthal (1990) and Zahra and George (2002). These have opened the path to several theoretical and empirical studies that have made meaningful contributions to the development and evolution of the first and second-order constructs of AC, to the establishment internal and external factors that help determine AC, and to the strengthening of the analysis methods and models around AC in relation to other constructs; these have provided more holistic and integrative approximations, analyses, and explanations to the phenomenon.

In fact, we could affirm that the notion of AC can be conceived as a general variable since it is a valuable construct for any organization, which in turn influences significantly the performance of the firm and its dynamics with and within the environment. Similarly, AC is determined, up to a great extent, by internal and external factors that also affect reciprocally the generation of organizational and institutional capabilities. According to the above, academics and experts in the field have realized the need for establishing more complex relationships in order to analyze and explain this dynamic capacity on the inside and the outside of an organization, which in turn accounts for a firm’s entrepreneurial, sectorial, regional, and national competitiveness. In this sense, we could claim that as long as firms possess capabilities to absorb and assimilate new external knowledge, it is essential for them that, in present and future environments, competitiveness focused on knowledge created and apprehended from the environment.

However, the construct still denotes some theoretical and empirical gaps given its accelerated reproduction and application to different contexts and theoretical perspectives. On the one hand, this situation has not facilitated reaching consensus with respect to a methodological basis that contributes to a conceptual consolidation accepted by the scientific community in the field. On the other hand, this situation has also made difficult the comparison and diffusion of the results stemming from studies in particular contexts (Lane et al., 2006).

This situation implies the need for understanding how knowledge is transferred from outside the organization to its inside and, once there, how it can be submitted to different actions or processes at distinct levels and dimensions that allow for adapting its properties and uses to the organizational needs of the very firm. In other words, it is necessary that organizational routines and processes, which constitute the AC, be identified and developed intentionally and deliberately using an approach featured as strategic, structural, process-based, while considering the organizational culture and the inter-organizational features (Lewin et al., 2011). Furthermore, it is necessary to establish organizational and technological systems that allow for deploying and functioning strategies for recodification and adaptation to newly acquired knowledge that has been assimilated by the staff within the organization. Systems and information technologies will help, partly, to give sustain to the organization, while generating and maintaining competitive advantages.

Notwithstanding, it is required to look at the implications that the individual level has over a firm's AC. This level has been questioned by academics in the field given its scarce presence in the literature. In spite of this, the individual level draws attention given its recognition as a major agent of change and innovation within organizations. Therefore, it requires further studies from rational, emotional, and behavioral perspectives to understand the organizational culture as a factor that probably influences the AC of firms (Nonaka et al., 1994).

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1. Full Professor, Business School, CEIPA Foundations University, Medellin, Colombia. PhD. in Management, EAFIT University, Medellín, Colombia. Researcher of ORYGEN group. E-mail: geovanny.perdomo@ceipa.edu.co

2. Professor & Researcher, Faculty of Economic Sciences, Universidad de Antioquia, Medellín, Colombia. Doctoral student, University of Valencia, Spain. Coordinator research group GESTOR, E-mail: nelson.lozada@udea.edu.co

3. PhD in scientific perspectives on tourism and management of tourism companies. Researcher Professor, Universidad de San Buenaventura, Cali, Colombia. E-mail: azuniga01@usbcali.edu.co

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Revista ESPACIOS. ISSN 0798 1015
Vol. 38 (Nº 36) Año 2017

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