

Tangible Resources and Integration Capabilities as Determinants of Knowledge Creation Capabilities¹

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Abstract

Firms on the market may differ in their capabilities to transform and exploit knowledge, which may cause a differential effect on profits, urging companies to explore diverse pathways from their resources and capabilities base to performance improvements. This article suggests that tangible resources and knowledge integration capabilities as determinants of knowledge creation. This path enables the emergence of new capabilities, helps build competitive advantages and improves the economic performance of firms. We worked with quantitative data made up of 2,093 Colombian manufacturing companies and ran multiple linear regressions to test our hypothesis. The results suggest that tangible resources are critical precursors of knowledge creation, highlighting the importance of assets and human management processes within firms. We also found evidence to endorse the integration of knowledge capabilities because they influence the ability of firms to exploit knowledge. Finally, we found that the reconfiguration capability influences knowledge creation within firms. Our findings support the role of organizational leaders in managing transformation processes by effectively combining these resources and capabilities to bring about new knowledge and exploit it for profit generation.

Keywords: Absorptive capability; marketing capability; reconfiguration capability; tangible assets; knowledge creation.

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Recursos tangibles y capacidades de integración como determinantes de las capacidades de creación de conocimiento

Resumen

Las empresas en el mercado pueden diferir en sus capacidades para transformar y explotar el conocimiento, lo que puede causar un efecto diferencial en las ganancias, instándolas a que exploren en diversas vías para pasar de su base de recursos y capacidades a mejoras reales en su desempeño. Considerando lo anterior, este artículo sugiere que los recursos tangibles y las capacidades de integración del conocimiento son determinantes de la creación de conocimiento. Este camino permite la aparición de nuevas capacidades, ayuda a generar ventajas competitivas y mejora el desempeño económico de las empresas. La investigación incluye datos cuantitativos de 2093 empresas manufactureras colombianas, con los cuales se realizaron múltiples regresiones lineales que permitieron contrastar las hipótesis. Los resultados indican que los recursos tangibles son precursores clave de la creación de conocimiento, lo que destaca la importancia de ambos: los activos y los procesos de gestión humana dentro de las empresas. También se encontró evidencia para respaldar la integración de las capacidades del conocimiento, ya que influyen en la capacidad de las empresas para explotar el mismo conocimiento. Finalmente, se demostró que la capacidad de reconfiguración influye en la creación de conocimiento dentro de las empresas. Los hallazgos respaldan el papel de los líderes organizacionales en la gestión de los procesos de transformación mediante la combinación efectiva de estos recursos y las capacidades para generar nuevos conocimientos y explotarlos para generar ganancias.

Palabras clave: capacidad de absorción; capacidad de marketing; capacidad de reconfiguración; recursos tangibles; creación de conocimiento.

1. Introduction

Absorptive Capabilities (AC) are considered of high relevance for organizations, given their role in the creation of knowledge and the development of competitive advantages within dynamic environments (Eisenhardt & Martin, 2000; Garzón-Castrillón, 2016; Cruz-González *et al.*, 2009; Jansen *et al.*, 2005; Olea-Miranda *et al.*, 2016; Schreyödd & Kliesch-Eberl, 2007; Wang & Ahmed, 2007; Zahra & George, 2002). This relevance is supported by AC's competitive benefits to companies (Ebers & Maurer, 2014; Jansen *et al.*, 2005). The literature supports that AC positively affects corporate performance, given its association with knowledge creation (Ebers & Maurer, 2014; Lane *et al.*, 2001; Tsai, 2001).

In this sense, CEOs and leaders of organizations might be interested in discovering ways to acquire and boost these AC from the side of organizations. This paper is relevant since it aids in solving an eternal question from practitioners' perspective of: how do we contribute to

increasing a firm's performance? We present paths that allow firms to get to AC and, therefore, knowledge creation processes, which become increasingly important over time in terms of competitiveness.

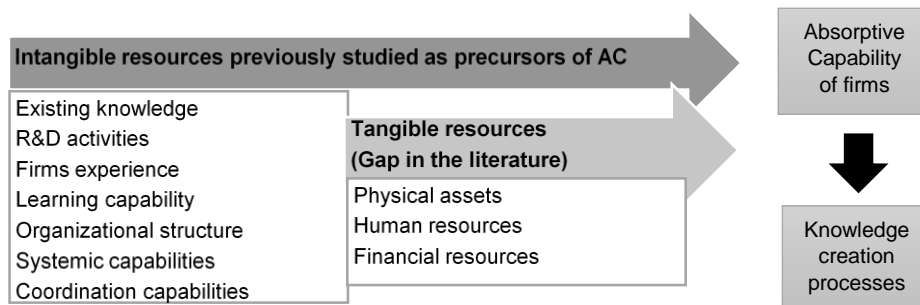
Given the importance of AC, previous researchers have tried to deepen its precursors, considering this capability as a unidimensional construct, whose most popular measure is R&D spending (Zahra & Hayton, 2008), identifying both: internal and external factors as precursors. Among internal ones, there have been identified: Investment in R&D, organizational knowledge, experience in the company, the culture of innovation and learning, qualified workforce, strategic orientation, financial resources, formalization, relationship skills, and social integration mechanisms, among others. External precursors of AC may include competitiveness of the environment, diversity, position in the knowledge network, and mergers and acquisitions, among others (Camisón & Forés, 2014; Kamien & Zang, 2000; Vinding, 2006; Mowery *et al.*, 1996; Torres-Barreto, Mendez-Duron, & Hernandez-Perlines, 2016; Vega-Jurado *et al.*, 2008).

Other studies have analyzed AC as a multi-dimensional construct, suggesting that companies who develop AC differ in performance due to their multi-dimensional characteristics (Fosfuri & Tribó, 2008; Jansen *et al.*, 2005). Indeed (Ebers & Maurer, 2014) demonstrated that absorptive capacity emerges as the unintended consequence of organizational boundary spanners' external and internal relational embeddedness. That relational empowerment of the staff and the amount of training they receive increase the capacity to transform and exploit the externally acquired knowledge (AC). Consequently, using diverse dimensions of AC may determine superior performance (Jansen *et al.*, 2005; Zahra & George, 2002), which is reinforced within this paper.

According to the mentioned in some studies, it is considered that the fundamental input of AC is information. Its output is knowledge since this implies the acquisition of information, which goes through a process of assimilation and transformation into knowledge that finally will be exploited (Rodríguez-Albor *et al.*, 2017; Teece *et al.*, 1997; Zollo & Winter, 2002).

Hence, the frequently studied drivers or determinants of CA are related to intangible resources and some types of capabilities, such as organizational experience, prior knowledge and R&D activities (Cohen & Levinthal, 1990), firm’s organization form (Van den Bosch *et al.*, 1999); systemic, coordination and socialization capabilities (Garzón-Castrillón, 2016; Jansen *et al.*, 2005), learning capabilities (Zahra & George, 2002), and staff skills and capabilities (Dyer & Singh, 1998; Garzón-Castrillón, 2016; Kim, 1998; Minbaeva *et al.*, 2003; Murovec & Prodan, 2009). Nevertheless, there is a lack of research on the role of tangible resources (particularly physical, human, and financial) in the development of AC (see Figure 1).

Figure 1. Previous research on AC, precursors, and literature gaps



Source: Own elaboration.

In this study, we focus on specific tangible resources (physical and human) and a subset of dynamic capabilities (absorptive, marketing, and reconfiguration). This selection is intended to illustrate the significance of these less-studied elements and reconstruct the path from dynamic capabilities with tangible resources to absorptive capabilities of firms and consequently to knowledge creation.

The article is organized into four segments: The first presents the theoretical fundamentals of the absorptive capability: Marketing and reconfiguration, and its relationship with knowledge creation, its dimensions (potential and realized), and precursors; as well as the relevance of two types of dynamic capabilities: marketing and reconfiguration, and their role as capabilities that integrate knowledge. The second is the relevance of tangible resources as physical, financial, and human in studying firms’ performance. In the third, we present the

theoretical construct and research hypothesis are presented that expose that companies can generate knowledge creation capabilities and, consequently, obtain a competitive advantage when they combine their tangible resources base with a set of integration capacities knowledge. Finally, the applied methodology and the definition of the study variables are described, followed by the results obtained from the relationships between the defined variables, based on mathematical models, and the conclusions of the research results.

2. Dynamic capabilities

The origins of dynamic capabilities (DC) can be traced back to the works of Teece & Pisano (1994) and Teece *et al.* (1997). They intended to improve the explanatory capability of the Resource-Based View of the firm (RBV) by explaining the differences in the performance of the companies and the sustainability of firms' competitive advantages in highly dynamic environments (Eisenhardt & Martin, 2000; Vivas-López, 2013; Wang & Ahmed, 2007). A deeper understanding of the RBV includes DC as a set of specific, identifiable, strategic, and organizational processes that facilitate the integration, construction, and reconfiguration of both: internal and external competencies in organizations. They allow firms to adapt to the dynamic environment (Miranda, 2015; Teece *et al.*, 1997; Torres-Barreto, Martínez, Meza-Ariza, & Molina, 2016) and to achieve competitive advantage by implementing fresh value-creating strategies that cannot be easily duplicated by competing firms (Eisenhardt & Martin, 2000).

The competitive advantage of firms arises from the organizational and strategic routines (DC) by which managers alter their resource base to generate new value-creating strategies (Grant, 1996). As such, DCs are the drivers behind the creation, evolution, and recombination of other resources into new sources of competitive advantage (Eisenhardt & Martin, 2000). Researchers have suggested that the central point of DC is its potential to integrate and generate knowledge (Helfat *et al.*, 2007; Ray *et al.*, 2004; Teece & Pisano, 1994; Wang & Ahmed, 2007), suggesting a path-dependence between them.

This is well illustrated, for example, when it comes to learning curves or repeated practices, where DC plays a role in the organizational routines by which firms achieve new resources configuration and accumulates tacit and explicit knowledge about how to execute a task and by doing so, achieve superior performance using its dynamic capabilities (Eisenhardt & Martin, 2000).

2.1. The absorptive capability: potential and realized

Absorptive Capability (AC) is a dynamic capability that refers to a firm's ability to value, assimilate, and utilize new external knowledge (Lane & Lubatkin, 1998). This ability is inherent to each firm, and each may develop such ability at different levels as it deals with its capacity to acquire external information, assimilate it and exploit it (Cohen & Levinthal, 1990). AC has been studied from the empirical and theoretical perspectives (Camisón & Forés, 2014) and occurs through a process of exploration, assimilation, and exploitation (Picaud-Bello, Johnsen & Calvi, 2022). Its implications have been considered in several fields, including engineering, management, and healthcare (Lane & Lubatkin, 1998; Minbaeva *et al.*, 2003; Tsai, 2001; Zahra & George, 2002). For Mowery & Oxley (1995), the AC is understood as the ability to manage the tacit component of transferred knowledge and to modify imported knowledge.

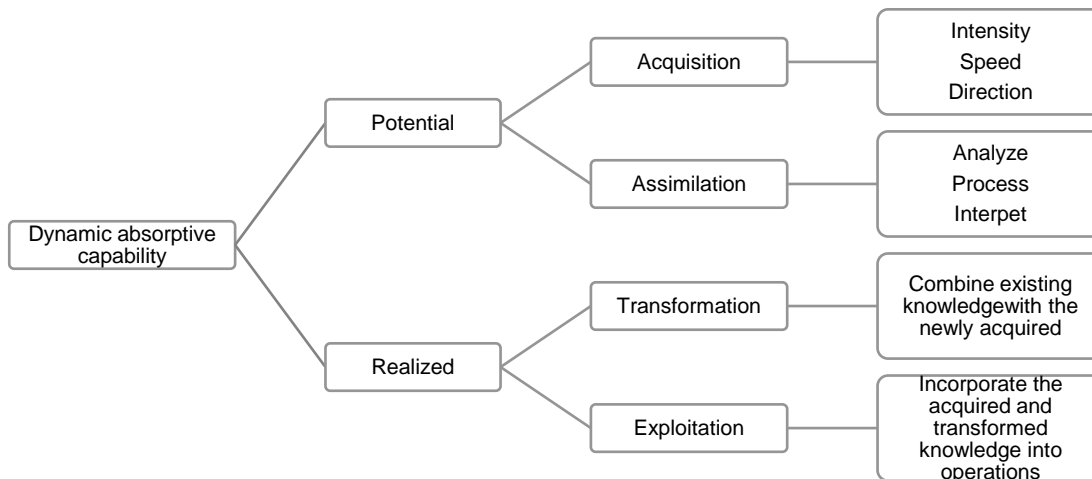
On the other hand, Kim (1998) describes it as the capability to learn, solve problems, assimilate external knowledge, and create new knowledge. Other authors characterize AC as recognizing the value of newly acquired external knowledge, assimilating it, and exploiting it for commercial purposes. AC also entails using the acquired knowledge to develop new capabilities (Deeds *et al.*, 2000; Todorova & Durisin, 2007; Van den Bosch *et al.*, 2003).

The work by Zahra & George (2002) acknowledges the term as a multidimensional construct, a set of routines and processes through which companies acquire, assimilate, transform, and exploit the external knowledge to foster the firm's ability to develop and sustain competitive advantages. Given its multidimensional characteristics, various dimensions for AC have been labeled. They include the identification, assimilation, and exploitation of knowledge (Cohen

& Levinthal, 1990; Mowery & Oxley, 1995); the valuation, assimilation, and application of it (Dyer & Singh, 1998; Lane & Lubatkin, 1998; Todorova & Durisin, 2007), and its efficiency and flexibility (Van den Bosch *et al.*, 1999). Despite the absence of a common dimensionality, the construct by Zahra & George (2002) is one of the most accepted by researchers and academics. They classify AC into two great dimensions: potential and realized (See Figure 2).

The potential absorptive capability (PAC) refers to the ability of a company to identify, acquire, and import the most relevant external knowledge (Lane & Lubatkin, 1998; Liao *et al.*, 2003; Rodríguez *et al.*, 2017; Zahra & George, 2002), and the ability to assimilate, interpret, understand, and process it (Camisón & Forés, 2010; Szulanski, 1996; Zahra & George, 2002). The PAC allows the company to connect with the environment and continuously renew its knowledge base (Volberda *et al.*, 2010).

Figure 2. The absorptive capabilities classification



Source. Own elaboration according to Zahra & George (2002).

The realized absorptive capability (RAC), on its side, refers to the firm's ability to: (1) Transform knowledge: internal processes and routines that ease the interpretation, transfer, and combination of the existing knowledge with the newly acquired knowledge (Camisón & Forés, 2010; Cohen & Levinthal, 1990; Poh-Lin, 2009; Zahra & George, 2002), and (2) Exploit knowledge: by using it to transform knowledge into operations (Jansen *et al.*, 2005; Zahra & George, 2002), as well as for commercial purposes (Jansen *et al.*, 2005; Szulanski, 1996).

Thus, from a capability-based perspective, the transformation or the exploitation of knowledge are essential to aid firm growth since they facilitate innovation and sustainable competitive advantages (Flor-Peris *et al.*, 2011). Whether the firm's capabilities transform or exploit knowledge, they provide adequate and timely access to corporate and external knowledge (strategic, tactical, and operational). They also provide the human resources of companies with specialized skills and experience, turning them into a knowledge community of practice. Without any doubt, RAC enables knowledge-based decision-making at all levels, which improves the quality and timeliness of the decisions made within the firm and provides it with short-term benefits through the exploitation of knowledge (Jansen *et al.*, 2005; Poh-Lin, 2009; Volberda *et al.*, 2010).

PAC and RAC have been studied separately due to their structural differences. The cooperation in research and development, the acquisition of knowledge, and the coordination capability have been identified as determinants of the PAC (Fosfuri & Tribó, 2008), while some recognized determinants of the RAC are socialization and the systemic capabilities (Jansen *et al.*, 2005). Nevertheless, not much attention has been given to the study of RAC (Volberda *et al.*, 2010), regardless of its importance as the primary source of knowledge integration and generation and consequently as a determinant of higher organizational performance (Leal-Rodríguez *et al.*, 2014).

2.2. The marketing capability

The marketing capability (MC) is a dynamic capability that defines the ability of a company to collect, trade, and disclose market information throughout the whole organization (Inan & Kop, 2018; Ripollés & Blesa, 2012). MC is the outcome of an integration process designed to apply the collective knowledge, commercial strategy, and organizational structure to the business needs related to the market (Day, 1994). Therefore, it signifies a relevant factor for competitive advantage since it increases the ability to discover and exploit market opportunities (Rodrigo-Alarcón *et al.*, 2013).

This capability also has can evaluate new markets, help firms better understand their changes, and identify those that would allow the company to operate efficiently (Day, 1994; Ripollés & Blesa, 2012). Doing so contributes to establishing relationships with new markets, growing distribution channels, and generating advertisement strategies (Danneels, 2002), facilitating the assimilation of market knowledge into internal processes (Ripollés & Blesa, 2012). The pronounced benefits enable companies to exploit their technologies and knowledge across different markets (Rodrigo-Alarcón *et al.*, 2013; Day, 1994).

A singular aspect of this capability is that it is based on knowledge integration and is decisive in developing new products, turning out into a key factor for a sustainable performance strategy (Inan & Kop, 2018; Shan *et al.*, 2014). Therefore, the lack of this capability might restrict the renewal of other resources and capabilities (Danneels, 2002).

2.3 The reconfiguration capability

The reconfiguration capability (RC) is considered a fundamental dynamic capability (Teece & Pisano, 1994). It involves the combination of the existing knowledge to develop new corporate applications and innovations (Eriksson, 2014; Grant, 1996; Hawass, 2010), and it differs from the previous mentioned “transformation capability” in that “reconfiguration” is not related to integrate newly acquired knowledge, but to reshape the existing one. It refers to the ability to transform and recombine existing processes, organizational structures, competencies, and knowledge necessary to maintain an evolutionary aptitude within the organization (Ambrosini & Bowman, 2009).

While the transformation capability deals with adding new knowledge to the organization and combining different sets of existing information to arrive at a new schema, reconfiguration relates to reshaping existing processes. It allows companies to react to market changes (Escandón *et al.*, 2013). Karim (2006) states that companies that reconfigure their business units can recombine their current resources and successfully adapt to the business environment changes. Reconfiguration is necessary for those scenarios where the existing capabilities make the organizational structures inefficient (Eriksson, 2014).

Moreover, the capability to reconfigure business influences the firm's ability to innovate (Hawass, 2010) and detect new opportunities (Eriksson, 2014) which are profitable and allow sustainable growth (Teece, 2007); hence, its importance.

At this point, we want to distinguish between a group of dynamic capabilities associated with the integration of knowledge, and another group, linked to knowledge creation. Reconfiguration capabilities belong to the integration-of-knowledge category since they enable the firm to renovate and recombine existing processes, routines, and knowledge. Marketing capabilities also belong to this group since they facilitate the assimilation of market knowledge and its utilization across different markets. However, they are not directly related to the creation of knowledge itself. The transformation capability is compulsory and related to creating new knowledge for innovation (Kim, 1998) is a mechanism that changes the character of knowledge through bisociation (Zahra & George, 2002), which occurs when firms recognize two incongruous sets of information and then combine them to arrive at new information.

3. The role of tangible assets

The RBV considers tangible assets as a set of elements with physical nature. They are identifiable and measurable (Blázquez & Mondino, 2012; Huerta *et al.*, 2004). They have the potential to generate higher earnings when the owned asset: is specific to the company, has a distinctive characteristic, or is unique and may not be transferred (Herzog, 2001). A common taxonomy includes a) Physical assets, such as machines, furniture (Barney, 1991), vehicles, buildings, raw materials, geographical location (Blázquez & Mondino, 2012; Grant, 1991), and production technologies (Navas & Guerras, 2002); b) Financial assets, such as cash, credits, investments, and financing sources (Amit & Schoemaker, 1993; Barney, 1991; Barney & Arkan, 2005; Grant, 1991), and c) Human resources, associated to skilled workers (Blázquez & Mondino, 2012; Ismail *et al.*, 2012; Rangone, 1999; Zahra & Dass, 1993).

Despite the abovementioned, the extant theory has largely left tangible resources as unstudied antecedents, thereby neglecting potential insights into how capabilities develop

from the resources themselves (Schriber & Löwstedt, 2015) and, in this way, limiting the theoretical understanding of capabilities development. We believe that a path to improve the economic performance of firms must include a well-structured set of capabilities, together with a carefully elaborated base of resources.

4. Hypothesis and research model

Literature supports that firms' capabilities emerge from the interaction between the resources and other capabilities (Alvarez-Melgarejo & Torres-Barreto, 2018; Amit & Schoemaker, 1993; D'Adderio, 2011; Zahra *et al.*, 2006). Likewise, resources in isolation do not generate any advantage for a company if it is not structured to adequately exploit them and utilize their value (through specific routines or organizational capabilities). Moreover, according to RVB, if tangible assets match any of the VRIO characteristics (valuable, rare, inimitable, organized), they not only have the potential to create competitive advantages for firms but also enable the creation of new capabilities (Herzog, 2001).

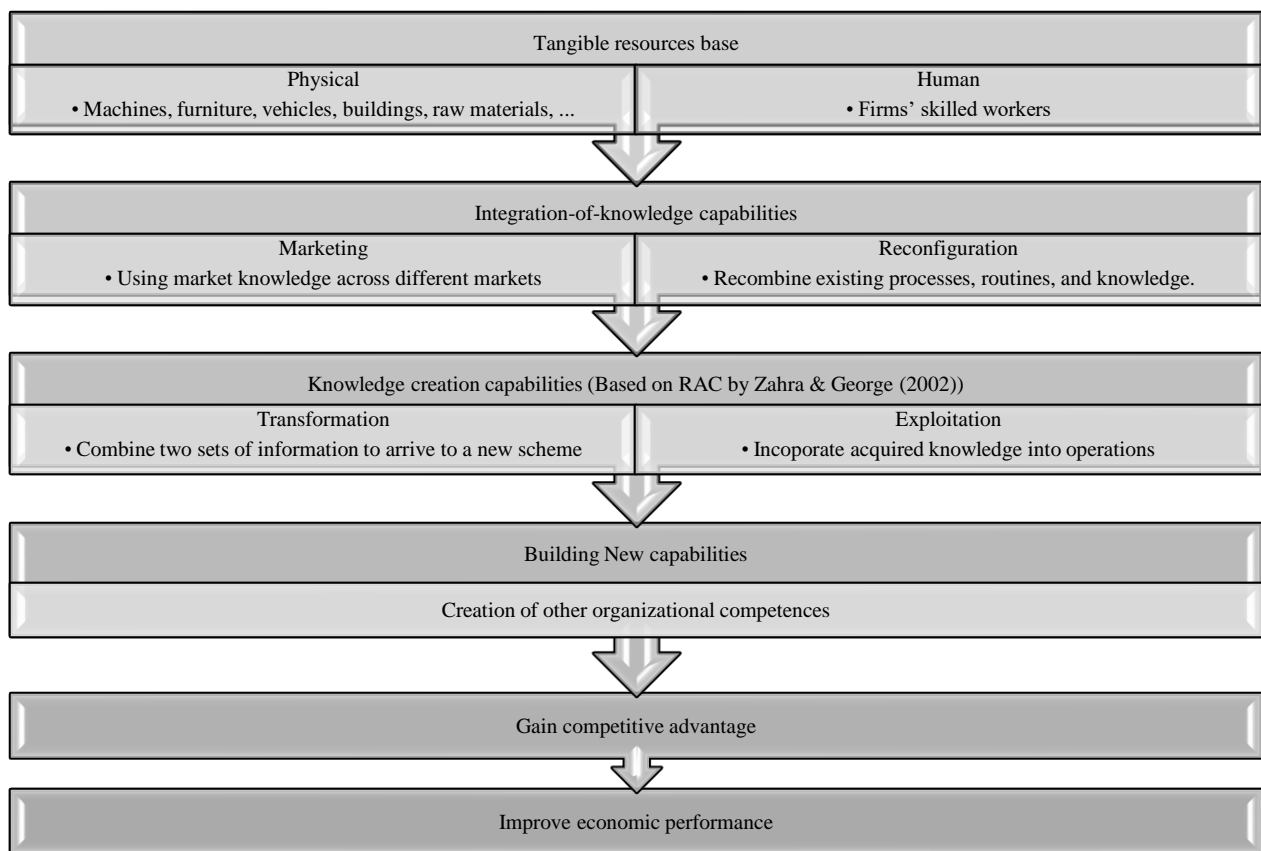
Nevertheless, research has focused on certain types of resources as antecedents of capabilities because they are intangible (Grant, 1996; Teece *et al.*, 1997). However, given that tangible resources are recognized as indispensable aspects of the context in which organizational activities occur (Reed, 2005), ignoring these resources means bypassing a potentially significant factor when accounting for how routines develop (D'Adderio, 2011; Schriber & Löwstedt, 2015).

Our specific interest is the study of physical and human resources, since the former may support the processing and use of information while the latter facilitates the integration of information obtained from external sources (Castro *et al.*, 2009; Lache *et al.*, 2016; Minbaeva *et al.*, 2003).

More specifically, we want to propose a path for organizational change that goes from a base of tangible resources and some capabilities, to knowledge creation processes. This path will allow firms to grow new capabilities from their previous and mature resources and capabilities. It will enable organizations to gain competitive advantages and improve

economic performance over time. Figure 3 shows our proposed pathway to gain a competitive advantage and improve organizational performance. It does not restrict the existence of parallel paths or constructs. Here, as described by many authors, realized absorptive capabilities are represented by “the transformation and exploitation capabilities,” so influential on firm’s results.

Figure 3. A proposed path from tangible resources and dynamic capabilities, to improvements in economic performance of firms



Source. Own elaboration.

We included the integration-of-knowledge capabilities in our proposed pathway: marketing and reconfiguration capabilities. They both encourage firms to perform actions that potentially produce significant changes in companies. Marketing capabilities, for example, aid organizations in sensing and responding to market changes such as competitors’ moves

or technological evolution. Meanwhile, reconfiguration capability represents the common skills needed to develop new capabilities, the power to combine recently created or obtained capabilities, and the self-reliance within those particular circumstances (Wogwu & Hamilton, 2018).

Considering that the RAC is determined by the appropriation and application of knowledge in the market in which it operates and by modifying of its internal processes, these two capabilities are of our particular interest. Still, literature that explores the influence of marketing and reconfiguration capabilities in the development of the RAC, and more precisely, in the development of transformation capabilities, is rare (Lin & Wu, 2014). This contrasts with their potential to aid firms' growth.

Grounded in these arguments, we intend to contribute to greater clarity about the domain and operationalization of paths conducting to a firm's improvement in performance. For that purpose, we start by highlighting the significance of tangible resources, as well as certain dynamic capabilities, as key factors in generating realized absorptive capabilities in firms by expressing that:

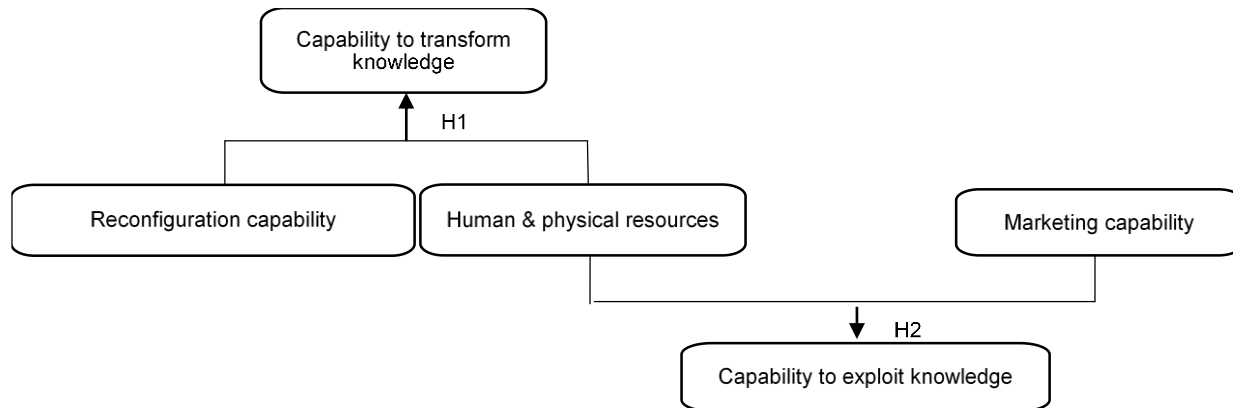
H1: Firms that combine their tangible resource base with a set of integration-of-knowledge capabilities, can generate knowledge-creation capabilities and consequently, gain competitive advantage.

H 1.1: Firms that combine human and physical resources with a reconfiguration capability, will be able to create knowledge by means of a transformation capability.

H 1.2: Firms that combine human and physical resources with marketing capabilities, will be able to create knowledge by means of an exploitation capability.

The construct of this research study is presented in figure 4.

Figure 4. Research construct



Source. Own elaboration.

5. Methodology

5.1. Data Collection

This study employs a Colombian census survey (EDIT Industria VII) with anonymized microdata; EDIT contains strategic technological information, as well as R&D activities of Colombian industrial firms. Following Oslo Manual recommendations, EDIT's primary statistical analysis unit is the firm. The survey covers 53 industrial activities according to the International Standard Industrial Classification of All Economic Activities (CIIU) and contains 590 variables. The data is collected biannually by the Colombian National Administrative Agency for Statistics (DANE). EDIT targets Colombian manufacturing companies with ten or more employees (DANE, 2015) and has been widely used by researchers due to the valuable information and its credibility (González-Campo & Hurtado-Ayala, 2014; Hurtado-Ayala & Gonzalez-Campo, 2015; Torres-Barreto & Antolinez, 2017).

5.2. Variables and sampling

To ensure the rationality of the study, we performed the sampling in three steps. In the first step, we compiled a subset of 112 proxy variables linked to tangible resources and realized absorptive capabilities. In the second step, we established inclusion and exclusion criteria. This allowed us to perform a transversal analysis with 2,093 firms and 55 variables of the study. The inclusion criteria include temporal characteristics (year =2014) and variables related to resources or capabilities previously identified in the extant literature, while the exclusion criteria omitted firms that reported a “null” value in any 52 selected variables. In the third step, we looked for data entry errors, misspellings, or contradictory values and filtered redundant variables that EDIT uses to verify firms’ answer reliability. Dependent variables

To find the determinants of realized absorptive capabilities, we assume Zahra & George’s (2002) dimensions of RAC: transformation and exploitation capabilities. Those two dimensions represented knowledge creation capabilities and were selected as our dependent variables.

Our proposal consists of a path dependency route to discover specific determinants of RAC. Prior studies draw attention to the lack of adequate scales to assess it (Jansen *et al.*, 2005) and state that a valid measurement that incorporates the diverse dimensions of this capability has not been studied (Flatten *et al.*, 2011; Van den Bosch *et al.*, 2003; Wang & Ahmed, 2007; Zahra & George, 2002). In this research, we proxied the transformation capability by the firms’ investment in consulting and technical assistance (INVASISTEC). We propose that institutional strengthening and capacity building for business knowledge generation can be reached through technical and consulting assistance. It may help firms add or select knowledge or interpret it differently, contributing to building a transformation capability, as proposed by Zahra & George (2002).

This proxy variable is similar to what Mowery & Oxley (1995) and Szulanski (1996) proposed. In this sense, we followed prior research that links the capability to transform

knowledge to the firms' ability to process and combine information (Flatten *et al.*, 2011), which leads to the construction of new cognitive structures (González-Campo & Hurtado-Ayala, 2014; Flor-Peris *et al.*, 2011).

We proxied exploitation capability by the number of new goods and services the company introduced to the market (BSMDO) as proposed by Zahra & George (2002). Although these capabilities have some commonalities across different firms, there are specific ways in which firms pursue, develop, and use them. Exploitation capability represents the integration of knowledge into the company's operations (Flatten *et al.*, 2011; González-Campo & Hurtado-Ayala, 2014; Flor-Peris *et al.*, 2011) and its application. The effects of exploitation routines or abilities are the persistent creation of new goods, systems, processes, knowledge, or new organizational forms (Spender, 1996). Those reasons supported our selection of the dependent variable BSDMO.

5.2.1. Independent variables.

Following our theoretical construct, physical and human resources were chosen as the tangible resources to include in the study. In the case of physical resources, we worked with the "firm's investment in machinery and equipment" (MACHINE) and the "firm's investment in communication and information technologies" (ICT) since they embody the assets which are controlled by the company and necessary to carry out their economic activity (Barney, 1991; McKelvie & Davidsson, 2009; Navas & Guerras, 2002).

To study tangible human resources, we used four (4) variables representing the number of employees with certain training or educational levels. Therefore, we consider employees with master's degrees (MASTER), Bachelor's degrees (PROFESIONAL), technicians (TÉCNICOS), and those who completed a training program at the Colombian National Training Service for Vocational Programs (FORSENA). This view of the tangible nature of human resources is well supported in previous literature (Blázquez & Mondino, 2012; Ismail *et al.*, 2012; Rangone, 1999; Sáez de Viteri Arranz, 2000).

We consider marketing and reconfiguration capabilities as a subset of integration-of-knowledge capabilities. They support the integration of knowledge into firms' processes and encourage the development of new products (Rodrigo-Alarcón *et al.*, 2013). We measured the marketing capability through the “investment in marketing” (MDOTECNIA). Likewise, we measured the reconfiguration capability by the “investment in engineering and industrial design” (INGDSINDU). It represents the evolutionary aptitude and the intra-organizational reinvention process (Teece, 2007). Investing in engineering or industrial design implies modifying of the operational processes, internal and external competencies, and of course, the transformation of the operational routines of the company (Giniuniene & Jurksiene, 2015).

5.2.2. Control variables.

This research was controlled by company size (total number of employees). We also segregated the individual effects of the industrial sectors by creating dummy variables for each economic activity in the database. Likewise, we included a couple of variables linked to potential absorptive capability (PAC) to identify additional factors that could explain varying levels of RAC. Following prior research, we proxied PAC by the ability to acquire (IAC) and assimilate knowledge by firms (RCTI) (Torres-Barreto *et al.*, 2020).

Finally, as Zahra and George (2002) suggested, there may be evidence of interdependence between transformation and exploitation functions. Therefore, each function was included as a control variable in the tested model. More specifically, in the equation related to H_{1.1}, we added the exploitation of knowledge as a control variable. In the equation related to H_{1.2} we included the transformation-of-knowledge as a control variable as well. All the considered variables are presented in table 1.

Table 1. Variables included in the proposed models

	Dependent Variable	Independent Variables	Control Variables
H_{1.1}	Investment in technical and consulting assistance. INVASISTEC.	<ul style="list-style-type: none"> • Investment in information or communication technologies. ICT. • Training or educational level of employees. MASTER, FORSENA. • Investment in engineering and industrial design. INGDISINDU. 	<ul style="list-style-type: none"> • New goods and services introduced by the company to the market. BSDMO. • Investment in technology transfer and knowledge acquisition. IAC. • Firms' relationships with the National System of Science, Technology and Innovation. RCTI. • Number of employees. TTEMPLEADOS. • Industrial sector. CIU dummies.
H_{1.2}	The company introduces new goods and services to the market . BSDMO.	<ul style="list-style-type: none"> • Investment in machinery. MACHINE. • Investment in information or communication technologies. ICT. • Training or educational level of employees. PROFESIONAL, TECNICOS. • Investment in engineering and industrial design. INGDISINDU. • Investment in marketing. MDOTECNIA 	<ul style="list-style-type: none"> • Investment in technical and consulting assistance. INVASISTEC. • Investment in technology transfer and knowledge acquisition. IAC. • Firms' relationships with the National System of Science, Technology and Innovation. RCTI. • Number of employees. TTEMPLEADOS. • Industrial sector. CIU dummies.

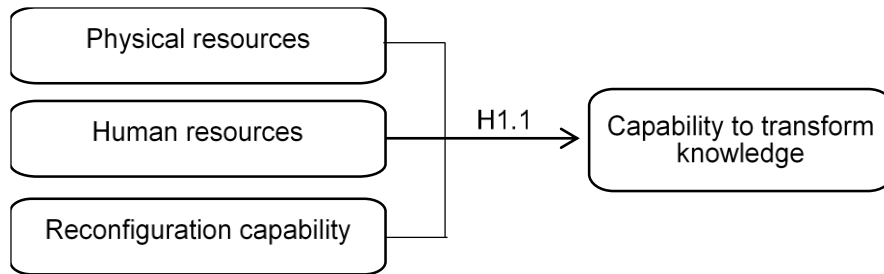
Source. Own elaboration.

6. Results

6.1. Relationship between the variables included in the hypotheses

Figure 5 presents the construct for hypothesis H_{1.1}, and table 2 presents the Pearson correlations, where a positive and moderate association is evident between the investments in technical assistance and the investment in engineering and industrial design (0.662). This is aligned with the Lind *et al.* (2005) proposal. They considered that having the support of experts is necessary to manage intra-organizational changes. Likewise, there is a positive and strong correlation between the number of employees with master's degrees and the investment in machinery and Information & Communication Technologies (0.811). It implies that, as the technology supporting manufacturing companies get more sophisticated, the company should have employees with higher qualifications.

Figure 5. Theoretical model of the H_{1.1}.



Source. Own elaboration.

Table 2. Pearson correlations for H_{1.1}.

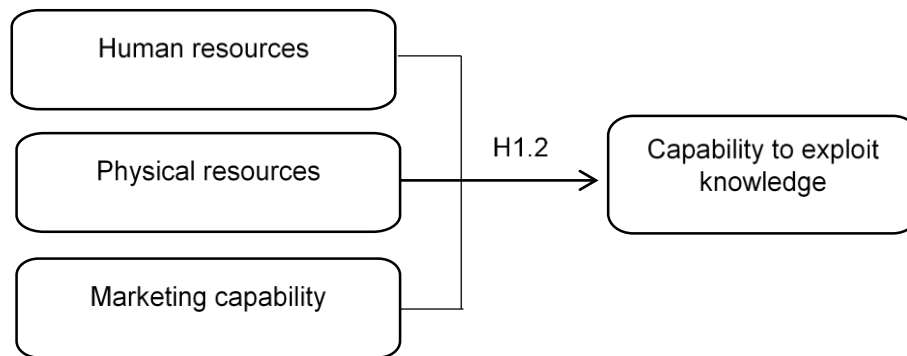
	1	2	3	4	5	6
1. INVASISTEC	1					
2. MASTER	0.074*	1				
3. FORSENA	0.074*	0.071*	1			
4. ICT	0.096*	0.811*	0.006	1		
5. INGDISINDU	0.662*	0.049*	0.052*	0.005	1	
6. TTEMPLEADOS	0.171*	0.481*	0.474*	0.366*	0.067*	1

Note: *Significance level at 5%.

Source. Own elaboration.

Figure 6 presents the construct for H_{1.2}, and table 3 presents the correlations between the variables included in this hypothesis. The results show a positive and moderate relationship between the investment in machinery and the total number of employees (0.525). It makes sense considering that: a) we are dealing with manufacturing companies, and b) when using advanced technology and additional machinery, the companies require more skilled staff, as remarked in the previous section.

Figure 6. Theoretical model of the $H_{1,1}$



Source. Own elaboration.

Table 3. Pearson correlations for $H_{1,2}$

	1	2	3	4	5	6	7	8
1. BSMDO	1							
2. PROFESIONAL	0.168*	1						
3. TÉCNICOS	0.129*	0.619*	1					
4. MACHINE	0.096*	0.382*	0.270*	1				
5. ICT	0.022	0.525*	0.276*	0.307*	1			
6. MDOTECNIA	0.083*	0.261*	0.241*	0.102*	0.015	1		
7. INGDISINDU	-0.004	0.146*	0.050*	0.027	0.005	0.040	1	
8. TTEMPLEADOS	0.158*	0.804*	0.673*	0.349*	0.366*	0.258*	0.067*	1

Note: *Significant at 5%.

Source. Own elaboration.

6.2 Hypothesis contrast and econometric models

The diagnostics tests suggested by Neter *et al.* (1989) indicated that multicollinearity was not a severe problem in our current sample. Therefore, in contrast, two multiple linear regressions were used (see equation 1). Both models were executed with non-standardized coefficients and robust standard errors, using the software Stata V.14. In the first model, two variables were transformed into their natural logarithms: the investment in technical assistance (INVASISTEC) and the investment in technology (ICT). In the second model, the variables: Investment in machinery (MACHINE), investment in marketing (MDOTECNIA),

and investment in engineering and industrial design (INGDISINDU) were also transformed using natural logarithms. These transformations were made to achieve a normal distribution of the variables, make the database more homogenous, reduce heteroscedasticity, and make the estimations more robust (Gujarati & Porter, 2009; Mukaka, 2012).

$$Y = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \varepsilon_i \quad (1)$$

The results for H_{1.1} are shown in Table 4. Column 1 presents the results of the regression, including exclusively human resources. Column 2 includes the physical resources, Column 3 includes the reconfiguration capabilities, and Column 4 includes all the construct variables. The model with the best adjustment is in Column 4 (R-squared=0.8439). The white test showed a p-value = 0.428; consequently, the hypothesis of heteroscedasticity is rejected with a confidence level of 95%.

Table 4. Results of the multiple linear regression model for H_{1.1}

INVASISTEC	1 Human Resources	2 Physical Resources	3 Reconfiguration capability	4 Complete model
MASTER	-0.006*			-0.084***
FORSENA	-0.004*			0.015*
ICT		0.399***		0.323**
INGDISINDU			0.514***	0.577***
BSDMO	0.005	0.009	0.027	-0.012
IAC	0.000*	0.000	0.000*	0.000
RCTI	0.0594	0.019	-0.056	0.071*
TTEMPLEADOS	0.001***	0.000	0.000	0.000
CONSTANT	9.4841	5.945	4.510	1.088
PROB > F	0.0000	0.0000	0.0000	0.0000
R-SQUARED	0.1672	0.2879	0.7126	0.8439
N.	486	179	90	43

Note: *p < 0.05, ** p < 0.01, *** p < 0.001.

Source: Own elaboration.

The results of the hybrid model (shown in Table 5) confirm that 84.39% of the capability to transform knowledge is explained by tangible resources (human and physical), along with the ability to reconfigure. Therefore, H_{1.1} is accepted.

Table 5. Selected model for $H_{1.1}$

INVASISTEC	COEF.	P-VALUE
MASTER	-0.084 (0.016)	0.000
FORSENA	0.015 (0.009)	0.050
ICT	0.323 (0.096)	0.002
INGDISINDU	0.577 (0.098)	0.000
BSDMO	-0.012 (0.061)	0.841
IAC	0.000 (0.000)	0.385
RCTI	0.071 (0.033)	0.036
TTEMPLEADOS	0.000 (0.000)	0.108
CONSTANT	1.088 (0.991)	0.281
PROB > F	0.0000	
R-SQUARED	0.8439	
N.	43	

Note: Standard errors are shown in parentheses.

Source. Own elaboration.

Table 6 illustrates the results of $H_{1.2}$. Column 1 shows the regression results, including only human resources, column 2 includes physical resources, and Column 3 includes marketing capability. Column 4 contains the reconfiguration capability, and Column 5 includes all the variables in the construct. The model in column 5 is the one that best explains the ability to exploit knowledge (R -squared=0.9657), and therefore it is presented in an extended version in table 7. The results of White's test show enough statistical evidence to reject the heteroscedasticity hypothesis with a p-value of 0.392 at a 95% confidence level.

Table 6. Results of the multiple linear regression for $H_{1,2}$

BSMDO	1 Human Resources	2 Physical Resources	3 Marketing Capability	4 Reconfiguration capability	5 Comple model
PROFESIONAL	0.002				0.091***
TECNICOS	0.001				0.167***
MACHINE		0.223*			3.086***
ICT		0.158			0.521
MDOTECNIA			0.211		0.806**
INGDISINDU				0.044*	-2.548**
INVASISTEC	-0.000	-0.000	0.000	-0.000	-0.000
IAC	-0.000***	0.000	-0.000***	0.000	0.000
RCTI	0.180***	0.330***	0.092	0.209	-0.144
TTEMPLEADOS	0.000	-0.000	-0.000	0.001	-0.034*
CONSTANT	0.457***	-3.273	-0.798	0.4964	-19.849
PROB > F	0.0000	0.0486	0.0000	0.0907	0.0000
R-SQUARED	0.0628	0.1690	0.0437	0.0664	0.9657
N.	2093	216	272	197	19

Note: *p < 0.05, ** p < 0.01, *** p < 0.001.

Source. Own elaboration.

The results indicate that 96.57% of the capability to exploit knowledge is explained by tangible resources (human and physical), together with the marketing and reconfiguration capabilities. Additionally, the “Investment in information or communication technologies” shows a positive but insignificant effect; nevertheless, its inclusion in the model allows it to be more specific.

Table 7. Selected model for $H_{1,2}$

BSMDO	COEF.	P-VALUE
PROFESIONAL	0.091 (0.054)	0.001
TÉCNICOS	0.167 (0.079)	0.000
MACHINE	3.086 (1.950)	0.001
ICT	0.521 (0.526)	0.360
MDOOTECNIA	0.806 (1.139)	0.010
INGDISINDU	-2.548 (1.267)	0.009
INVASISTEC	-0.000 (0.000)	0.249
IAC	0.000 (0.000)	0.258
RCTI	-0.144 (0.192)	0.393
TTEMPLEADOS	-0.034 (0.022)	0.039
CONST.	-19.849 (17.234)	0.091 - 0.293
PROB > F	0.0000	
R-SQUARED	0.9657	
N.	19	

Note: Standard errors are shown in parentheses.

Source. Own elaboration.

7. Discussion of the results

The preceding analysis has shown that realized absorptive capabilities emerge through interaction between a subset of firm resources and capabilities (Amit & Schoemaker, 1993; Zahra *et al.*, 2006). In this work, we suggest that tangible resources, along with reconfiguration and marketing capabilities, could help reinforce the realized absorptive capability of firms (RAC). Our analysis broadens the resource-based research agenda to include greater attention to the role of human and physical resources as drivers of the capability to transform and exploit knowledge.

Our findings also indicate that the employees' level of training influences the capability of transforming knowledge. More specifically, the results suggest that if the number of employees with vocational education (FORSENA) increases by one, the investment in technical assistance will increase by 1.5%. Nevertheless, the number of employees with a master's degree negatively affects knowledge transformation (p -value = -0.084). This is probably because the knowledge level and the analysis ability of master's degree personnel are high. Therefore, the process of transforming and combining the knowledge within firms would be performed by these employees and not through external outsourcing.

Our results also suggest that skilled personnel influence the capability to exploit knowledge (H_{1.2}). More precisely, if the number of skilled employees (with bachelor's or technician's diplomas) increases by one, the exploitation capability will increase by 9% or 16% each, keeping the remaining variables constant. These results are consistent with extant literature that highlights the importance of workforce skills in the development of dynamic capabilities (Kim, 2010) and emphasizes the role of the individuals in using and exploiting knowledge (Minbaeva *et al.*, 2003), as well as the importance of employees qualifications in creating absorptive capabilities (Vinding, 2006).

From our findings, we conclude that human resource is a fundamental asset in developing the realized absorptive capability. Former results endorse our conclusions. Some authors revealed that a firm's critical mass (the relative number of skilled staff the company has) determines its provisions to value, assimilate, transform and exploit knowledge (Castro *et al.*, 2009). Also, companies with highly skilled, trained, and technically capable employees are potentially more receptive to assimilating and transforming external knowledge (Vinding, 2006; Vega-Jurado *et al.*, 2008).

Concerning the set of firms' resources, previous literature suggests that intangible resources are more likely to be the source of sustainable competitive advantage since they are more difficult to imitate (Barney, 1991; Dierickx & Cool, 1989). Nevertheless, we found a relationship between some tangible resources (firms' assets and technology) and the capability to transform and exploit knowledge. From the first model, an increase of 1% is

suggested for the investment in information or communications technologies, which would upturn the investment in technical assistance and consulting by 0.32%. The second model supports that an increase of 1% in the investment in machinery and equipment would increase the number of goods and services introduced to the market by 3.08%.

When analyzing the dataset used for this research, we realized that a limited number of manufacturing companies renewed their operational base: 46% of firms purchased new machinery or equipment, and 19% invested in information or communications technology within the period of study. These numbers may be affecting the absorptive capability development in Colombia's manufacturing industry. They might explain the low influence of the physical resources on the realized absorptive capability. Extant literature regarding the role of physical resources on absorptive capabilities is limited, but it prompts that tangible assets enable the integration of knowledge in organizations (Lache *et al.*, 2016).

We conclude that the available amount and quality of the physical resources the company owns denotes better results in its ability to transform and exploit knowledge. Moreover, regarding the reconfiguration capability, our findings suggest that an increase of 1% in the investment in engineering and industrial design represents an increase of 0.57% in the investment in technical assistance and consulting. It is consistent with previous literature in terms of the potential of reconfiguration capability to help companies to better sense and analyze market changes and respond to them (Escandón *et al.*, 2013) because it involves the combination, transformation, and exploitation of knowledge (Eriksson, 2014; Grant, 1996). Nevertheless, in our model, the effect of the reconfiguration capability on the exploitation of knowledge is inverse (p-value = -2.54), which may be because the reconfiguration capability is more evident in continuously changing environments (Eriksson, 2014).

Given that the dynamics of the Colombian manufacturing industry are limited, their organizational structures are not very flexible; subsequently, the companies may exhibit a weak ability to explore and exploit competitive contexts, as well as to make transformation processes in a responsive manner (Bravo-Ibarra & Herrera, 2009). In this sense, within a low-

dynamic environment, a firm that constantly performs reconfiguration processes might be inefficient in the development of the exploitation capability.

We found a positive influence of marketing capability on exploitation (H_{1.2}). If there is an increase of 1% in the investment in marketing, the total number of goods or services introduced to the market would also increase by 0.81%. It implies that the successful development of a given product may help explain the current success of a firm but more importantly, create long-term competitive advantages via dynamic capabilities. It demands much more attention and may be obtained by developing and nurturing dynamic exploitation of knowledge. This result is consistent with other previous studies (Rodrigo-Alarcón *et al.*, 2013; Danneels, 2002; Ripollés & Blesa, 2012). The marketing capabilities push product development activities in ways that build on and develop capabilities of exploiting knowledge. According to some authors (Marsh & Stock, 2003), this creates platforms for future product development.

Our results for H_{1.2} indicate that the size of companies has a negative effect on the exploitation capability, measured through the number of new products or services the firm has introduced to the market. It may be due to two factors: a) Big-sized industrial companies are not emphasizing the generation of new products or services for the market. At the same time, small firms can be more innovative because they have greater flexibility and versatility. Regarding innovation, a small firm fosters collaboration and cooperation among employees, which makes it more prone to develop the ability to exploit knowledge. This finding has support in the literature.

Another potential factor is b) the scarce innovation activity of firms in the sample: 76.9% of the surveyed industrial companies did not register any innovation during 2014, and most innovative companies neglect the efficiency of their processes. Barely 2.8% of the sampled companies introduced new products into the domestic market, and 0.3% did so in international markets. According to what is expressed by innovative companies, the main obstacles to innovation are associated with the easiness of their products being copied or

counterfeited by third parties, the difficulties in accessing external financing, and the scarce possibilities of cooperating with external entities (DANE, 2015).

As outlined above, the realized absorptive capabilities, together with the tangible resources of firms, have the potential to help us understand why corporate transformation and exploitation capabilities differ between firms. These theoretical results endorse our outlined path from tangible resources and integration-of-knowledge capabilities to knowledge creation processes. As stated previously, firms gain experience through exposure and interaction with their base of resources and capabilities, enabling firms to develop new routines that influence the locus of a future search for knowledge.

This research, therefore, quantitatively supports some insights regarding the dimensions of absorptive capabilities and presents a path from their antecedents to the improvement of firms' performance. As a suggestion, future research could focus on knowledge management heterogeneity. As authors, we suggest delving deeper into how other capabilities affect organizational adaptation and change in terms of knowledge management, as well as the effect of cooperation between firms. Additionally, as an empirical matter, we require a better understanding of how the two capabilities linked to knowledge creation (transformation and exploitation) affect strategic change in firms. Both statistical and case study evidence can help in this regard.

This study presents some limitations. On one side, our models were tested using proxies for RAC. Nevertheless, the use of these variables as proxies of absorptive capabilities is supported in the existing literature. On the other hand, we worked with transversal data, limiting the analysis of the capabilities' development over time. Our proposal for future research is to use longitudinal data.

8. Conclusions

Research about absorptive capabilities is essentially focused on its results, that is, on the effect they have on the competitive advantage of firms and their corporate performance (Ebers & Maurer, 2014; Lane *et al.*, 2001; Tsai, 2001; Zahra & George, 2002). Recent studies

by Ávila (2021), Limaj & Bernroider (2019), Pangarso *et al.* (2020), and Wang *et al.* (2020) give empirical evidence for the positive impact of absorptive capacity on innovation. However, there is still a lack of related literature regarding the origins of this so important capability (absorptive capability).

Notwithstanding, in the last decade, the study of key factors that generate absorptive capabilities has become more relevant. Most of these studies address the intangible resources as precedents of realized absorptive capabilities (Rua *et al.*, 2019) and neglect the tangible resources, which prevents them from having a broader integrative vision of the various determinants of these capabilities. Therefore, this research seeks to contribute to the literature about absorptive capabilities by studying their development when tangible resources are acknowledged as precursors. A more inclusive approach to absorptive capabilities (*e.g.*, by considering tangible resources and other dynamic capabilities) may help fill the gap in the Resource-Based View Theory.

We focused our study on realized absorptive capabilities and considered them “knowledge-creation capabilities.” Our findings show that tangible resources (physical and human), and two types of dynamic capabilities (marketing and reconfiguration), encourage the development of realized absorptive capabilities; this led us to reveal a pathway related to RAC. It starts in the interactions between tangible resources and marketing and reconfiguration capabilities and ends in competitive advantages for organizations.

Our findings denote significant implications for industries. Based on the verified hypothesis, companies that are more prone to develop RAC are those with higher physical and human resources available (skilled staff, specialized machinery, more information, or communications technologies available). Additionally, firms able to recombine capabilities to generate new ones and recombine their processes to sense and react to market changes can develop new processes and routines. This ease the interpretation, transfer, and combination of the existing knowledge in the company with the newly acquired.

Marketing investments are also endorsed by this study due to their capability to empower the company to use the absorbed knowledge for commercial purposes. Also, we verified the potential of physical resources since a company may discover and learn different ways to use them efficiently and make the most out of them. It may create differences in the development of capabilities and, hence, in corporate performance.

These findings are relevant in three different manners. First, we add to the theory about precursors of absorptive capabilities by considering the tangible resources essential elements in the development of realized absorptive capabilities. While most of the literature suggests that physical resources cannot be considered a competitiveness key factor by themselves (given that they are easily available (Peteraf, 1993; Teece *et al.*, 1997), we demonstrated their relevance as precursors of capabilities and generators of competitive advantages.

Second, we broaden the theoretical interpretation of some dynamic capabilities (marketing and reconfiguration) by presenting them as integration-of-knowledge capabilities and differentiating them from knowledge generation capabilities. From a theoretical approach, we proposed a pathway for organizational change in which tangible resources and the integration of knowledge capabilities are precursors of knowledge creation. The path provides organizations with multiple sources of competitive advantage, thereby enabling economic performance improvement.

Third, we reassure the role of practitioners in fostering organizational competencies. Our study suggests that a value is generated by the exploitation of physical resources along with marketing or reconfiguration capabilities, which is related to knowledge creation. Therefore, organizational leaders could manage a transformation process by combining these resources and capabilities to generate new knowledge and use it for profit generation. It is consistent with prior empirical research in terms of the need to have skilled human capital to harvest and exploit the firm's knowledge base (Hitt, Ireland & Lee, 2000; Floyd & Lane, 2000).

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