Knowledge Management Mechanisms at MNCs

The Enhancing Effect of Absorptive Capacity and its Effects on Performance and Innovation

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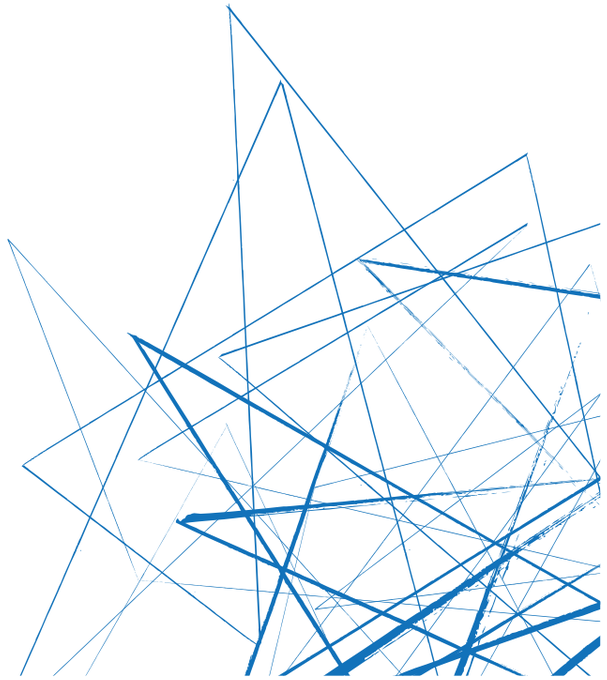

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English abstract

The importance of innovation for firm´s competitiveness has long been discussed by the literature, and therefore, knowledge management has taken a pivotal role in innovation processes. In order to generate innovations, firms may access knowledge from different sources, including its internal and external environment. However, to fully assimilate such knowledge and apply it to commercial ends, firms need absorptive capacity (AC). Absorptive capacity is particularly important for multinational corporations, as they face several learning challenges arising from increased global competition as well as geographic, institutional and cultural differences. With this in mind, this thesis explores the relationship between knowledge management mechanisms and innovation and performance outcomes in multinational corporations (MNCs). I also explore the role of absorptive capacity in such relationships. In order to contribute to the existing literature in specific ways, this thesis unfolds in three empirical papers, which consider distinct sorts of knowledge management mechanisms (knowledge sourcing mechanisms, knowledge management capabilities, project-team dynamics), coming from different sources (MNC internal and external environment), entailing different types of innovation (product and process innovation), which result in different outcomes (local innovation, global innovation, and performance), explored in different contexts (reverse innovation, reverse knowledge transfer, and intra-organizational knowledge sharing projects). The thesis relies on a rationale that absorptive capacity can enhance the relationship between knowledge management mechanisms and innovation and performance outcomes. Therefore, the studies embraced several theoretical aspects of AC: i) the diminishing effect on AC in environments where learning is more difficult; ii) the different roles of R&D investment and innovation training in fostering AC; iii) the trade-off between inward-looking and outward-looking determinants of AC; iv) the need for more intense efforts and diversified knowledge to develop AC for problem solving as complexity increases. With the increasing importance of emerging markets in the global innovation landscape, the three studies primarily focus on an emerging market, Brazil, as the context of the studies. This thesis is structured as follows. First, I introduce the general research question and the specific theoretical and methodological aspects explored in each of the papers. Then, I present each of the papers, with its particular literature review, hypothesis development, methods, results and discussion. Finally I discuss the conclusions of the thesis, in light of the research questions raised and the overall contribution of the three studies. At last, an appendix in provided with further

information on a case study at a Brazilian MNC, InterCement, from where one of the papers originated.

Danish abstract

Innovationens betydning for virksomhedens konkurrenceevne er et væsentligt tema i litteraturen, og videns-processer spiller en helt central rolle i innovationsprocesserne. For at generere innovationer udnytter virksomhederne adgang til viden fra forskellige kilder, herunder dets interne og eksterne miljø. For at fuldt ud overføre og anvende viden til kommercielle formål har virksomheder brug for Absorptive Capacity (AC). Absorptive Capacity er især vigtig for multinationale selskaber, da de står over for adskillige læringsudfordringer, der stammer fra øget global konkurrence såvel som geografiske, institutionelle og kulturelle forskelle. Med dette for øje undersøger denne afhandling forholdet mellem videnstyrings-mekanismer og innovations- og præstations-resultater i multinationale selskaber (MNC'er). Jeg udforsker også den rolle som Absorptive Capacity spiller i denne sammenhæng. For at bidrage til den eksisterende litteratur på specifikke måder, udfoldes denne afhandling i tre empiriske artikler, der overvejer forskellige former for videnstyrings-mekanismer (viden sourcing mekanismer, viden-styring kapaciteter, projekt-team dynamik), der kommer fra forskellige kilder (MNC interne og eksternt miljø), der indebærer forskellige typer af innovation (produkt- og procesinnovation), som resulterer i forskellige resultater (lokal innovation, global innovation og præstation), udforsket i forskellige sammenhænge (omvendt innovation, omvendt viden-overførsel og intern organisatorisk viden deling af projekter). Specialet bygger på en begrundelse for, at Absorptive Capacity kan forbedre forholdet mellem videnstyrings-mekanismer og innovations- og præstationsresultater. Derfor geneemføres omfattede undersøgelser af flere teoretiske aspekter af AC: i) den formindskende effekt på AC i miljøer, hvor læring er vanskeligere; ii) de forskellige roller inden for F & U-investering og innovationsuddannelse i fremme af AC; iii) afvekslingen mellem indvendige og udadrettede determinanter af AC; iv) behovet for mere intensiv indsats og diversificeret viden for at udvikle AC til problemløsning, når kompleksiteten øges. Med de voksende markeders voksende betydning i det globale innovationslandskab fokuserer de tre studier primært på et voksende marked, Brasilien, som kontekst for undersøgelserne. Denne afhandling er struktureret som følger. Først introducerer jeg de generelle forskningsspørgsmål og de specifikke teoretiske og metodologiske aspekter, der undersøges i hvert af artiklerne. Derefter præsenterer jeg hvert af

artiklerne med dens særlige litteratur review, hypoteseudvikling, metoder, resultater og diskussion. Til sidst diskuterer jeg konklusionerne fra afhandlingen i lyset af de rejste forskningsspørgsmål og det samlede bidrag fra de tre undersøgelser. Til sidst er inkluderet et appendiks med yderligere oplysninger om et casestudie af en brasiliansk MNC, InterCement, der danner udgangspunkt for et af de tre artikler.

Contents

Chapter 1

Introduction

Summary

This thesis explores the relationship between knowledge management mechanisms and innovation and performance outcomes in multinational corporations (MNCs). While this topic is relatively broad, the thesis unfolds in three distinct papers in order to advance the existing literature and build testable hypothesis. In order to do so, I consider distinct sorts of knowledge management mechanisms (knowledge sourcing mechanisms, knowledge management capabilities, project-team dynamics), different types of innovation (product and process innovation), two outcomes (innovation and performance), and different contexts (reverse innovation, reverse knowledge transfer, and intra-organizational knowledge sharing projects). In this Introduction, I present an overview of the extant literature on knowledge management which raise relevant research gaps and bring opportunities for emerging research, which I try to address in the studies conducted along the period of the PhD studies at Copenhagen Business School.

Literature overview

Knowledge and the MNC

The importance of knowledge for organizations has been emphasized by the Resource Based View, which argued that knowledge is one among the many resources that can lead to sustained competitive advantages of firms (Barney, 1991; Teece & Pisano, 1994; Wernerfelt, 1984). Emerging from such ideas, knowledge quickly gained a much larger relevance in distinguishing firms from its competitors. For instance, Conner and Prahalad (1996) argue that knowledge differences between individuals may differentiate one firm from another and lead to competitive advantages. Grant (1996) argued that the primary role of the firm is integrating such specialist knowledge of individuals into goods and services by managerial coordination. Such coordination may be achieved through: i) establishing rules that convert tacit knowledge into comprehensible explicit knowledge; ii) sequencing production activities such that each specialist's input occurs independently; iii) organizational routines that support complex patterns of interactions between

individuals; and iv) group problem solving and decision making to unusual, complex, and important tasks.

Almost simultaneously, Organizational Learning Theories provided a complementary understanding of knowledge processes at organizations. For instance, Levitt and March (1988) see organizations as learning entities that develop their routines, behaviors, and paradigms based on what they have learned from their own experiences and from the experiences of others. Huber (1991) point to four elements of organizational learning: knowledge acquisition, information distribution, information interpretation, and organizational memory. The author argues that more organizational learning occurs when the organization recognizes knowledge as potentially useful, when more varied interpretations are developed and when more organizational units develop uniform comprehensions of the various interpretations. Cohen and Levinthal (1990) argue that firms need to have absorptive capacity in order to assimilate and apply external knowledge into commercial ends. Nonaka (1994) focuses on the processes of creating knowledge through socialization, combination, externalization, and internalization, in a dynamic process between tacit knowledge and explicit knowledge in which both individuals and organizations are essential actors.

Knowledge management gained so much relevance that Kogut and Zander (1992) claimed that the reason why firms do better than markets is because of their ability to share and transfer knowledge internally and that firms learn new skills by recombining their current capabilities. Zander and Kogut (1995) discuss the transferability of knowledge in terms of characteristics such as codifiability, complexity, teachability, and system dependency. For instance, they show that the degree of knowledge codification and the easiness of teaching organizational capabilities is related to the speed of transfer, which naturally has implications for cross border transfers. Later, Van den Bosch, Volberda, and de Boer (1999) add to this emergent Knowledge Based View by arguing that the characteristics of the knowledge environment also influence a firm's ability to learn. The authors propose a co-evolutionary perspective in which firms operating in turbulent knowledge environments are more likely to increase their absorptive capacity by developing organizational forms and combinative capabilities than firms operating in more stable environments.

When it comes to international operations, knowledge plays an even more prominent role, given the challenges that can arise with increased global

competition, as well as geographic and cultural distances. Ghoshal and Bartlett (1990, p. 603) conceptualize a multinational corporation (MNC) as "a group of geographically dispersed and goal-disparate organizations that include its headquarters and the different national subsidiaries. Such an entity can be conceptualized as an interorganizational network that is embedded in an external network consisting of all other organizations such as customers, suppliers, regulators, and so on, with which the different units of the multinational must interact". Thus, MNCs have been regarded as networks of firms with a superior ability to effectively transfer and manage dispersed knowledge across borders (Kogut & Zander, 1993; Mudambi, 2002). Later on, Bartlett and Ghoshal (1998) distinguish between four types of firms operating in the global environment and discuss their implications for the development and diffusion of knowledge. For instance, in the *multinational* organization, knowledge is developed and retained within each unit. Conversely, in the *global* organization, knowledge is developed and retained at the headquarters. In the *international* organization, knowledge is developed at the headquarters and transferred to foreign units. Finally, the authors propose a forth type, the *transnational* organization, in which knowledge is developed jointly by headquarters and units and shared worldwide. With all these developments in the concept of the MNC taking into account its knowledge management capabilities, knowledge has become a key research area in the international business field (Foss & Pedersen, 2004).

Research gap and research questions

Indeed, over the last decades, the literature has reinforced the role of knowledge in the creation of competitive advantages. Meta-analytic studies have reviewed and consolidated the literature on antecedents and consequences of organizational knowledge management. For instance, Argote, McEvily, and Reagans (2003) propose two critical dimensions of knowledge management: knowledge management outcomes (knowledge creation, retention, and transfer) and properties of the knowledge management context (properties of units, properties of the relationships between units, and properties of knowledge). According to the authors: "Knowledge creation occurs when new knowledge is generated in organizations. Knowledge retention involves embedding knowledge in a repository so that it exhibits some persistence over time. Knowledge transfer is evident when experience acquired in one unit affects another." (Argote et al., 2003, p.572). The authors suggest that these outcomes are related and that future research should encompass:

i) the importance of social relations for knowledge management outcomes; ii) the fit between properties of knowledge, units, relationships, and the environment; iii) the mechanisms through which organizational boundaries affect knowledge transfer; iv) the types of experience that facilitate, impede, or have no effect on learning outcomes; v) how learning by other firms or populations of firms can affect a focal firm; and vi) how and where knowledge is embedded in an organization's memory and its effect on performance outcomes. This thesis addresses some of these research gaps, in particular in regards to socialization mechanisms for knowledge management, the diversity of knowledge and international experiences accessed through cross-border organizational boundaries, and the fit between properties of knowledge management such as ability, motivation, and opportunities in project-team compositions.

Focusing specifically on knowledge transfer, the bibliometric study from Van Wijk, Jansen, and Lyles (2008) identifies the most commonly researched antecedents of knowledge transfer within the organization: i) knowledge characteristics, such as knowledge ambiguity; ii) organizational characteristics, such as absorptive capacity, descentralization, firm size and age; and iii) network characteristics, such as the number of relations and centralized position, tie strength and trust, and shared vision and systems as well as cultural distance. The study also points to the consequences of knowledge transfer found in the literature such as performance and innovativeness. Despite the advent of studies exploring the effect of different knowledge management mechanisms on knowledge outcomes, Van Wijk et al. (2008) argue that the antecedents of knowledge transfer have received disproportionally lower attention in the literature than its outcomes. In line with this call, this thesis concentrates great effort in exploring some antecedents of knowledge transfer in MNCs, such as the different *sources of knowledge*, and various *organizational knowledge management mechanisms*, as will be discussed in more details later on.

In addition to that, Van Wijk et al. (2008, p. 844) claim that *absorptive capacity* has an important enabling role in the knowledge management processes that deserves future attention: "given its importance to organizational knowledge transfer, it is surprising that organizational antecedents of absorptive capacity have been largely ignored". Despite the extant research on absorptive capacity, there is still scope for a deeper understanding of the construct since its impact on knowledge outcomes differ across studies (Lane & Lubatkin, 1998; Van Wijk et al., 2008). Furthermore,

as will be discussed later on, the absorptive capacity literature following Cohen and Levinthal (1990) has neglected some important aspects that deserve attention by emerging studies (Pedersen, Larsen, & Dasí, 2020; Volberda, Foss, & Lyles, 2010). Therefore, this thesis also explores the role of absorptive capacity, as well as its antecedents, on the competitive advantage of firms in line with its knowledge management strategy.

Finally, as regards to the knowledge outcomes, previous literature has provided evidence that knowledge management strategies positively impact organizational *performance* and *innovation* (Lane, Salk, & Lyles, 2001; Van Wijk et al., 2008). The rationale is that firms may pursue different types of innovations, and achieve different levels of performance. For instance, while some firms pursue exploitative innovations from existing knowledge sources focusing on short-term results, others pursue exploitative innovations from diverse knowledge sources focusing on long term results (Jansen, Van Den Bosch, & Volberda, 2006; March, 1991). For those reasons, exploitative innovation seems to be more associated with process innovation and higher performance whereas exploratory innovation seems to be more associated with higher innovativeness, in particular product innovation (Jansen et al., 2006; March, 1991). Yet, several studies suggest that this may not necessarily be the case (Katila & Ahuja, 2002; Steensma, Tihanyi, Lyles, & Dhanaraj, 2005). Therefore, further investigation is needed to validate such premises and to understand possible contextual variables affecting those relationships (Van Wijk et al., 2008).

In conclusion, although antecedents and consequences have been consistently assessed across studies, some have not been studied extensively and deserve further investigation in terms of how knowledge management mechanisms lead to the outcomes of interest, the magnitude of such relationships, the role of absorptive capacity, and the expected variations in terms of context of the studies.

With this in mind, the general research questions of this thesis are: *Can (and which) knowledge management mechanisms promote innovation and performance outcomes? What is the role of absorptive capacity?*

In order to address such research questions in specific ways, three studies have been developed. **Paper 1** contributes to answer these questions by examining the effect of absorptive capacity enhancing practices (e.g. R&D investment and innovation training) on the relationship between knowledge sourcing mechanisms and both

local and global innovation. **Paper 2** contributes to answer these questions by exploring knowledge management capabilities, multinationality and the trade-off effect between such inward-looking and outward-looking determinants of absorptive capacity in the context of international reverse knowledge transfers. **Paper 3** contributes to answer this question by exploring the interplay between team's ability, motivation, and opportunity as knowledge management mechanisms to carry simple and complex projects in a multinational corporation (InterCement), leading to higher project performance. In summary:

Contribution of each paper to the thesis´ overall research questions	Paper 1: examines the effect of absorptive capacity enhancing practices (e.g. R&D investment and innovation training) on the relationship between knowledge sourcing mechanisms and both local and global innovation.
	Paper 2: investigates the trade-off effect between inward- and outward-looking determinants of absorptive capacity, by exploring the interactions between knowledge management capabilities and multinationality in the international reverse knowledge transfer context.
	Paper 3: explores the interplay among team's ability, motivation, and opportunity as knowledge management mechanisms to carry simple and complex projects in a multinational corporation (InterCement), leading to higher project performance.

Next, I discuss in more details each aspect of knowledge management explored in this thesis and the contribution of each of the three studies to existing literature.

Sources of knowledge

Taking a deeper look into the international knowledge management literature we can identify several types of knowledge flows within MNCs. For instance, Mudambi (2002) point to: i) traditional knowledge flows from the parent to the subsidiary, where the subsidiary exploits a home-based knowledge advantage; ii) reverse knowledge flows from subsidiary to parent, that enable MNC headquarters to exploit local competencies, iii) flows from location to subsidiary, which consist of local competence exploitation, and local resource utilization; and iv) flows from subsidiary to location, which are termed spillovers. Such knowledge flows include both inter-organizational and intra-organizational knowledge transfers. Therefore, organizations access both external and internal knowledge sources to generate innovations (Andersson, Dasí, Mudambi, & Pedersen, 2016; Eisenhardt & Santos, 2001). While both are important, scholars have argued that internal transfers are

more likely to impact performance (Darr & Argote, 1995; Ingram & Simons, 2002; Kane, Argote, & Levine, 2005), while external knowledge transfers are more likely to impact innovation (Phene & Almeida, 2008). In addition to that, a perspective that integrates both internal and external knowledge sourcing is still scarce in the literature (Papa, Dezi, Gregori Gian, Mueller, & Miglietta, 2018) and scholars have called for more research on "the conditions under which using internal versus external knowledge is more (or less) likely to improve a unit's performance" (Argote et al., 2003, p.578). While this thesis is mainly focused on knowledge flows taking place within MNCs, we also consider knowledge coming from external sources. For instance, **Paper 1** encompasses knowledge accessed in the local market from sources within and outside the firm boundaries. **Paper 2** is focuses on knowledge transfers from MNCs´ subsidiaries to headquarters, and **Paper 3** considers knowledge sharing within teams in constant improvement projects within an MNC. In summary:

Source of knowledge	Paper 1: MNC internal and external environment
	Paper 2: foreign subsidiaries of MNCs
	Paper 3: internal to the MNC (among project-team members)

Intra-organizational knowledge management mechanisms

Over the past two decades, a number of studies have explored the importance of effective intra-organizational knowledge management mechanisms in the various knowledge flows taking place at MNCs. For instance, Bresman, Birkinshaw, and Nobel (1999) show that communication, visits and meetings facilitate the transfer of technological know-how after acquisitions and that although the initial post-acquisition period is characterized by one-way transfers of knowledge from the acquirer to the acquired, over time such knowledge flows tend to become more reciprocal, including transfers from the acquired to the acquirer. Gupta and Govindarajan (1991) see subsidiaries of MNCs as both users and providers of knowledge to the rest of the corporation. For this reason, they argue that the control mechanisms should vary for different subsidiary types (i.e., Global Innovators, Integrated Players, Implementors, and Local Innovators). On a later study, Gupta and Govindarajan (2000) found that knowledge outflows from subsidiaries is positively related with the value of the subsidiary's knowledge stock and the

richness of transmission channels while knowledge inflows into subsidiaries is positively associated with the richness of transmission channels, its motivational disposition to acquire knowledge, and the capacity to absorb the incoming knowledge. With that in mind, scholars have argued that conventional and reverse knowledge flows are based on different logics (Yang, Mudambi, & Meyer, 2008). In regards to reverse knowledge flows, Rabbiosi (2011) showed that personal coordination mechanisms are especially effective when MNCs are trying to learn from innovator subsidiaries while electronic-based coordination mechanisms are more effective to stimulate reverse knowledge transfers with contributor subsidiaries. Andersen and Foss (2005) found that the use of information technology to facilitate cross-border communication helps MNCs to better develop and coordinate strategic opportunities, which in turn is associated with superior performance.

While the literature has advanced our understanding of knowledge flows within the MNC, scholars have called for more studies on the antecedents of knowledge management (Argote et al., 2003; Van Wijk et al., 2008). Other scholars suggest that future studies should include a "view of organizational mechanisms as instruments of influencing the sourcing, building, deployment and transfer of knowledge resources" (Foss & Pedersen, 2004, p.348). Thus, this thesis attempts to addresses such gaps by investigating the effect of several types of knowledge management mechanisms on knowledge outcomes.

For instance, to explore the effect of knowledge management mechanisms´ on local and global innovation at the organizational level, we consider both internal and external knowledge sources (Andersson et al., 2016) as well as the moderating effect of R&D investment and innovation training in **Paper 1**. To explore knowledge management mechanisms at the organizational level considering international reverse knowledge transfers we test the effect of three knowledge management capabilities (systems, coordination and socialization) (Jansen, Van den Bosch, & Volberda, 2005; Van den Bosch et al., 1999) on headquarters´ absorptive capacity in **Paper 2**. To understand knowledge management mechanisms at the team level we use the ability-motivation-opportunity (AMO) framework (Appelbaum, Bailey, Berg, & Kalleberg, 2000; Blumberg & Pringle, 1982; Boxall, 2003) in **Paper 3**. As Argote et al. (2003, p.575) state, "just as successful individual performance depends on an individual's ability, motivation, and opportunities to perform, successful knowledge management also depends on ability, motivation, and opportunity". The

AMO framework has then been considered "beneficial for framing and potentially extending our thinking about mechanisms that contribute to knowledge transfer in MNCs" (Minbaeva, Pedersen, Björkman, & Fey, 2014, p.57). In summary:

Knowledge management mechanism	Paper 1: knowledge sourcing mechanisms, absorptive capacity enhancing practices (e.g. R&D investment, innovation training)
	Paper 2: systems, coordination, and socialization capabilities
	Paper 3: project-teams´ ability, motivation and opportunity

Absorptive capacity

Despite the recognized importance of knowledge transfer for the development of MNC competitive advantages, research has also shown that firms often engage in knowledge transfers that do not produce substantial benefits (Ambos, Nell, & Pedersen, 2013) and that the recipient's lack of absorptive capacity is one of the major impediments for successful transfers (Szulanski, 1996). With that in mind, absorptive capacity has been identified as one of the most important aspects associated with knowledge transfer within the organization (Lane & Lubatkin, 1998; Van Wijk et al., 2008). Absorptive capacity is particularly important in the internationalization process, since it reduces the gap between the knowledge possessed and the knowledge needed for accomplishing foreign ventures (Petersen, Pedersen, & Lyles, 2008). Internationalizing firms must apprehend, share, and assimilate new knowledge in order to compete and grow in markets in which they have little or no previous experience (Autio, Sapienza, & Almeida, 2000).

Cohen and Levinthal (1990) are the authors who first discussed the concept in depth in their seminal paper "Absorptive Capacity: A new perspective on learning and innovation", although related ideas are found in the literature before then (Dierickx & Cool, 1989; Kedia & Bhagat, 1988). Absorptive capacity (AC) can then be understood as the ability to recognize, assimilate and apply new external knowledge and is a function of the pre-existing stock of knowledge (Cohen & Levinthal, 1990).

Following Cohen and Levinthal (1990) a number of studies have extended or proposed reconceptualizations of absorptive capacity. For instance, Lane and Lubatkin (1998) introduce the concept of relative absorptive capacity. According to the authors, a firm´s ability to learn is given at the dyad-level and depends on the

similarity with other firm´s knowledge bases, organizational structures and compensation policies, and dominant logics. Zahra & George (2002) distinguish between potential and realized AC. Potential AC refers to a firm´s ability to acquire and assimilate external knowledge, while realized AC encompasses transformation and exploitation dimensions. According to the authors, realized AC generally produces outcomes related to innovation and creation of competitive advantage while potential AC provides strategic flexibility to adapt and evolve in dynamic environments helping to sustain competitive advantage. Finally, Lane, Koka, and Pathak (2006, p.856) redefine absorptive capacity as sequential processes consisting of "(1) recognizing and understanding potentially valuable new knowledge outside the firm through exploratory learning, (2) assimilating valuable new knowledge through transformative learning, and (3) using the assimilated knowledge to create new knowledge and commercial outputs through exploitative learning". Although subsequent studies bring a valuable contribution to our understanding of absorptive capacity, most of them rely on the original Cohen and Levinthal (1990)´s definition (as opposed to replacing it). Also, scholars have called for more studies that "demonstrate an understanding of absorptive capacity's original assumptions and then test them through replications and extensions that build on the theory, metrics, and findings of prior studies via tests in several contexts" (Lane et al., 2006, p.858). Therefore, this thesis builds on Cohen and Levinthal (1990)´s absorptive capacity theory while taking into consideration the studies and reconceptualizations published since then.

Some theoretical aspects of absorptive capacity are particularly relevant for this thesis. First, when discussing the role of R&D in building organizational absorptive capacity, Cohen and Levinthal (1990) introduce a circumstance where absorptive capacity may be diminished, that is, in environments where learning is more difficult. In such settings, more prior knowledge must be accumulated via R&D for effective learning to occur. This aspect of the absorptive capacity original concept is further explored in **Paper 1** when discussing why R&D investment is expected to moderate the relationship between knowledge sourcing mechanisms and local innovation, instead of global innovation. Furthermore, Cohen and Levinthal (1990) argue that absorptive capacity requires two components: i) prior related knowledge, in the form of shared knowledge and expertise that favour effective internal communication, and ii) diversity of knowledge, which is acquired mainly at the interface with external sources of knowledge by individuals who act as gatekeepers or boundary-spanners. These two components are regarded as inward-looking AC

and outward-looking AC, respectively. The authors then discuss a potential trade-off effect between these two components suggesting that inward-looking and outward-looking AC complement each other up to a certain extent: “While both of these organizational components are necessary for effective organizational learning, excessive dominance by one or the other will be dysfunctional. If all actors in the organization share the same specialized language, they will be effective in communicating with one another, but they may not be able to tap into diverse external knowledge sources” (Cohen & Levinthal, 1990, p.133). As the authors do not test this trade-off effect nor elaborate on the interplay between inward-looking AC and outward-looking AC, scholars have called for more studies exploring this particular aspect of Cohen and Levinthal (1990)´s work (Pedersen et al., 2020; Volberda et al., 2010), which is the main subject of **Paper 2**. The problem with the current lack of understanding on this trade-off is that firms may attempt to maximize both inward-looking and outward-looking AC while the final outcome may not be optimal. Therefore, more clarification on the knowledge overlap needed to increase absorptive capacity is “highly significant to understanding the process of value creation” (Ambos et al., 2013, p.287). Finally, Cohen and Levinthal (1990) reinforce the relevance of absorptive capacity for problem solving, in particular when complexity increases as more intense efforts and diversified knowledge are needed to come up with solutions. This underlying idea is fundamental for the distinction of simple and complex projects and the factors affecting each in **Paper 3**. In summary:

Theoretical aspect of absorptive capacity	Paper 1: absorptive capacity may be diminished in environments where learning is more difficult.
	Paper 2: trade-off between inward-looking and outward-looking determinants of absorptive capacity.
	Paper 3: need for more intense efforts and diversified knowledge to develop absorptive capacity for problem solving as complexity increases.

This thesis also answers calls in the literature for more studies on antecedents of absorptive capacity (Van Wijk et al., 2008). The literature review from Volberda et al. (2010) points that the intraorganizational antecedents of AC have received less attention in the literature and suggest that future studies further explore internal mechanisms that can influence AC at firm level, such as the structure of communication, organizational structure and human resource management (HRM)

practices. Finally, Minbaeva et al. (2014) call for additional research to refine our understanding of how different contextual factors affect the conditions for the development of absorptive capacity, a claim that is sustained to the current date as Pedersen et al. (2020, page unidentified) argue that "there is still scope for more studies on the formation, development, and contextualization of this capacity". While Cohen and Levinthal (1990) overemphasized the role of R&D investments in increasing absorptive capacity they only briefly mention the importance of training in building such ability. Therefore, **Paper 1** contributes to our understanding of the antecedents of AC by arguing that both R&D investments and innovation training act as absorptive capacity enhancing practices with different roles in generating local and global innovation originated from knowledge sourcing mechanisms. **Paper 2** particularly addresses the antecedents gap in the context of international reverse knowledge transfers by exploring the effect of knowledge management capabilities (systems, coordination and socialization) (Jansen et al., 2005; Van den Bosch et al., 1999) and multinationality (Barkema & Vermeulen, 1998; Denison, Dutton, Kahn, & Hart, 1996; Hitt, Hoskisson, & Kim, 1997) as inward-looking and outward-looking determinants of AC, respectively. **Paper 3** discusses the contextual factors that affect AC by comparing team dynamics in simple and complex projects, relying on Cohen and Levinthal (1990)´s assumption that as complexity increases, more intense efforts and diversified knowledge may be needed in order to develop absorptive capacity for problem solving. In summary:

Contribution to the understanding of absorptive capacity	Paper 1: R&D investment and innovation training as absorptive capacity enhancing practices with different impact on local and global innovation.
	Paper 2: knowledge management capabilities and multinationality as inward-looking and outward-looking determinants of absorptive capacity, respectively.
	Paper 3: contextual factors that affect absorptive capacity (simple x complext projects).

Innovation types and knowledge management outcomes

As regards to the type of innovation, the literature distinguishes between exploratory innovations and exploitative innovations (Jansen et al., 2006; March, 1991). Exploratory innovations are radical innovations designed to meet the needs of new customers or markets and usually focus on long-term outcomes. Exploitative innovations are incremental innovations designed to meet the needs of existing

customers or markets and usually focus on short-term outcomes. Within these types of innovation, product innovation and process innovation are recognized as two distinct outcomes (Cohen & Klepper, 1996; Levin, Klevorick, Nelson, & Winter, 1987). In general, exploratory innovation has been associated with product innovation while exploitative innovation has been more associated with process innovation and firm performance (Jansen et al., 2006; Van Wijk et al., 2008). This thesis considers both types of innovation. **Paper 1**, investigates primarily exploratory innovations (e.g. product innovations) as the dependent variable here is patents, which has been more associated with product innovation than process innovations (Levin et al., 1987). **Paper 2** encompasses the two types of innovation as the dependent variable is related to the headquarters´ ability to absorb knowledge from foreign subsidiaries, where the knowledge in question is related to product, service, and/or process innovation. **Paper 3** is primarily focused on exploitative innovation, as the projects at InterCement aim to explore the existing knowledge pool and to generate constant improvements in production. Indeed the short-term and decentralized nature of project-based organizations, especially the ones in the construction industry, facilitate exploitation rather than exploration of knowledge (Eriksson, 2013). In summary:

Type of innovation	Paper 1: exploratory innovation (e.g. product innovation)
	Paper 2: both exploitative and exploratory innovation
	Paper 3: exploitative innovation (e.g. process innovation)

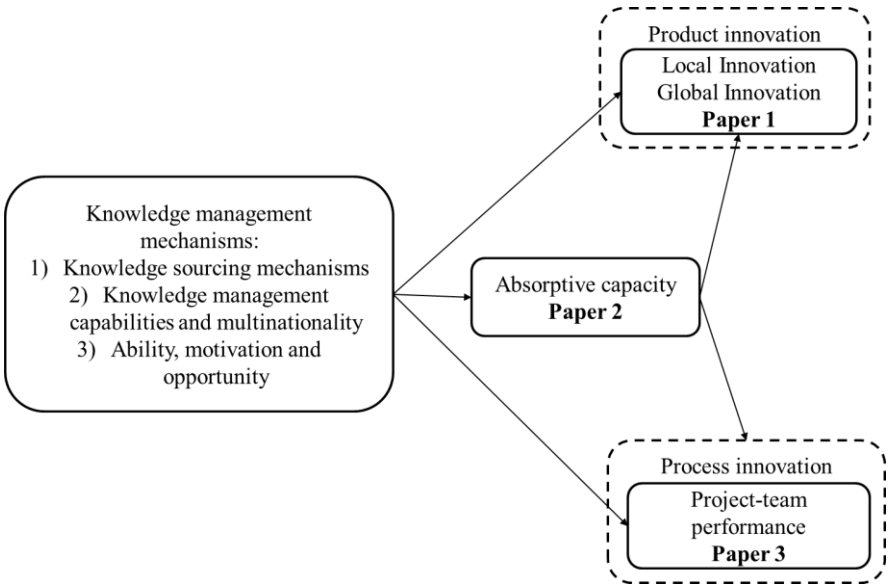
As regards to the outcomes of effective knowledge management, the literature has identified performance and innovativeness as the main outcomes. Van Wijk et al. (2008) and Volberda et al. (2010) provide excellent reviews of the literature on knowledge transfer and absorptive capacity respectively. For instance, Tsai (2001) shows that absorptive capacity helps to increase firm innovation and performance, especially when units occupy a central position in the organizational network because they access useful knowledge from other units. Despite the beneficial effects of knowledge management mechanisms on both innovation and performance, studies have shown that certain mechanisms impact performance but do not generate learning (Lane et al., 2001). Therefore, this thesis has different expected outcomes depending on the type of knowledge management mechanism

and context studied. For instance, Jansen et al. (2006) showed that firms that pursue exploitative innovations in highly competitive environments improve their performance more than firms that pursue exploratory innovations. Therefore, the study presented in **Paper 1** has local and global innovation as the outcome of interest. **Paper 2** is focused on the inward-looking and outward-looking determinants of absorptive capacity and therefore the outcome of interest in absorptive capacity. **Paper 3** aimed at assessing performance outcomes from exploitative innovation (e.g. process innovation) in project teams. In summary:

Knowledge management outcome	Paper 1: local and global innovation
	Paper 2: absorptive capacity
	Paper 3: project-team performance

Overall framework

In conclusion, each of the papers contributes to answer this thesis´ general research questions and adds value to the ongoing debate of how knowledge management mechanisms can more effectively lead to innovation and performance outcomes in multinational corporations and what is the role of absorptive capacity. The figure below summarizes this thesis´ overall framework:



Besides their own contribution to this thesis´ overall research question, each of the papers bring additional contributions to the management field, as expressed by their specific research questions:

Individual papers´ specific research questions	Paper 1: To what extent can the innovation process be fostered by absorptive capacity enhancing practices? What is the role of R&D investment on the relationship between knowledge sourcing mechanisms and local innovation? What is the role of training on the relationship between knowledge sourcing mechanisms and global innovation?
	Paper 2: To what extent do knowledge management capabilities (the inward-looking determinant of AC) affect headquarters´ ability to learn from subsidiaries? Does multinationality (the outward-looking determinant of AC) influence headquarters´ ability to learn from subsidiaries? Does a trade-off exist between inward-looking and outward-looking determinants of AC in the context of international reverse knowledge transfers?
	Paper 3: In what ways do teams´ ability, motivation, and opportunity affect project performance? How do these factors interact? To what extent does the effect depend on the complexity of the project?

Context of the studies

This thesis´ studies are primarily done in the context of an emerging market, Brazil. The literature has widely discussed to what extent emerging market firms generate innovations. Studies range from an assumption of very limited contribution to global innovation (e.g. Luintel & Khan, 2017) to different innovation styles more focused on process innovation and business model innovation coming from emerging market firms, in particular from Latin American firms (Casanova, 2009; Cuervo-Cazurra, 2019). While innovation levels seem to be partially accountable on nation-level characteristics such as host country policies, institutions, human capital and research, infrastructure, market and business sophistication (Crespo & Crespo, 2016; Santangelo, Meyer, & Jindra, 2016; Sofka, Grimpe, Hasanov, & Cherif, 2018), the way emerging market firms manage their R&D activities vary significantly with different outcomes in terms of innovation performance (Awate, Larsen, & Mudambi, 2012, 2015).

Emerging markets have attracted more attention recently from the literature. Multinational corporations from developed economies are increasingly globalizing their R&D activities to emerging economies (Alcacer, Cantwell, & Piscitello, 2016) while emerging market firms are catching up in the global innovation landscape, developing their own innovative capabilities (Lynch & Jin, 2016) and moving from a process to a product focus and from imitation to innovation (Li & Kozhikode, 2009). With that in mind, firms operating in emerging markets have increasingly carried innovation activities and become a source of reverse innovation (Govindarajan & Ramamurti, 2011; Kumar, Mudambi, & Gray, 2013).

Such innovation however, has not come without challenges. Emerging markets in general face less sophisticated institutional environments and scarcer resources, which impose additional constraints to develop technology advantages (Gammeltoft, Barnard, & Madhok, 2010; Ramamurti, 2012). Therefore, emerging market firms need to be particularly concerned with what types of managerial practices and incentives are more effective to generate innovations in order to develop their competitive advantages (Lynch & Jin, 2016). Knowledge management then has crucial importance for emerging market firms to compete both locally and globally.

Brazil was chosen as the primary setting for conducting this thesis´ studies. Although the country shows relatively low levels of breakthrough innovation, it has grew lately in innovation capability and is currently in 40th position, among 137 nations, according to the World Competitiveness Ranking, being also the highest ranked among Latin American and Caribbean countries in this specific criteria (WEF, 2019). Also, we expect Brazilian firms to be able to combine effectively their organizational competences and develop superior process innovation and business model innovation in order to compensate for the reduced technological capacity (Casanova, 2009; Cuervo-Cazurra, 2019). In fact, in a study of 61 Brazilian multinationals, Fleury, Fleury, and Borini (2013) showed that such management-related innovative capabilities is what allows Brazilian MNCs to internationalize successfully. Thus, **Paper 1** focuses on reverse innovation, in this case, innovation generated from firms operating in Brazil – either subsidiaries of foreign MNCs and locally headquartered MNCs. **Paper 2** focuses on headquarters of an emerging market, Brazil and a non-emerging market, Portugal, including controls for potential differences between those markets when testing its hypotheses. **Paper 3** again turns attention to Brazil as the context of study by exploring knowledge sharing projects

in a Brazilian multinational, InterCement. Conducting the studies in Brazilian MNCs attest the consistency of past research that has explored similar constructs in developed economies and brings additional insights into successful knowledge management strategies that can apply to firms from various development-level markets, not exclusively to emerging market firms. In summary:

Context	Paper 1: reverse innovation from an emerging market, Brazil.
	Paper 2: absorptive capacity of headquarters from emerging market MNCs (Brazil) and non-emerging market MNCs (Portugal).
	Paper 3: knowledge sharing in projects in an emerging market/Brazilian MNC.

Methods

This thesis relies mainly on empirical quantitative studies that use different data collection, analytical methods and tools. **Paper 1** uses data from an annual survey carried through eight years (2012-2019) with subsidiaries of foreign MNCs and local internationalized companies operating in Brazil. Data on the independent variables, controls and moderators in the three initial years of the survey were combined with data on the dependent variables provided by the same firms in the three final years of the survey, in order to lag knowledge sourcing initiatives and innovation outcomes in five years and allow for cause-and-effect inferences. Statistical analysis were based on a random effects negative binomial model using the software R. **Paper 2** uses data from a cross-sectional survey conducted at 106 Brazilian and Portuguese MNCs in 2017. Companies are in general large and from various industries. All of them have engaged in foreign direct investments, with operations abroad beyond exports, that is, commercial offices, and/or distribution centres, and/or manufacturing facilities, and/or services, and/or R&D units. Statistical analysis were based on OLS regression using the software SPSS. **Paper 3** originates from a case-study at InterCement, an MNC producer of cement, lime, and special mortars headquartered in Brazil. The case study aimed at understanding in depth the knowledge management mechanisms used by an MNC focused on exploitative innovation (e.g. process innovation). InterCement has 40 business units spread across eight countries: Brazil, Argentina, Paraguay, Portugal, Mozambique, Cape Verde, Egypt, and South Africa and exports to 17 countries. One key initiative

at InterCement is the Continuous Improvement Program, which aims to establish, monitor, and foster process improvement projects. The program has directly affected the company's overall performance and contributed about EUR 2.5 million in savings per year. Objective data on project-team´s ability, motivation and opportunity as well as financial performance was provided by the firm in 2016, totalling 285 continuous improvement projects. Statistical analysis were based on OLS regression using the software SAS. A complete report on InterCement´s knowledge management initiatives is presented in Appendix 1. In summary:

Methods	Paper 1: empirical, quantitative, time-lagged, survey with 108 subsidiaries of foreign MNCs and headquarters of national MNCs operating in Brazil.
	Paper 2: empirical, quantitative, cross-sectional, survey with 106 MNCs headquartered in Brazil and Portugal.
	Paper 3: empirical, quantitative, cross-sectional, 285 projects, individual and team data provided by Intercement, a Brazilian MNC.

In regards to the levels of analysis, this thesis´ interest lies primarily in knowledge management mechanisms at more aggregate levels of analysis. Therefore, Paper 1 and Paper 2 focus on the firm level. **Paper 1** includes both subsidiaries of foreign MNCs and headquarters of local MNCs. Therefore, the unit of analysis is firms operating in Brazil since firms operating in emerging markets have increasingly carried innovation activities and become a source of reverse innovation (Govindarajan & Ramamurti, 2011; Kumar et al., 2013). **Paper 2** has the MNC headquarter as the unit of analysis since the purpose of the study was to explore reverse knowledge transfer from the recipient of knowledge perspective, answering calls in the literature for studies that shed light on the strategies and mechanisms by which MNC's headquarters can improve their ability to absorb the knowledge created by their foreign subsidiaries (Ambos, Ambos, & Schlegelmilch, 2006; Rabbiosi, 2011). **Paper 3** studies knowledge management mechanisms at the team-level. The team level is an appropriate level of analysis for this study as firms make extensive use of team-based projects to share knowledge and best practices internally (Gupta & Govindarajan, 2000; Sydow, Lindkvist, & DeFillippi, 2004). Project teams are associations of employees with varied knowledge, expertise, and experience who work together over the lifespan of a project to achieve a common objective of either developing an incrementally or radically new concept, service,

product, activity, or generating change (Chiocchio, 2015). Therefore, project-teams are appropriate to study exploitative innovation at an MNC. Finally, it is worth mentioning that we see absorptive capacity as multi-level construct where "the capacity to absorb knowledge ultimately resides within the minds of individuals and teams, while synergies are manifested at the organizational level" (Minbaeva et al., 2014, p. 58). Thus, in order to operationalize our measures we follow Cohen and Levinthal (1990) logic that a firm's absorptive capacity is more than the mere sum of the absorptive capacities of its employees and therefore we use firm-level and team-level measures. In summary:

Levels of analysis	Paper 1: firm level - subsidiaries of foreign MNCs and headquarters of local MNCs
	Paper 2: firm level - MNCs´ headquarters
	Paper 3: project-team level

Publication status

Finally, the papers are in slight different stages of development for final publication at academic journals. **Paper 1** has been presented and awarded as the best paper at the EnANPAD conference (online, Brazil, October 2020) and is being prepared for submission to a journal. **Paper 2** has been presented at the Academy of International Business (AIB) conference and at the Innovation, Entrepreneurship and Knowledge Flows In and Out of Emerging Economies Workshop at CBS, both in June 2019 (Copenhagen, Denmark) and is currently under review Journal of International Management. **Paper 3** has been presented at the European International Business Academy (EIBA) conference in December, 2018 (Poznán, Poland) and has been published at the Project Management Journal (2020). Also, following CBS´s PhD guidelines, one of the papers is single authored while the other two are co-authored. Co-authors have provided declarations in which they state my contribution to each of the papers.

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Chapter 2

Fostering local and global innovation through absorptive capacity enhancing practices

Lívia Lopes Barakat

Abstract

This study discusses the different absorptive capacity enhancing practices needed to generate local innovation versus global innovation. More specifically, we assume different nature of such practices and suggest that R&D investment moderates the relationship between knowledge sourcing mechanisms and local innovation, while training moderates the relationship between knowledge sourcing mechanisms and global innovation. The hypotheses are tested on a sample of multinational corporations (MNCs) operating in an emerging market, Brazil. By measuring the variables in two points in time with a five-year gap between them, cause and effect relationships are inferred. This study contributes to the literature by demonstrating the different roles of two absorptive capacity enhancing practices - R&D investment and training - on innovation at different levels, local and global respectively.

Keywords: local innovation, global innovation, absorptive capacity, R&D investment, training

1. Introduction

In order to develop innovation capabilities, firms may use knowledge sourcing mechanisms intended to exploit as well as to explore knowledge within and outside the firm boundaries (Andersson, Dasí, Mudambi, & Pedersen, 2016; Scuotto, Santoro, Bresciani, & Del Giudice, 2017). While such mechanisms are effective to acquire knowledge, the imperatives to innovate locally and globally impose additional challenges to assimilate, transform and exploit such knowledge (Phene & Almeida, 2008). The increased global competition, as well as all the cultural, institutional and economic differences involved in cross-border activities make

innovating globally different (and likely more difficult), than innovating locally (Fallah & Lechler, 2008; Tarraço, Bernardes, Borini, & Rossetto, 2019). The difficulties in transferability of knowledge from one environment to another (Zander & Kogut, 1995) may help to explain why, for instance, innovation tends to be localized in the originating country at first, becoming more geographically spread over time (Jaffe, Trajtenberg, & Henderson, 1993). Furthermore, while innovating locally requires a high level of local embeddedness (Cantwell & Mudambi, 2011; Isaac, Borini, Raziq, & Benito, 2019), innovating globally requires a more global perspective and mindset (Un, 2016). Therefore, firms need to take proper actions to foster their ability to recognize the value of new information, assimilate it, and apply it, that is, their absorptive capacity (Cohen & Levinthal, 1990) in order to generate innovation at local and/or global levels (Gupta & Govindarajan, 1991).

Cohen and Levinthal (1990) argues that one way of increasing absorptive capacity is through R&D investments. However, subsequent literature has pointed that other practices, such as training and education are also important to increase knowledge transfer and absorptive (Lane, Salk, & Lyles, 2001; Minbaeva, Pedersen, Björkman, Fey, & Park, 2003). Firms with well-developed capabilities of knowledge acquisition, assimilation, transformation and exploitation are more likely to achieve a competitive advantage through innovation and to sustain their competitive advantage than those with less developed capabilities (Zahra & George, 2002). The literature has clearly shown that firm´s ability to assimilate knowledge and learn produces outcomes such as innovation and superior performance (Lyles & Salk, 1996; Phene & Almeida, 2008; Tsai, 2001; Van Wijk, Jansen, & Lyles, 2008).

The purpose of this study is to explore the role of two absorptive capacity enhancing practices, R&D investment and training, in fostering local and global innovation. More specifically, given their different nature, we expect R&D investments to moderate the positive relationship between knowledge sourcing mechanisms and *local* innovation, and training to moderate the relationship between knowledge sourcing mechanisms and *global* innovation. Both are expected to have an enhancing effect on absorptive capacity, which is an important antecedent of innovation. Yet, the rationale for the different moderating effects lies in the contribution of R&D to generate new knowledge (Cohen & Levinthal, 1990; Grimpe, Sofka, Bhargava, & Chatterjee, 2017; Helfat, 1994) and insert firms in local innovation networks (Cantwell & Mudambi, 2011; Scott-Kennel & Saittakari, 2020) while training is particularly beneficial to disseminating existing knowledge

(Cabrera & Cabrera, 2005; Minbaeva, Mäkelä, & Rabbiosi, 2012) and fostering intercultural skills (Ramsey & Lorenz, 2016; Un, 2016).

Therefore, this study aims to answer the following research questions: To what extent can the innovation process be fostered by absorptive capacity enhancing practices? What is the role of R&D investment on the relationship between knowledge sourcing mechanisms and local innovation? What is the role of training on the relationship between knowledge sourcing mechanisms and global innovation?

The hypotheses are tested in a sample of subsidiaries of foreign multinational corporations (MNCs) and headquarters of national MNCs operating in an emerging market, Brazil. The emerging market context is relevant for this study as MNCs from developed economies are increasingly globalizing their R&D activities to such markets (Alcacer, Cantwell, & Piscitello, 2016) while emerging market MNCs which traditionally occupied a secondary role in the global innovation landscape, have been catching up in developing their own innovative capabilities (Lynch & Jin, 2016), moving from a process to a product focus and from imitation to innovation (Li & Kozhikode, 2009). With that in mind, firms operating in emerging markets have increasingly carried innovation activities and become a source of reverse innovation (Govindarajan & Ramamurti, 2011; Kumar, Mudambi, & Gray, 2013).

This study contributes to the literature by: i) discussing the different knowledge requisites to innovate locally and globally, which has been scarcely explored by existing literature; ii) exploring the different nature of R&D investment and training that lead to distinct moderating effects on local and global innovation respectively, and iii) reinforcing the need for absorptive capacity enhancing practices to generate effective innovation outcomes from knowledge sourcing mechanisms. By doing so, we advance emerging literature in the field (Fallah & Lechler, 2008; Isaac et al., 2019; Tarraço et al., 2019), answer calls for more studies that shed light on how local R&D activities impact overall R&D activities of the MNC (Andersson & Pedersen, 2010), and address calls for more studies on the role of HRM practices, such as training, in fostering innovation development (Foss, 2007; Lane, Koka, & Pathak, 2006).

The paper is structured as follows. First, we provide an overview of the well-established link between knowledge sourcing mechanisms and innovation. Then,

we discuss the differences in local and global innovation which raise the need for absorptive capacity enhancing practices (R&D investment and training). Following, we develop the two hypotheses of this study. Then, we present the methods and results of the hypotheses tests. A discussion follows with implications for theory, practice and future research.

2. Theoretical background and hypothesis development

2.1Knowledge sourcing mechanisms and innovation

Knowledge is seen by the knowledge-based-view as a key resource for firm value creation and sustained competitive advantage (Conner & Prahalad, 1996; Grant, 1996). The literature shows that knowledge processes at MNCs can originate from different sources, including external and internal knowledge sourcing (Andersson et al., 2016; Eisenhardt & Santos, 2001). The dynamic capabilities perspective further suggests that firms combine internal and external knowledge to exploit technological opportunities and to cope with the dynamic environment (Teece, Peteraf, & Leih, 2016). However, a perspective that integrates both internal and external knowledge sourcing is still scarce in the literature (Papa, Dezi, Gregori Gian, Mueller, & Miglietta, 2018).

Sourcing knowledge from both the internal and the external environment is important as it allow firms to benefit from diverse knowledge leading to enhanced knowledge outcomes. For instance, Khedhaouria and Jamal (2015) show that sourcing knowledge within groups and repositories increases knowledge reuse while sourcing knowledge from external sources (e.g. the Internet) increases knowledge creation. Scuotto et al. (2017) shows that both external (e.g. open innovation) and internal (e.g. in-house R&D) knowledge sourcing improve firm´s innovation performance. Knowledge sourcing at early stages of the innovation process focuses on acquiring knowledge for research and creation of new ideas, which has been associated with greater innovation performance primarily focused on long term market relevance (Garg & Zhao, 2018). In this study, we name such external and internal processes as knowledge sourcing mechanisms.

External knowledge sourcing are therefore processes that take place outside the firm boundaries, by interacting with other firms such as joint venture partners, host country institutions or knowledge clusters (Andersson et al., 2016). In this regard, knowledge assimilated from the local environment is very important to the scale and quality of innovation (Phene & Almeida, 2008). More than that, the more

embedded is the local unit with the external local network the more it is able to generate local innovations, which is then transformed into global innovation (Isaac et al., 2019). One of the mechanisms increasingly used by MNCs for this sort of learning activity is the open innovation, which sources knowledge externally and is complementary to other R&D activities (Chesbrough & Crowther, 2006; Naqshbandi & Jasimuddin, 2018). Also, past research has shown that the more open to external scientific knowledge a firm is, the stronger the effect of its in-house R&D on financial performance (Kafouros & Forsans, 2012).

Internal knowledge sourcing refers to knowledge sourcing within firms' boundaries, with particular interest to the knowledge flows within departments or units of a firm (Andersson et al., 2016; Gupta & Govindarajan, 2000). Research has shown that different intraorganizational knowledge sourcing mechanisms are required for successful transfers. For instance, Lagerstrom and Andersson (2003) showed that internal forums that promote socialization of team members is more important than information technology to efficiently create and share knowledge. Naqshbandi and Jasimuddin (2018) showed that firms can develop knowledge sourcing mechanisms by having processes and structures that enable the acquisition, generation, development, experimentation, exchange and transfer of knowledge not only with external partners but also within the firm, with positive impact on innovation outcomes.

In conclusion, MNCs constantly face the challenge of developing innovative products and services through effective sourcing and sharing of knowledge either within or outside their boundaries (Scott-Kennel & Saittakari, 2020). In addition, since managers may be selectively biased in their knowledge sourcing decisions (Monteiro, 2015), this study assumes that accessing and interpreting knowledge from a variety of sources leads to more organizational learning (Huber, 1991) because it increases the chance that new incoming knowledge is considerably similar to what is already known, while being relatively diverse to enable new linkages with pre-existing knowledge (Cohen & Levinthal, 1990). Laursen and Salter (2006, p.135) refer to this *search breadth* as "the number of different search channels that a firm draws upon in its innovative activities", which is shown to influence innovative performance. Also, Mudambi and Navarra (2004) showed that the greater the knowledge inflows into a subsidiary, the more knowledge outputs it generates. Hence, in this study, knowledge sourcing mechanisms represent the

quantity of knowledge accessed by the firm to generate local and/or global innovation.

2.2Local innovation and global innovation

As discussed above, it is widely recognized that knowledge sourcing mechanisms lead to innovation. But such knowledge sourcing mechanisms can lead to different innovation outcomes, as innovation can take place at both local and global levels, requiring specific managerial practices to succeed in each.

In fact, the rules to innovate globally are different from those to innovate locally given the challenges of global competition such as dispersion of technological knowledge, greater cultural diversity of customer needs, and the fact that the home country is not necessarily the lead market for innovations (Fallah & Lechler, 2008). Therefore, new knowledge such as patents tends to be localized in the originating country at first, becoming more geographically spread over time (Jaffe et al., 1993). Zander and Kogut's (1995) discuss difficulties in transferability of knowledge that may help to understand why innovating globally is different, if not more difficult, than innovating locally. Such constraints are related to low codifiability, high complexity, low teachability, and high system dependency, that is, the degree to which a capability is dependent on several different experienced people for its production. This is particularly the case of some emerging markets such as Brazil. For instance, Tarraço et al. (2019) show that it is more difficult for MNC foreign subsidiaries operating in Brazil to generate global innovations than local innovations, because global innovation depends on the firm´s accumulation of R&D capacities by continuously performing product and process innovation activities locally. Yet, as the Brazilian environment is not much conducive to breakthrough innovation (Fleury, Fleury, & Borini, 2013) and product innovation is generally focused on meeting the needs of low-income population (Cuervo-Cazurra, 2019), it is likely that some part of such innovation will not be transferred to the global environment. Because generating global innovation can be more challenging than generating local innovation, this study suggests that firms need to carefully take into account which mechanisms are appropriate to foster each one.

Gupta and Govindarajan (1991) offers a typology of subsidiaries that sheds light on the importance of choosing adequate mechanisms to generate local innovation and/or global innovation. Adapting such typology to the context of this study (i.e. not only subsidiaries of foreign MNCs but also headquarters of national MNCs), we

can assume that the Local Innovator is able to create relevant know-how, but such knowledge becomes so specific to the local environment that it is hardly transferred or used globally to create competitive advantages. These firms are primarily generating local innovation. On the other hand, the Integrated Player creates knowledge that can be utilized globally but is not self-sufficient in creating its own local knowledge. These firms are primarily generating global innovation. The Global Innovator generates both local and global innovations as it serves as a source of knowledge for the global environment, while it is also self-sufficient in its own local knowledge creation. Finally, the Implementor is a local firm that engages in little knowledge creation (presumably this firm makes little or no use of the knowledge sourcing mechanisms and absorptive capacity enhancing practices to generate innovation). Gupta and Govindarajan (1991) argue that different structural and control mechanisms apply for each. For instance, Integrated Players use more communication, formal coordination mechanisms and socialization of top management teams than Local Innovators. Hence, Integrated Players have been shown to provide the most valuable knowledge for the rest of the MNC (Ambos, Ambos, & Schlegelmilch, 2006). Building on this rationale, this study assumes that MNCs need different practices to foster different types of innovation (i.e. local versus global).

While knowledge sourcing mechanisms in this study represent the *quantity* of knowledge accessed by the firm, firms need to have absorptive capacity (AC) in order to fully assimilate and apply such incoming knowledge. Absorptive capacity is the "ability of firms to recognize the value of new, external information, assimilate it, and apply it to commercial ends" (Cohen & Levinthal, 1990, p.128). Without such ability, the knowledge acquired from the knowledge sourcing mechanisms would have little or no value to the *quality* of knowledge creation. In fact, recent conceptualizations of AC building on Cohen and Levinthal (1990) distinguish between a knowledge acquisition dimension and its subsequent phases, including assimilation, transformation and exploitation of such knowledge (Lane et al., 2006; Zahra & George, 2002). Therefore, firms should adopt practices that enhance their absorptive capacity in order to better exploit the knowledge acquired when using knowledge sourcing mechanisms to produce innovation outcomes (Van Wijk et al., 2008).

2.3Absorptive capacity enhancing practices

The literature has shown that one way of increasing absorptive capacity is through R&D investments (Cohen & Levinthal, 1990). For instance, under conditions of increased global competition, firms may use financial incentives such as R&D investments to keep up with their innovation capabilities and to improve its distinctive technological competitiveness (Cuervo-Cazurra & Un, 2007).

However, R&D is not enough on its own and other factors, such as training and education are also important to increase knowledge transfer and absorptive capacity (Daghfous, 2004). For instance, Minbaeva et al. (2003) point to practices that increase absorptive capacity as those that influence individual behavior, such as performance-based compensation, training and performance appraisals.

In addition to this, following the innovation literature (e.g. Criscuolo, Haskel, & Slaughter, 2010), we assume that the output of new knowledge is affected by two variables: i) investment in discovering new knowledge, e.g., research and development, and ii) the exchange of ideas from the existing knowledge stock, e.g. employees´ knowledge base (which we assume can be enhanced through training). In fact, R&D investment is focused on developing new knowledge with outcomes such as new product development, patents, and innovation performance (Cohen & Levinthal, 1990; Grimpe et al., 2017; Helfat, 1994). On the other hand, training is related to disseminating existing knowledge as it creates informal networks across the different parts of the organization, develops team-work skills and increases the capacity to articulate and communicate knowledge (Cabrera & Cabrera, 2005; Minbaeva et al., 2012). We thus suggest that while R&D investments and training can both enhance absorptive capacity and moderate the relationship between knowledge sourcing mechanisms and innovation, their different nature makes them more effective to produce either local innovation or global innovation. Next, we describe such expected relationships and develop the hypotheses.

2.3.1 Role of R&D investment

R&D investment is the traditional explanation of the innovativeness of the firm (Levin, Cohen, & Mowery, 1985) as it not only generates new knowledge but also contributes to the firm's absorptive capacity, which in turn generates innovation (Cohen & Levinthal, 1990). This study suggests that R&D investment impacts innovation through its enhancing effect on absorptive capacity.

Investing in R&D is a way of developing firm´s stock of knowledge and skills internally, which makes firms more prone to take advantage of external knowledge (Daghfous, 2004). The level of local R&D investments may be dependent upon factors such as government incentives, the quality of local institutions as well as the role of the unit within the MNC (Cantwell & Mudambi, 2005; Santangelo, Meyer, & Jindra, 2016; Sofka, Grimpe, Hasanov, & Cherif, 2018).

In this study, R&D investments are expected to be particularly relevant to generate *local* innovations. In the case of national internationalized firms operating in emerging markets, R&D investments are used to differentiate them from foreign competitors mainly through process innovation and development of products considering low-income population and infrastructure challenges (Cuervo-Cazurra, 2019). Because such products may be too country specific, R&D investments may be directed more easily to generate innovations that meet local needs. Also, in the case of subsidiaries of foreign MNCs, creating knowledge locally requires greater autonomy on their R&D investment decisions in host countries (Cantwell & Mudambi, 2005). Such R&D investments may also help to develop a competence-creation mandate and insert firms more easily in local innovation networks, turning them into 'insiders' with stronger connections to local partners (Cantwell & Mudambi, 2011; Scott-Kennel & Saittakari, 2020). In turn, local network ties help firms attract more capital from local partners (Coombs, Mudambi, & Deeds, 2006) and are more effective to generate innovation performance than global innovation ties (Wang, Li, & Huang, 2018). This can be particularly important in the Brazilian environment as relational embeddedness with the local network is fundamental for developing local innovations as opposed to global innovations (Isaac et al., 2019).

In addition to that, as the global environment is marked by several cultural, administrative, geographic and economic differences (Ghemawat, 2001) the learning process can be affected (Ambos & Ambos, 2009; Kedia & Bhagat, 1988) making it more difficult to apply R&D investments to generate global innovations. As Cohen and Levinthal (1990) explain, in environments where learning is more difficult, absorptive capacity is diminished so that more prior knowledge has to have been accumulated via R&D for effective learning to occur. Therefore, R&D investments in conjunction with knowledge sourcing mechanisms may produce optimal *local* innovation outcomes. This leads to the first hypothesis:

H1: R&D investment positively moderates the relationship between knowledge sourcing mechanisms and local innovation.

2.3.2 Role of training

Scholars have called for more studies on the importance of Human Resource Management (HRM) mechanisms for knowledge management and innovation development (Foss, 2007; Lane et al., 2006; Volberda, Foss, & Lyles, 2010). HRM practices have a pivotal role in assuring coordination among subunits of a firm to foster knowledge sharing (Cabrera & Cabrera, 2005). HRM practices have also been found to moderate the relationship between knowledge acquisition and innovation performance (Papa et al., 2018).

Among the many HRM practices, training is particularly important to generate knowledge outcomes. Training connects people from different departments or units of an organization and create shared workflow interfaces (Galbraith, Downey, & Kates, 2002; Van den Bosch, Volberda, & de Boer, 1999). It enhances employees´ knowledge and skills that are needed to effectively create and transfer knowledge (Zárraga & Bonache, 2003) as well as to develop firm´s capability innovate (Beugelsdijk, 2008; Laursen & Foss, 2003).

This study suggests that training impacts innovation through its enhancing effect on absorptive capacity. As Cohen and Levinthal (1990, p.129) state "Firms also invest in absorptive capacity directly, as when they send personnel for advanced technical training". The international business literature provides some evidences of this effect. For instance, Minbaeva et al. (2003) show that the extent to which MNC subsidiaries apply training to develop the skills of the workforce directly impact its absorptive capacity. Also, when studying knowledge transfers in international joint ventures Lane et al. (2001) show that prior knowledge acquired from the foreign parent only influences learning when combined with high levels of training by that parent. Simonin and Özsomer (2009) suggest that training is a moderating variable that fosters the relationship between knowledge acquisition and dissemination and knowledge outcomes, as it is commonly used to transfer knowledge between subsidiaries and headquarters of MNCs.

In addition to improving a firms´ absorptive capacity, training may be particularly relevant to foster *global* innovation as it focusses on disseminating existing knowledge throughout different units of the firm. Training is an important vehicle to acquire tacit knowledge by shared experience, that is, by socialization of members of an organization (Nonaka, 1994). Thus, training may be used not only to enhance managerial skills, but also to intentionally to create informal networks

across the different parts of the organization (Minbaeva et al., 2012), which facilitates the international transfer of knowledge (Minbaeva et al., 2003). By fostering social interaction among individuals, training may also help to develop multicultural skills that can help firms overcome their liability of localness in innovation, that is, a competitive disadvantage local firms face in generating global product innovation (Un, 2016). That is likely because training increases cultural intelligence (Ramsey & Lorenz, 2016) which has been associated with higher levels of firm innovativeness (Elenkov & Manev, 2009).

Therefore, training not only increases firm´s absorptive capacity but also fosters the international dissemination of existing knowledge and the development of cultural intelligence which are particularly important to promote *global* innovations. Finally, it is important to note that while the majority of the literature explores the effect of technical or managerial training on knowledge outcomes, this study is to the best of our knowledge the first to focus on innovation training, that is, training intentionally designed to enhance innovation skills of employees. With this in mind, we suggest the following hypothesis:

H2: Training on innovation positively moderates the relationship between knowledge sourcing mechanisms and global innovation.

The next table summarizes this study´s key constructs and definition:

Table 1. Key study´s constructs and definitions

Key constructs	Definition in this study	References
Knowledge sourcing mechanisms	Mechanisms employed by firms to source knowledge either internally or externally.	Andersson et al. (2016); Eisenhardt & Santos (2001); Khedhaouria and Jamal (2015); Scott-Kennel & Saittakari (2020); Scuotto, Santoro, Bresciani, and Del Giudice (2017).
Absorptive capacity enhancing practices	Practices employed by firms that foster their ability to absorb the knowledge acquired through knowledge sourcing mechanisms.	Cohen and Levinthal (1990); Daghfous (2004); Minbaeva et al. (2003).
R&D investment	Investment made by the firm to develop new products.	Cantwell & Mudambi (2005); Cohen & Levinthal (1990); Cuervo-Cazurra (2019); Levin, Cohen, & Mowery (1985); Santangelo, Meyer, & Jindra (2016); Sofka, Grimpe, Hasanov, & Cherif (2018).
Training on innovation	Training provided by firms to develop innovation skills and promote socialization of members from different units of an organization.	Beugelsdijk (2008); Lane et al. (2001); Laursen & Foss (2003); Nonaka (1994); Minbaeva et al. (2003); Minbaeva et al. (2012); Simonin and Özsomer (2009); Zárraga & Bonache (2003).

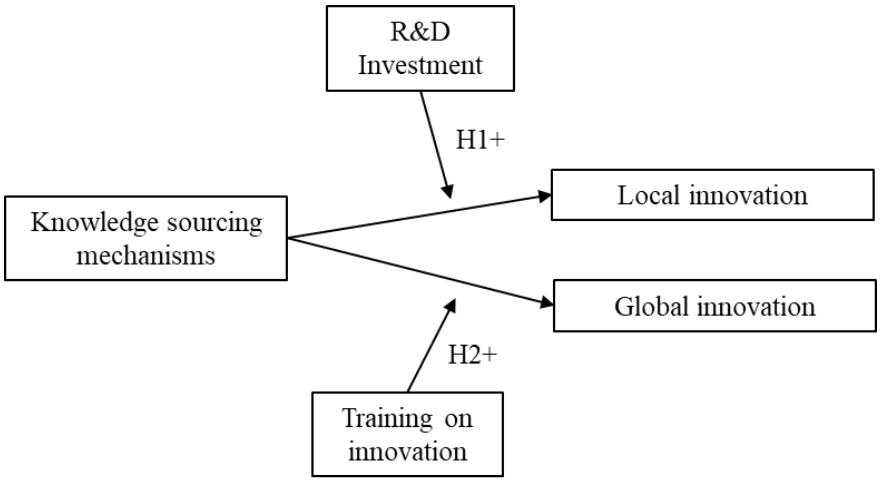
Table continues...

Key constructs	Definition in this study	References
Local innovation	Innovations generated by firms in the particular country studied (country of origin for local MNCs and host country for foreign MNCs).	Fallah & Lechler (2008); Gupta and Govindarajan (1991); Jaffe, Trajtenberg, & Henderson (1993); Tarraço, Bernardes, Borini, and Rossetto (2019).
Global innovation	Innovations generated by firms in foreign countries (rather than the country studied).	

Source: The author

The next figure illustrates the proposed model:

Figure 1. Proposed model



3. Methods

3.1Sample and data collection

In order to capture local and global innovation arising from an emerging market, this study includes both headquarters of national MNCs and subsidiaries of foreign MNCs operating in Brazil. We follow recent trends in the literature comprising knowledge sourcing of both types of firms (Scott-Kennel & Saittakari, 2020).

Our sample included firms from different sizes and industries. The list of potential companies included the ones listed at the Bovespa Stock Exchange and additional non-listed companies identified in the Biggest and Best survey by EXAME magazine as well as institutional contacts. Roughly 1000 companies with revenues of at least R$200 million (USD 51.6 million) were invited to participate in the survey every year. As there are several medium-sized and unlisted enterprises that rarely publish financial and operational information, all information needed was collected through a survey. Data was collected during an 8-year-period (2012-

2019). Sample sizes ranged from a minimum of 200 in 2012 to a maximum of 363 in 2019, averaging 292.3. Therefore, the response rate ranges from 20.0% to 36.4% over this period, averaging 28.2%. As the samples vary from one year to another, this study originates from an unbalanced panel. Over the eight years, we had 2340 observations from 696 firms. As participation was voluntary, not necessarily all firms participated in all years, which would be required for a balanced panel. For instance, only 52 firms participated in all eight years while 219 participate in only one year of the survey.

For the purpose of this study, we built a new database matching knowledge sourcing mechanisms (independent variable), training and investment (moderators) and company information (controls) in time-1, with innovation data (dependent variable) provided by the same firm in time-2 (five years later). Since there is an expected time lag between the adoption of knowledge sourcing mechanisms and the actual innovation outcomes (e.g. patent granting) (Un, 2016), we capture the study´s variables in different points in time with a five-year gap between them. Emergent studies have also lagged innovation inputs and outcomes in five-years to account for such time delay (Sofka et al., 2018). Therefore, data from the 2012 survey was matched with data provided by the same firm in the 2017 survey, and accordingly for the years 2013 with 2018 and 2014 with 2019. This procedure allowed us to more securely infer cause and effect relationships and answer calls in the literature to consider time lags in the relationships between knowledge inputs and its associated outcomes (Van Wijk et al., 2008). We discarded companies that have not participated in the pairs of years analyzed, which reduced the sample size to 385. Missing values were found in all the dependent variables, moderators and controls. Missing value rates varies from 0.0% to 63.6% among the variables of interest. Given the high number of missing data in some variables, imputation by regression was carried for 20% of missing values only in the dependent variables in order not to distort the results (we thus discarded companies that did not provide full data on the moderators and controls). The final sample size is of 108 observations from 87 companies. Among those, 70 firms (80.5%) participated in only one of the periods analyzed, 13 firms (14.9%) participated in two of the periods analyzed and 4 firms (4.6%) participated in three of the periods analyzed.

As we have repeated measures from 17 companies, the use of mixed effect models is advisable to account for the interdependencies among observations from the same firm over the 3-year window that we observe firms. We thus test the hypothesis

using hierarchical linear model. As most of the firms appear only once in the final sample, using fixed effect models to estimate one coefficient for each firm is not feasible considering the necessary degrees of freedom. Still, we were able to use a random effects model, which accounts for the heterogeneity among firms and therefore is superior to a pooled ordinary least square model (Croissant & Millo, 2008; Fitrianto & Musakkal, 2016). Also, considering that our dependent variable is a count variable and has an over dispersion of zeroes, we test our hypothesis using a negative binomial model (Booth, Casella, Friedl, & Hobert, 2003). Finally, for the purpose of hypotheses tests, which include interaction terms, all independent variables and interaction terms were standardized (Field, 2013).

3.2Measures

All the variables used in this study were operationalized with objective measures provided by the firms through the survey questions. The use of self-reported measures coming from the same source (survey) entail potential common method bias. To handle it, we followed several recommendations from Podsakoff, MacKenzie, Jeong-Yeon, and Podsakoff (2003). First, we protected respondent and firm anonymity, thus contributing to reduce the propensity for acquiescent or socially acceptable responses. Second, for each firm, we had two people in charge of the responses. Person 1 (usually someone from the management team - either from the institutional relations or the innovation department) provides the answers to the survey items. Once submitted to the research team, we contacted person 2 (in general the head of innovation or the company CEO), who is in charge of verifying the answers and signing an accuracy term of behalf of the firm. Third, by lagging the independent and dependent variables in five years, common method bias is considerably reduced, as the data provided by the company in time-1 is not made available for the company by the research team in the time-2 data collection process. Finally, for turnover reasons, respondents are usually different on the two time-periods. Therefore, the answers for explanatory and explained variables are less likely to suffer from common method bias. Next, we describe how each variable was operationalized.

3.2.1 Dependent variables

Innovation was measured as the number of patents granted in the previous five years. As the duration of the patent granting process can vary by industry and product, the innovation measure accounted for patents granted *over the previous*

five-years. Local innovation regards patents granted in Brazil by INPI (National Institute for Intellectual Property), while global innovation regards patents granted in other countries by patent authorities. The literature has frequently used patents to measure innovation performance and technological capabilities of MNCs (Belitz & Molders, 2016; Blomkvist, Kappen, & Zander, 2017). Patents have the advantage of being assessed by an independent institution based on their degree of novelty and allows comparisons across different industries and organizations (Sofka et al., 2018). Although the innovation data was self-reported by the surveyed firms, we checked patent data in patent authorities whenever information was available. For instance, for global patents, we checked patents reported at the World Intellectual Property Organization (WIPO) for each company participating in the study and compared with patent information provided in the survey. The high significant correlation between these two sources (0.837) point to the data consistency. We therefore assumed the same consistency for local patent information as this information is not made public nor shared by the Brazilian patent authority INPI.

3.2.2 Independent variables

This study´s measure of *knowledge sourcing mechanisms* intend to capture both internal and external processes that can take place to exploit and explore knowledge (Andersson et al., 2016; Scott-Kennel & Saittakari, 2020). Therefore, companies answered which initiatives they adopted to source knowledge in the given year among the six items: internal innovation forums, external innovation forums, open innovation platform, process and methodology to generate ideas, process and methodology to develop ideas, process and methodology to test/experiment ideas. Similar items have been used by a variety of studies exploring different internal and external sources of innovation (e.g. Criscuolo et al., 2010; Johnston & Paladino, 2007; Naqshbandi & Jasimuddin, 2018). As each item represents a dummy variable, the final variable used is the sum of the items, ranging from 0 to 6. This procedure is aligned with our aim to measure the breadth of knowledge sourcing mechanisms (Laursen & Salter, 2006). Cronbach´s alpha is 0.84 and average variance extracted (AVE) is 0.563 which are within recommended levels of reliability (Hair, Anderson, Tathem, & Black, 2005).

R&D investment captures the percentage of the net revenues invested in R&D on a given year. This measure controls for the effect of firm size, which affects the return per unit of R&D effort (Cohen & Levinthal, 1990). A similar measure of R&D has been used by previous literature to measure R&D intensity (Beugelsdijk, 2008;

Cuervo-Cazurra & Un, 2007). *Training* was measured as the percentage of employees who have received innovation training on that given year. A similar measure has been used in previous studies (e.g. Laursen & Foss, 2003).

3.2.3 Control variables

We controlled for *firm size* as it has been shown to positively affect knowledge transfer (Van Wijk et al., 2008) and since larger firms tend to have better access to local market knowledge (Petersen, Pedersen, & Lyles, 2008). Firm size was measured by net revenues. We also controlled for *capital control* as domestic firms and subsidiaries of foreign MNCs may have different approaches to R&D investments with distinct innovation performance outcomes (Sofka et al., 2018; Un & Rodríguez, 2018). Thus, I measured if the majority of the company is national-private-owned or foreign-private-owned, with national-state-owned as the reference group. There is no foreign state owned company in the sample. We also controlled for *industry*, which included the categories retail, manufacturing and services. The reference group was composed by government, financial institutions and other industries. We aggregated those industries as each had few observations to be entered individually in the regression and doing so could reduce the statistical power. Thus, the results regarding industry should be interpreted against the omitted industries (government, financial institutions and others). Finally, we controlled for *local innovation* in the models in which global innovation is the dependent variable as *global innovation* may be highly correlated with the degree of local innovation (Isaac et al., 2019). Likewise, we controlled for *global innovation* in the models which have *local innovation* as the dependent variable. In fact, there may be some innovations that are both patented in the local and in the global environment (e.g. in the case of the Global Innovator in Gupta and Govindarajan (1991)´s terminology). Therefore, this procedure intends to measure the innovation that is exclusively local (Local Innovator) and exclusively global (Integrated Player) in each model, therefore, discounting the effect of potential double counting that may be responsible for the high correlation among such variables.

4. Results

The next table shows the descriptive statistics and correlations among the variables in the study:

Table 2. Descriptive statistics and correlations

	N	Mean/(%)	Stand. Dev.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Local innovation	108	44.21	98.65	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2. Global innovation	108	90.78	403.31	0.194	-	-	-	-	-	-	-	-	-	-	-	-	-
3. Knowledge sourcing	108	3.00	2.13	0.137	**0.235**	-	-	-	-	-	-	-	-	-	-	-	-
4. Training on innovation	108	24.71	29.49	0.299	**0.274**	0.140	-	-	-	-	-	-	-	-	-	-	-
5. R&D investment	108	3.06	4.02	0.157	-0.030	0.163	0.194	-	-	-	-	-	-	-	-	-	-
6. Firm size	108	22520.53	120191.22	0.116	-0.010	**0.185**	-0.066	**-0.087**	-	-	-	-	-	-	-	-	-
7. Foreign-private-owned	108	19.44%	-	0.217	0.248	**0.274**	0.198	-0.001	-0.083	-	-	-	-	-	-	-	-
8. National-private-owned	108	71.30%	-	-0.148	-0.168	**-0.248**	-0.153	0.156	0.039	**-0.655**	-	-	-	-	-	-	-
9. National-state-owned	108	9.26%	-	-0.057	-0.067	0.040	-0.014	**-0.318**	0.058	**-0.206**	**-0.576**	-	-	-	-	-	-
10. Service industry	108	37.04%	-	**-0.282**	**-0.149**	-0.036	**-0.169**	0.023	**-0.135**	-0.211	0.058	0.166	-	-	-	-	-
11. Finance industry	108	0.93%	-	**0.244**	**-0.067**	**0.089**	**-0.301**	**-0.269**	**1.000**	**0.101**	**-0.081**	**0.262**	**-0.094**	-	-	-	-
12. Other industries	108	5.56%	-	**-0.175**	**-0.106**	-0.103	**-0.335**	**-0.253**	**-0.079**	**-0.229**	**0.309**	**-0.044**	**-0.267**	**0.365**	-	-	-
13. Government industry	108	1.85%	-	**-0.144**	**-0.092**	-0.007	**-0.285**	**-0.210**	**-0.070**	**0.008**	**-0.476**	**0.732**	**-0.165**	**0.607**	**0.307**	-	-
14. Manufacturing industry	108	47.22%	-	0.067	**0.226**	0.178	**0.280**	-0.079	-0.057	**0.359**	-0.208	-0.189	**-0.582**	**-0.181**	**-0.341**	**-0.251**	-
15. Retail industry	108	7.41%	-	0.711	**-0.114**	-0.315	0.075	0.480	-0.041	-0.120	0.228	**-0.102**	**-0.310**	**0.304**	**0.107**	**0.247**	**-0.380**

Significant correlations ($p<0.050$) are in bold.

The next table shows the results of the regressions:

Table 3. Regression results

	Local innovation				Global innovation			
	Estimate (z)	**P-value**	**Estimate (z)**	**P-value**	**Estimate (z)**	**P-value**	**Estimate (z)**	**P-value**
Intercept	2.170	**0.030**	1.770	0.077	1.550	0.122	1.180	0.239
Knowledge sourcing	1.040	0.300	-0.390	0.700	2.520	**0.012**	4.540	**0.000**
R&D investment	1.580	0.114	-0.590	0.558	1.910	0.056	4.620	**0.000**
Training on innovation	2.060	**0.040**	2.320	**0.020**	14.440	**0.000**	3.040	**0.002**
Knowledge sourcing*R&D investment			8.020	**0.000**			-7.710	**0.000**
Knowledge sourcing*Training on innovation			-5.270	**0.000**			5.200	**0.000**
Controls								
Foreign-private-owned	-0.390	0.698	-0.370	0.710	0.840	0.399	0.650	0.516
National-private-owned	-1.200	0.229	-0.860	0.390	-0.030	0.977	-0.110	0.910
Retail industry	0.660	0.511	0.140	0.889	-1.970	**0.049**	-1.450	0.146
Manufacturing industry	0.830	0.406	0.260	0.791	0.030	0.977	0.440	0.657
Service industry	0.460	0.645	0.110	0.915	-1.890	0.059	-1.570	0.116
Firm size	1.870	0.062	-0.120	0.903	4.460	**0.000**	7.590	**0.000**
Local innovation					18.330	**0.000**	20.760	**0.000**
Global innovation	3.660	**0.000**	15.420	**0.000**				
Variance of random effects	4.210		7.280		9.140		12.190	
R^2	0.220		0.230		0.280		0.340	
N	108		108		108		108	

Significant correlations ($p<0.050$) are in bold.

The results provide support for H1, which assumed that local R&D investment positively moderates the relationship between knowledge sourcing mechanisms and local innovation ($\beta=8.020$, $p<0.000$). Support was also found for H2 which assumed that training on innovation would have a positive moderating effect on the relationship between knowledge sourcing mechanisms and global innovation ($\beta=5.200$, $p<0.000$).

As for the control variables, the results show that firm size is not related with local innovations ($\beta=-0.120$, $p=0.903$) but is positively related to global innovations ($\beta=7.590$, $p<0.000$). The models also show that local and global innovation reinforce each other as the effect of global innovation is significant in the regression on local innovation ($\beta=15.420$, $p<0.000$) and the same is true for the model on global innovation, where local innovation is also positively related ($\beta=20.760$, $p<0.000$). Finally, industry (retail, manufacturing and services industries) has no

impact on either local or global innovation (except for a barely significant impact of retail industry on global innovation).

The models are able to explain above 20.0% of the variance of the dependent variables, with the highest R^2 found in the complete model on global innovation (including interaction terms), which is able to explain 34.0% of such dependent variable.

5. Discussion

This study assumed that in order to obtain optimal local and global innovation outcomes from knowledge sourcing mechanisms firms need to employ different absorptive capacity enhancing practices that positively moderate this relationship. Therefore, this study hypothesized that R&D investments positively moderates the relationship between knowledge sourcing mechanisms and *local* innovation while innovation training positively moderates the relationship between knowledge sourcing mechanisms and *global* innovation. The hypotheses were tested on a sample of foreign MNC subsidiaries and national MNCs´ headquarters operating in an emerging market, Brazil.

The results show that indeed local R&D investment has a positive influence on the relationship between knowledge sourcing mechanisms and *local* innovation which we assume to be due to an increased absorptive capacity caused by such R&D investment with an additional effect of inserting firms more easily in local innovation networks and creating product innovations that are country-specific. Those investments, which traditionally focus on creating new knowledge (Criscuolo et al., 2010; Grimpe et al., 2017), seem to be effective in driving the focus of innovation initiatives to the home market and enhancing its local embeddedness to generate local innovation, which is in line with previous literature (Cantwell & Mudambi, 2011; Scott-Kennel & Saittakari, 2020). Also, it is important to consider that in environments were learning is more difficult (e.g. the global environment), firms would need to invest more in R&D to have the same innovation outcomes (Cohen & Levinthal, 1990), so R&D investments may convert into local innovation more easily than into global innovation. In this regard, the potential lack of emerging market firms´ ability to protect its patented products globally due to weak regimes of appropriability should also be taken into account. This means that the likelihood of knowledge spillovers in the global environment may result in low investments to turn local practices into innovations targeting a competitive advantage in the global

environment (Zahra & George, 2002), especially from a country where the scientific breakthrough type of innovation it not common ground (Fleury et al., 2013).

The results also show that training on innovation has a positive moderating effect on the relationship between knowledge sourcing mechanisms and *global* innovation. Differently from R&D investments, training on innovation is focused on dissemination of existing knowledge among the various departments of the organization (Cabrera & Cabrera, 2005; Minbaeva et al., 2012) and therefore is an important socialization practice for firms with widespread operations. By stimulating such interactions, training also broadens the perspectives of employees to the worldwide operations of the firm and favors the transfer of local knowledge to the global environment. This result is in line with Un (2016) who argues that training is good mechanism to overcome the liability of localness in innovation. Finally, it is also possible that firms with more extensive training opportunities focus less on local innovation as in thosescases they usually provide employees with fewer formal financial incentives (e.g. R&D investments) to develop knowledge (Simonin & Özsomer, 2009).

Although not hypothesized, the results show no direct effect of knowledge sourcing mechanisms on local innovation, suggesting that in such cases, R&D investment is the key absorptive capacity enhancing practice. On the other hand, knowledge sourcing mechanisms do have a significant direct effect on global innovation, showing that they also serve to widen the perspectives of employees regarding the potential to globalize their innovations, with an additional effect of training in fostering this multicultural mindset (Ramsey & Lorenz, 2016).

The key theoretical contribution of this study lies in the idea that R&D investments and innovation training impact local and global innovation differently given their different nature. Both are deemed as absorptive capacity enhancing practices with positive moderating effect on the relationship between knowledge sourcing mechanisms and innovation. However, R&D investment focuses on developing new knowledge, while training focuses on disseminating existing knowledge. By developing new knowledge through R&D, firms become more embedded with local networks and generate innovations that are highly applicable to the local environment. By disseminating existing knowledge through innovation training, employees share experiences with globally widespread units or departments and broaden their mindsets to generate global innovations. Thus, this study advances

existing literature (Fallah & Lechler, 2008; Isaac, Borini, Raziq, & Benito, 2019) by testing empirically the different requisites to innovate locally and globally.

Practical implications

The most important implication for practice is that there is no "one practice" that can enhance the effect of knowledge sourcing mechanisms on both local innovation and global innovation. Therefore, firms willing to foster local innovation should concentrate their efforts mainly in increasing local R&D investments in order to achieve effective outcomes from their knowledge sourcing mechanisms. On the other hand, firms willing to foster global innovations should rather focus on providing innovation training to their employees. Sourcing knowledge both internally and externally with a great variety of mechanisms also helps firms achieve better innovation outcomes.

Limitations and future research

This study has some limitations that should be taken into account. First, as we designed our study in two-time periods with a five-year gap between them to allow for cause-and-effect inferences, the fact that not all companies participated in the two phases has reduced considerably the sample size. In order to warrant good statistical power the study has replaced some missing values. Future studies with larger sample sizes may increase robustness of the findings and attest the consistency of the results. Also, we have used single items to measure several variables in the study. While it is not possible to calculate internal consistency estimates with single-items (Fisher, Matthews, & Gibbons, 2016) they are more acceptable when constructs are concrete, unidimensional and the sample is small and diverse (Diamantopoulos, Sarstedt, Fuchs, Wilczynski, & Kaiser, 2012; Fuchs & Diamantopoulos, 2009), which is the case of this study. Also, this study considers companies operating only in one country and therefore generalizations to other contexts should be taken carefully. In addition to that, all variables in this study were provided by the participating firms in self-reported questionnaires. While several actions were adopted to reduce potential bias (e.g. lagging variables in two time-periods, requiring data verification by a second respondent, checking patent data whenever available), we do acknowledge that some potential bias may occur. Also, our measure of patents granted in the previous five-years does not capture patents that could have taken longer than five-years to be granted. Furthermore, although we assumed that R&D investment and innovation training are absorptive

capacity enhancing practices based on existing literature, this study does not measure absorptive capacity itself nor test its mediating effect empirically as some recent literature has done (Wang et al., 2018). Future studies could further explore these and other variables that can work as absorptive capacity enhancing practices with a significant contribution to the hypothesized relationships. Finally, we urge future research to shed light on the different requisites to innovate locally and globally in order to deepen our understating on the knowledge management mechanisms that can better lead to each of the types of innovation.

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Chapter 3

Too much of two good things: Explicating the limited complementarity between drivers of MNCs' absorptive capacity

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Abstract

Applying a logic of limited complementarity between the efficiency of a firm´s internal communication and its ability to absorb knowledge from external sources, and relying on organizational learning and knowledge-based theoretical underpinnings, we build on Cohen and Levinthal (1990)'s inward-looking and outward-looking absorptive capacities (AC) and show how they apply to determinants of AC in the context of international reverse knowledge transfer, including, in particular, knowledge management capabilities and multinationality. We test our hypotheses on a sample of 106 Brazilian and Portuguese multinational corporations (MNCs). The hypothesised trade-off between inward and outward determinants of AC was supported for high levels of coordination capabilities and multinationality, indicating that too much of both such determinants may reduce their positive contribution to the AC of MNC headquarters. Our findings also confirmed that knowledge management capabilities (systems, coordination and socialization) and multinationality have a positive direct effect on the AC of MNC headquarters.

Keywords: absorptive capacity, knowledge management capability, multinational corporation, multinationality, international reverse knowledge transfer

1. Introduction

Multinational corporations (MNCs) generally have a superior ability to orchestrate various types of knowledge flows in their networks and to use knowledge as a source of competitive advantage (Bartlett & Ghoshal, 2001; Ghoshal & Bartlett, 1988; Kogut & Zander, 1993; Mudambi, 2002; Mundra, Gulati, & Vashisth, 2011). The ability to recognize, assimilate, and apply new external knowledge—or absorptive capacity (AC) (Cohen & Levinthal, 1990)—is critical for MNCs, as it reduces knowledge gaps (Petersen, Pedersen, & Lyles, 2008) and fosters cross-border knowledge transfers (Lane, Salk, & Lyles, 2001). Ultimately, a firm´s ability to learn can produce such outcomes as innovation and superior performance (Lyles & Salk, 1996; Phene & Almeida, 2008; Tsai, 2001; Van Wijk, Jansen, & Lyles, 2008).

An organization's ability to absorb external knowledge increases when new, incoming knowledge is related to what the organization already knows (Cohen & Levinthal, 1990). Therefore, in their seminal paper, Cohen and Levinthal (1990) distinguish between inward-looking and outward-looking AC, and proposed a trade-off between them. While either types of AC are needed, the authors suggest that too much of both may be detrimental to learning. The problem is that firms may attempt to maximize both commonality and diversity of knowledge while the final knowledge outcomes may not be optimal. For example, in an organization in which internal actors share too much of a common knowledge structure that facilitates internal communication (inward-looking AC), the ability to absorb knowledge from a variety of external sources (outward-looking AC) may be reduced due to a phenomenon called the not-invented-here (NIH) syndrome (Katz & Allen, 1982). NIH syndrome can be detrimental to firm innovation because it suggests that knowledge coming from outsiders is not valuable (Antons & Piller, 2015; Burcharth, Knudsen, & Søndergaard, 2014). Therefore, clarification on the extent of knowledge overlap needed to increase AC is key for our understanding of the value-creation process (Ambos, Nell, & Pedersen, 2013). At the same time, too much diversity may hinder the absorption of knowledge if the new knowledge is too distant from the firms' existing knowledge base (Lane & Lubatkin, 1998). This is particularly important for firms operating internationally, as cultural, administrative, geographical, and economic differences (Ghemawat, 2001) can affect the learning process (Ambos & Ambos, 2009; Kedia & Bhagat, 1988). Cohen and Levinthal (1990) do not test their proposed trade-off between inward-looking

AC and outward-looking AC, or examine the interplay between them. Consequently, scholars have recently called for more studies focused on this particular aspect of AC (Pedersen, Larsen, & Dasí, 2020; Volberda, Foss, & Lyles, 2010).

We respond to this call by carefully examining the underexplored trade-off between the inward-looking and outward-looking determinants of AC. More specifically, we elaborate and test the direct and moderating effects of two determinants of AC in MNCs in the context of international reverse knowledge transfers. The inward-looking determinants of AC that promote internal communication efficiency are knowledge management capabilities, including systems, coordination, and socialization capabilities (Jansen, Van den Bosch, & Volberda, 2005; Van den Bosch, Volberda, & de Boer, 1999). The outward-looking determinants of AC that provide access to knowledge from dispersed external sources are the magnitude and diversity of the MNC's foreign operations, or its multinationality, which affects knowledge outcomes (Barkema & Vermeulen, 1998; Hitt, Hoskisson, & Kim, 1997; Jiménez-Jiménez, Martínez-Costa, & Sanz-Valle, 2014).

We probe whether headquarters experience an increase in their AC when they employ knowledge management capabilities (the inward-looking determinant) to improve learning from their foreign subsidiaries. We also examine the extent to which multinationality (the outward-looking determinant) may increase headquarters' AC. Our main contribution lies in our exploration of the expected trade-off, which revolves around an analysis of the interaction between knowledge management capabilities and multinationality. As such, our research questions are the following: To what extent do knowledge management capabilities (the inward-looking determinant of AC) affect headquarters´ ability to learn from subsidiaries? Does multinationality (the outward-looking determinant of AC) influence headquarters´ ability to learn from subsidiaries? Does a trade-off exist between inward-looking and outward-looking determinants of AC in the context of international reverse knowledge transfers?

Our analysis focuses on international reverse knowledge transfers (from subsidiary to parent) because foreign subsidiaries of MNCs have increasingly become a crucial source of knowledge (Forsgren, 2002; Holm & Pedersen, 2000; Ryan, Giblin, Andersson, & Clancy, 2018), leading to more valuable and intense reverse knowledge transfers (Blomkvist, Kappen, & Zander, 2017; Yang, Mudambi, & Meyer, 2008). This fact has led to numerous calls for studies that shed light on the

strategies and mechanisms through which MNCs' headquarters can improve their ability to absorb the knowledge created by their foreign subsidiaries (Ambos, Ambos, & Schlegelmilch, 2006; Rabbiosi, 2011).

We add to the literature on absorptive capacity and international reverse knowledge transfers by: i) explaining the contingent interplay of knowledge management capabilities and multinationality as inward- and outward-looking determinants of AC (Cohen & Levinthal, 1990; Volberda et al., 2010), ii) responding to calls for a deeper understanding of the antecedents of AC (Apriliyanti & Alon, 2017; Lane, Koka, & Pathak, 2006; Van Wijk et al., 2008; Volberda et al., 2010), and iii) adding new perspectives to the ongoing debate on how headquarters can create learning advantages and facilitate knowledge transfers in their interactions with foreign subsidiaries (Ambos et al., 2006; Forsgren, Holm, & Johanson, 2015; Gaur, Ma, & Ge, 2019).

2. Theoretical background and hypotheses

2.1. International reverse knowledge transfers

Knowledge-based theoretical reasoning suggests that knowledge differentiates one firm from another and leads to competitive advantages (Conner & Prahalad, 1996). Grant (1996) argues that the primary role of the firm is to integrate the specialist knowledge of individuals into goods and services, and Kogut and Zander (1993) see MNCs as networks of firms with a superior ability to effectively transfer and manage dispersed knowledge across borders. In line with this view, MNCs must acquire and absorb knowledge from either their subsidiaries or external sources in other countries (e.g. clients, suppliers, research institutes) (Mudambi, 2002). While external sources of knowledge are not always easily accessible (Argote, 1999), intra-MNC knowledge, which is the focus of this study, is comparatively more likely to be transferred and affect performance (Darr & Argote, 1995; Ingram & Simons, 2002; Kane, Argote, & Levine, 2005).

The international business literature has extensively discussed conventional knowledge transfers from headquarters to subsidiaries (Birkinshaw, Morrison, & Hulland, 1995; Kogut & Zander, 1993; Phene & Almeida, 2008; Tsai, 2001). However, foreign subsidiaries have become a major source of knowledge (Blomkvist et al., 2017; Forsgren, 2002), as they help to balance the need for global integration with the need for local responsiveness (Bartlett & Ghoshal, 2001; Bresman, Birkinshaw, & Nobel, 2010). In some circumstances, they may become

centers of excellence in the MNC's network (Frost, Birkinshaw, & Ensign, 2002; Holm & Pedersen, 2000). Therefore, reverse knowledge transfers (from subsidiary to parent) are also likely, especially knowledge transfers from competence-creating subsidiaries (Blomkvist et al., 2017; Yang et al., 2008). Hence, reverse knowledge flows have recently been subject to increasing attention in the literature (Ambos et al., 2006; McGuinness, Demirbag, & Bandara, 2013; Rabbiosi, 2011) and scholars have called for more research on the contextual conditions that make reverse knowledge transfers effective in MNCs (Gaur et al., 2019).

The reverse knowledge transfer perspective applied in this study implies that headquarters play a central role in allocating resources and tools to the knowledge transfer process. It postulates that headquarters can both influence (Ghoshal & Bartlett, 1988) and intervene (Campbell, Goold, & Alexander, 1994; Chandler, 1962) in order to achieve higher efficiency and effectiveness in the process (Ciabuschi, Martín, & Ståhl, 2010). According to Schleimer and Pedersen (2014), an MNC's ability to learn is enhanced by its headquarters' efforts to transfer strategic knowledge by means of resource commitments as well as articulation and adaptation in communication and learning processes.

This view does not suggest that subsidiaries are reactive in the reverse knowledge transfer process. Instead, it implies that headquarters should stimulate and manage such knowledge processes (Ciabuschi, Forscjren, & Martín, 2011) and introduce proper mechanisms to do so (Gupta & Govindarajan, 1991; Rabbiosi, 2011). In addition, as the recipient unit, headquarters may experience an increase in its AC as a result of the benefits from the reverse knowledge transfer process (Ambos et al., 2006). In the following sections, we discuss the concept and drivers of AC as well as the roles of knowledge management capabilities and multinationality in the context of international knowledge transfers.

2.2. MNCs' absorptive capacity

Absorptive capacity has been widely studied as one of the most important aspects associated with organizational knowledge transfer and firm innovativeness (Lane et al., 2006; Van Wijk et al., 2008; Volberda et al., 2010). The concept first appeared in a study on international technology transfers by Kedia and Bhagat (1988) (according to the bibliometric study of Volberda et al., 2010). It was then scrutinized

by Cohen and Levinthal (1989, 1990, 1994), who conceptualized it as the ability of firms to recognize, assimilate, and apply new external knowledge.

In this study, we draw theoretical perspectives on AC from the organizational learning literature, as several early studies link a firm's ability to absorb knowledge to its learning and performance outcomes (Cohen & Levinthal, 1990; Fiol & Lyles, 1985; Kedia & Bhagat, 1988; Levitt & March, 1988). Later studies proposed reconceptualizations of AC, thereby adding to the richness of the construct (Lane et al., 2006; Lane & Lubatkin, 1998; Zahra & George, 2002). For instance, Zahra and George (2002) distinguish between potential and realized AC. Potential AC refers to a firm´s ability to acquire and assimilate external knowledge, while realized AC encompasses transformation and exploitation dimensions. Lane et al. (2006) conceive of AC as a sequential process consisting of exploratory, transformative, and exploitative learning.

From an organizational learning perspective, Cohen and Levinthal (1990, p.129) posit that AC is largely a function of a firm´s prior related knowledge, which "enhances learning because memory - or the storage of knowledge - is developed by associative learning in which events are recorded into memory by establishing linkages with pre-existing concepts". At the organizational level, this implies that shared knowledge and expertise permit effective internal communication, which the authors term "inward-looking AC". However, while prior related knowledge is the primary element in the learning process, it is not sufficient for developing effective AC. According to Cohen and Levinthal (1990, p.131), the diversity of the knowledge plays an important role, as diversity "provides a more robust basis for learning because it increases the prospect that incoming information will relate to what is already known (…) and facilitates the innovative process by enabling the individual to make novel associations and linkages". This diversity mainly emerges through interactions with external sources of knowledge by individuals who act as gatekeepers or boundary-spanners. These individuals translate the information in a way that the firm can understand. Cohen and Levinthal (1990) refer to the firm's ability to absorb knowledge from external sources (i.e. other subunits or the environment) as "outward-looking AC".

Inward-looking and outward-looking AC are complementary, but only to a certain extent: "While both of these organizational components are necessary for effective organizational learning, excessive dominance by one or the other will be dysfunctional. If all actors in the organization share the same specialized language,

they will be effective in communicating with one another, but they may not be able to tap into diverse external knowledge sources" (Cohen & Levinthal, 1990, p.133). However, Cohen and Levinthal (1990) do not elaborate on these concepts or the interplay that leads to this limited complementarity. Subsequent reconceptualizations of AC (Lane et al., 2006; Lane & Lubatkin, 1998; Zahra & George, 2002) have not addressed these issues either. Consequently, several key questions remain: What are the potential sources of inward-looking and outward-looking AC in different knowledge transfer contexts? How do inward-looking and outward-looking AC interact to generate more effective organizational learning outcomes? Given these gaps in the extant research, scholars have called for more investigations of these aspects of AC (Pedersen et al., 2020; Volberda et al., 2010).

Furthermore, bibliometric studies show that the majority of the literature focuses on the outcomes of AC as opposed to its antecedents (Lane et al., 2006; Van Wijk et al., 2008; Volberda et al., 2010). For instance, Volberda et al. (2010) identify three types of antecedents of AC: i) interorganizational, ii) managerial, and iii) intraorganizational. They also note that the latter receive less attention in the literature. These authors argue that internal mechanisms that can influence AC at the firm level, such as the structure of communication, organizational structure, and human resource management (HRM) practices, should be further explored in subsequent studies. In their meta-analytic study on knowledge transfer, Van Wijk et al. (2008, p. 844) claim that "given its importance to organizational knowledge transfer, it is surprising that organizational antecedents of absorptive capacity have been largely ignored".

We address these gaps in the extant literature by applying the logic of inward-looking and outward-looking components and their interplay to underexplored antecedents of AC. We argue that in order to increase their AC, firms need an inward-looking antecedent that enables them to develop effective internal communication that builds on existing knowledge. They also need an outward-looking antecedent that enables them to access diverse sources of knowledge and make novel associations. In the context of international knowledge transfers, the inward-looking determinant is found in the MNC´s knowledge management capabilities while the outward-looking determinant is the MNC´s multinationality.

Our approach is twofold. First, we review and test the direct effects between these antecedents and AC, which we define in our baseline hypotheses. Second, we

examine the interaction effects of multinationality and knowledge management capabilities on the AC of MNCs' headquarters.

2.3. Knowledge management capabilities and absorptive capacity: direct effects

As previously mentioned, AC is primarily a function of prior related knowledge. According to Cohen and Levinthal (1990, p.129-130): "the notion that prior knowledge facilitates the learning of new related knowledge can be extended to include the case in which the knowledge in question may itself be a set of learning skills". Therefore, our focus is on the organization's learning capabilities.

To understand the sources of a firm's AC at the organizational level, Cohen and Levinthal (1990) examine the structure of communication as well as the learning incentives and skills within the organization (i.e. knowledge management capabilities. Van den Bosch et al. (1999) show that these capabilities play a salient role in the formation of AC. The authors define three categories of knowledge management capabilities: systems, coordination, and socialization. They argue that firms may use these capabilities differently to promote changes in the efficiency, scope, and flexibility of knowledge absorption. Later, Jansen et al. (2005) empirically show how each of these capabilities affect different dimensions of AC (Zahra & George, 2002). Furthermore, following the widespread application of the absorptive capacity concept in the management literature, the meta-analytic study by Volberda et al. (2010) highlighted that capabilities related to organizational structures and processes, incentives, informal networks, and internal communication were the most important antecedents of AC.

We posit that these sets of knowledge management capabilities represent the inward-looking determinant of AC, as they promote efficiency in communication, which enhances a firm´s ability to recognize the value of new information, assimilate it, and apply it to commercial ends (Cohen & Levinthal, 1990). Therefore, we expect knowledge management capabilities (the inward-looking determinant) to have a direct effect on the AC of MNCs' headquarters. Previous research examining this relationship (Jansen et al., 2005; Van den Bosch et al., 1999) has overlooked the specific context of cross-border flows. This context is particularly important, as it can create additional challenges for knowledge transfers (Ambos & Ambos, 2009; Kedia & Bhagat, 1988).

In the international knowledge transfer context, this means that MNCs' headquarters enhance their learning abilities by adopting knowledge management capabilities that aim to foster communication with subsidiaries. While such capabilities are commonly employed to transfer knowledge from headquarters to subsidiaries (e.g. in the early stages of a foreign acquisition), the exchanges are likely to become more reciprocal over time. As such, they eventually include knowledge flows from subsidiaries to headquarters (Bresman, Birkinshaw, & Nobel, 1999), especially in interactions with competence-creating subsidiaries (Blomkvist et al., 2017; Yang et al., 2008). We argue that by using knowledge management capabilities to transfer knowledge in multiple directions within the MNC, the headquarters, as an orchestrator of knowledge flows, expands its sources of learning and, thus, reaps additional benefits from the transfers (i.e. increases its own absorptive capacity). Therefore, our focus is on the recipient of knowledge (i.e. the MNC's headquarters) as the primary entity that should benefit from reverse knowledge transfers (Ambos et al., 2006). In addition, following Lenox and King (2004), who suggest that prior related knowledge should be distributed throughout the organization to more effectively influence AC, we argue that these knowledge management capabilities should be implemented not only in the headquarters but throughout the subsidiaries to optimize their effect on AC. Next, we develop baseline hypotheses for the three types of knowledge management capabilities identified in the literature: systems, coordination, and socialization (Jansen et al., 2005; Van den Bosch et al., 1999).

2.3.1. Systems capabilities and absorptive capacity

Van den Bosch et al. (1999, p.556) define systems capabilities as "the degree to which rules, procedures, instructions, and communications are laid down in written documents or formal systems". Research on organizational learning has examined the role of systems capabilities in promoting knowledge absorption by integrating explicit knowledge (Nonaka, 1994) and framing behaviors for handling structured situations (Galbraith, 1973; Van den Bosch et al., 1999). It has also investigated the underlying mechanisms by which systems capabilities help promote managerial relationships and facilitate knowledge sharing and communication (Inkpen, 1998; Niederman, 2005). These mechanisms include electronic-based conduits, such as groupware applications, instant messaging, and virtual community platforms (Buckley & Carter, 1999; Rabbiosi, 2011), which are instrumental in capturing, disseminating, and transferring knowledge internationally (Almeida, Song, &

Grant, 2002; Andersen & Foss, 2005; Persaud, 2005). This is particularly true among geographically-dispersed units (Carbonara, 2005; Jasimuddin, 2007). By enacting virtual collaboration and learning, systems capabilities reduce the time barriers and transaction costs involved in the coordination of information-intensive activities (Carbonara, 2005). They also promote incremental learning, the reutilization of existing knowledge, and knowledge homogeneity (Kane et al., 2005), ultimately increasing firm competitiveness (Andreeva & Kianto, 2012).

In the context of knowledge transfers from subsidiaries, the extant research seems to confirm the presence of links between systems capabilities and absorptive capacity. For instance, Gupta and Govindarajan (2000) find that knowledge outflows from a subsidiary are positively related to the richness of transmission channels, and Rabbiosi (2011) shows that systems mechanisms positively affects the level of reverse knowledge transfer, especially when used with contributor subsidiaries. Crespo, Griffith, and Lages (2014) find that the frequency of communication plays a central role in facilitating flows of knowledge from subsidiaries to other units in the MNC. However, these studies do not specifically link such systems capabilities to absorptive capacity. A notable exception is Nair, Demirbag, and Mellahi (2016), who examine international reverse knowledge transfers from subsidiaries to headquarters of Indian MNCs and find that the firm's technical knowledge infrastructure (i.e. business intelligence, collaboration, and distributed learning software) positively affect AC at the parent level. Thus, in light of the expected effect of systems capabilities on the AC of MNC headquarters, we arrive at the following baseline hypothesis:

H1: As systems capabilities increase, the ability of MNC headquarters to absorb knowledge from foreign subsidiaries increases as well.

2.3.2. Coordination capabilities and absorptive capacity

Routines related to coordination generate firm-specific capabilities and interorganizational learning that may help explain why some firms respond better to external changes that affect their competitive position (Teece, Pisano, & Shuen, 1997). From a coordination standpoint, firms may require lateral capabilities nested in interpersonal and cross-functional links to foster knowledge sharing (Galbraith, Downey, & Kates, 2002). In MNCs, the presence of lateral integrative mechanisms as well as performance assessments may vary systematically across subsidiaries and produce different learning outcomes (Gupta & Govindarajan, 1991). Coordination

capabilities are associated with formal structural mechanisms, such as R&D departments, interdivisional cooperation mechanisms (Argyres, 1995), matrix structures, and cross-unit interfaces (Galbraith, 1973; Nadler & Tushman, 1987). These structural mechanisms function as liaison devices that cut across functions and lines of authority and, thereby, facilitate knowledge absorption (Van den Bosch et al., 1999). For instance, Argyres and Silverman (2004) show that organizations with centralized R&D structures are able to generate innovations that have a broader impact on subsequent technological evolution than organizations with decentralized R&D activities, although they do not test the effect on absorptive capacity. Jansen et al. (2005) show that coordination capabilities (e.g. cross-functional interfaces, participation in decision-making, and job rotation) are particularly effective in enhancing a unit's potential AC (i.e. the acquisition and assimilation dimensions of AC) (Zahra & George, 2002).

In their review of the AC literature, Lane et al. (2006) show that organizational antecedents related to HRM mechanisms have largely been ignored. HRM practices play a pivotal role in ensuring coordination among subunits of a firm to foster knowledge sharing (Cabrera & Cabrera, 2005; Minbaeva, Mäkelä, & Rabbiosi, 2012). For instance, training programs connect people from different departments or units, and they create shared workflow interfaces (Galbraith et al., 2002; Van den Bosch et al., 1999).

In the international business context, Lane et al. (2001) demonstrate that learning structures and processes positively affect the ability of international joint ventures (IJVs) to assimilate new knowledge from parent firms, while the training competence of IJVs affects their ability to apply the assimilated knowledge. Furthermore, the establishment of explicit goals that recognize knowledge-sharing behaviors helps IJVs acquire knowledge from their foreign parents (Lyles & Salk, 1996). However, these studies do not explore knowledge transfers in the opposite direction (i.e. from IJVs to parents).

Drawing on previous literature that establishes a link between coordination capabilities and firms' learning abilities (Jansen et al., 2005; Lane et al., 2001; Lyles & Salk, 1996; Van den Bosch et al., 1999), we suggest that, in the context of international reverse knowledge transfer, an MNC's use of coordination capabilities on a global scale will positively influence the AC of the MNC's headquarters. Therefore, as a baseline hypothesis, we propose that:

H2: As coordination capabilities increase, the ability of MNC headquarters to absorb knowledge from foreign subsidiaries increases as well.

2.3.3. Socialization capabilities and absorptive capacity

Extant research suggests that transfers of tacit knowledge may be more important than transfers of explicit knowledge (Day & Nedungadi, 1994; Polanyi, 1958). In this sense, Bresman et al. (1999, p.442) argue that "individuals will only participate willingly in knowledge exchange once they share a sense of identity or belonging with their colleagues". Therefore, the stimulation of social relations between headquarters managers and subsidiary managers may help enhance not only identity (Ashforth & Saks, 1996) but also commitment and compliance (Adler & Kwon, 2002). Gupta and Govindarajan (2000, p.479) characterize socialization mechanisms as the practices and interactions that "build interpersonal familiarity, personal affinity and convergence in cognitive maps among personnel from different subsidiaries".

Several researchers suggest that superior socialization capabilities are likely to have a direct effect on intra-MNC knowledge management processes and outcomes. For instance, Gooderham, Minbaeva, and Pedersen (2011) show that governance mechanisms, especially social relations, positively affect firms' social capital, which, in turn, facilitates the transfer of knowledge. Bresman et al. (1999), who focus on knowledge transfers in international acquisitions, show that more tacit forms of knowledge (e.g. technological know-how) are best transferred through extended visits and technical meetings. Ghoshal, Korine, and Szulanski (1994) find that interpersonal relationships stimulated by joint work in teams, taskforces, and meetings are positively related to the frequency of subsidiary-headquarters communications. These authors also highlight the importance of spending time at the firm´s headquarters and in inter-unit communities of practice. A similar perspective on the role of extensive travel and joint assignments in enabling subsidiary-headquarters integration is featured in Ghoshal and Bartlett (1988). Nevertheless, none of these studies address the role of socialization capabilities in the formation of AC. This aspect was examined by Van den Bosch et al. (1999) and Jansen et al. (2005), although not in in the context of international knowledge transfers. These authors showed that socialization capabilities in the form of connectedness and socialization tactics directly affect firms´ AC. Based on these arguments and with a focus on AC at the headquarters level, we derive the following baseline hypothesis:

H3: As socialization capabilities increase, the ability of MNC headquarters to absorb knowledge from foreign subsidiaries also as well.

2.4 Multinationality and absorptive capacity: direct effects

As previously discussed, knowledge diversity is the outward-looking driver that is needed to access relevant knowledge bases outside the firm. It complements existing knowledge in the formation of AC, as Cohen and Levinthal (1990, p.133) state: "Assuming a sufficient level of knowledge overlap to ensure effective communication, interactions across individuals who each possess diverse and different knowledge structures will augment the organization's capacity for making novel linkages and associations - innovating - beyond what any one individual can achieve". This suggests a positive relationship between knowledge diversity and AC. Other scholars claim that accessing and interpreting knowledge from a variety of sources leads to more organizational learning (Huber, 1991) and innovation (Laursen & Salter, 2006).

In the context of international knowledge transfers, multinationality is one characteristic that could ensure knowledge diversity, as an MNC operates in different countries and in distinct cultural, administrative, geographical and economic settings (Ghemawat, 2001). Multinationality reflects the magnitude of a firm´s foreign operations as well as its geographical dispersion (Gomes & Ramaswamy, 1999; Ietto-Gillies, 1998; Sullivan, 1994), and it extends the firm's knowledge base and brings new learning opportunities (Johanson & Vahlne, 1977, 2003).

The potential relationship between multinationality and absorptive capacity has been highlighted in the extant literature. For instance, Barkema and Vermeulen (1998) empirically show that multinational diversity helps firms develop richer knowledge structures and more robust technological capabilities, while Hitt et al. (1997) find a positive effect of international diversification on firm innovation. Denison, Dutton, Kahn, and Hart (1996) argue that experience in international markets increases CEOs´ perceptions of foreign investments as opportunities rather than threats. These studies do not test whether international diversity actually leads to absorptive capacity, although Denison et al. (1996) consider the concept of absorptive capacity in their rationale. According to these authors, the organizational memory of past foreign direct investment (FDI) behaviors and routines increases the firm´s absorptive capacity and leads to more positive interpretations of

subsequent transactions. In fact, MNCs with greater absorptive capacity are better able to perceive benefits from reverse knowledge transfers (Ambos et al., 2006). Multinationality also positively affects the level of reverse knowledge transfer, which then affects firm innovation (Jiménez-Jiménez et al., 2014). Therefore, as a firm internationalizes, it should expose itself to more diverse knowledge bases, which facilitate new associations with prior existing knowledge and create opportunities to exploit external knowledge. This, in turn, should enhance the absorptive capacity of the MNC's headquarters. Accordingly, we hypothesize that:

H4: As multinationality increases, the ability of MNC headquarters to absorb knowledge from foreign subsidiaries increases as well.

2.5 Interaction effects of multinationality and knowledge management capabilities

Building on our previous arguments, we can theorize about the ways in which interactions between an MNC's multinationality and its knowledge management capabilities may affect its headquarters' AC. Although we expect a positive relationship between both the inward-looking determinant (knowledge management capabilities) and the outward-looking determinant (multinationality) and AC, too much of both could be detrimental. As Cohen and Levinthal (1990, p.133) state: "With regard to the absorptive capacity of the firm as a whole, there may, however, be a trade-off in the efficiency of internal communication against the ability of the subunit to assimilate and exploit information originating from other subunits or the environment. This can be seen as a trade-off between inward-looking versus outward-looking absorptive capacities". This suggests a negative interaction effect between knowledge management capabilities and multinationality. When knowledge management capabilities are highly developed (i.e. widely used and functioning in the entire MNC), units should be effective in communicating with one another but they may not be able to recognize and value knowledge from diverse external sources, such as the various geographies in which the MNC operates. As Cohen and Levinthal (1990, p.134) note: "While common knowledge improves communication, commonality should not be carried so far that diversity across individuals is substantially diminished". This phenomenon may be explained by the pathology of the not-invented-here (NIH) syndrome (Cohen & Levinthal, 1990; Volberda et al., 2010). The NIH syndrome involves a group's perception that it possesses a monopoly on knowledge, which leads it to reject new ideas from the outside (Katz & Allen, 1982). This, in turn, negatively affects firm innovation

(Burcharth et al., 2014) and performance outcomes (Antons & Piller, 2015). Therefore, too much commonality among knowledge management capabilities within the MNC may reduce its openness to new, external knowledge and jeopardize its ability to learn. Although the extant literature acknowledges the need to assess the amount of knowledge overlap that is optimal for value creation (Ambos et al., 2013), no studies have theoretically or empirically explored this trade-off (Volberda et al., 2010).

Correspondingly, high levels of international diversity can lead to difficulties in accessing, interpreting, and translating new external knowledge into a form that is understandable by the firm, thereby reducing internal communication efficiency, as such new knowledge may be too distant from the firm's existing knowledge base (Lane & Lubatkin, 1998). We posit that this is the case in highly internationalized MNCs, as they face significant challenges in transferring knowledge from subsidiaries to headquarters due to geographical, cultural, and linguistic distance (Ambos & Ambos, 2009; Lyles & Salk, 1996; Van Wijk et al., 2008). In such situations, it is more difficult and costly to achieve coordination and synergy among units (Argyres, 1996; Gupta & Govindarajan, 1991), and organizational complexity may increase to a point at which learning is hampered by information overload (Barkema & Vermeulen, 1998).

Distance matters in this regard, as greater international diversification increases managerial transaction costs and information-processing demands (Hitt et al., 1997). Gomes and Ramaswamy (1999), for instance, show that higher levels of multinationality are beneficial up to a certain point beyond which performance benefits decrease. Eriksson, Majkgård, and Sharma (2000) argue that firms that start their international expansion in culturally-distant countries are more likely to lack internationalization knowledge. As the international footprint of MNCs widens, the complexity of integrating increasingly diverse subsidiary knowledge reduces the effectiveness of knowledge transfer mechanisms at the headquarters level. Indeed, as Gaur et al. (2019, p.1895) point out: "When knowledge generated in one subsidiary needs to be combined with the knowledge generated at another subsidiary, the transfer challenges get accentuated". Martin and Salomon (2003, p. 357) add to this rationale, as they posit that "the level of tacitness of such knowledge places major constraints on the extent and manner in which it can be used to support corporate expansion". Meyer, Mudambi, and Narula (2011) refer to this compromise as "multiple embeddedness". In other words, an MNC must find a

balance between their "'internal' embeddedness within the MNE network, with their 'external' embeddedness in the host milieu" (Meyer et al., 2011, p.235), without being overwhelmed by the managerial challenges created by diversity.

Although the extant studies suggest limited complementarity between knowledge management capabilities and multinationality, most of them do not test the effects of these interactions on knowledge outcomes. They also neglect the potential trade-off in light of the fundamental rationale for the AC concept. In this study, we specifically address this gap in the literature. Thus, we expect the trade-off between knowledge management capabilities (the inward-looking determinant of AC) and multinationality (the outward-looking determinant of AC) to result in a negative interaction effect, such that headquarters will be less effective in absorbing knowledge from foreign subsidiaries when MNCs are highly internationalized and make extensive use of knowledge management capabilities across their global operations. Hence, we hypothesize that:

H5: Multinationality and knowledge management capabilities (H5a: systems capabilities; H5b: coordination capabilities; H5c: socialization capabilities) have a negative interaction effect on the ability of MNC headquarters to absorb knowledge from foreign subsidiaries.

In sum, the extant literature has advanced our understanding of the determinants of AC but it has left a few important gaps that motivate this paper. A summary of the key studies and gaps of interest is presented in Table 1. The theoretical underpinnings developed in this paper suggest the conceptual model depicted in Figure 1.

Table 1. Research gap

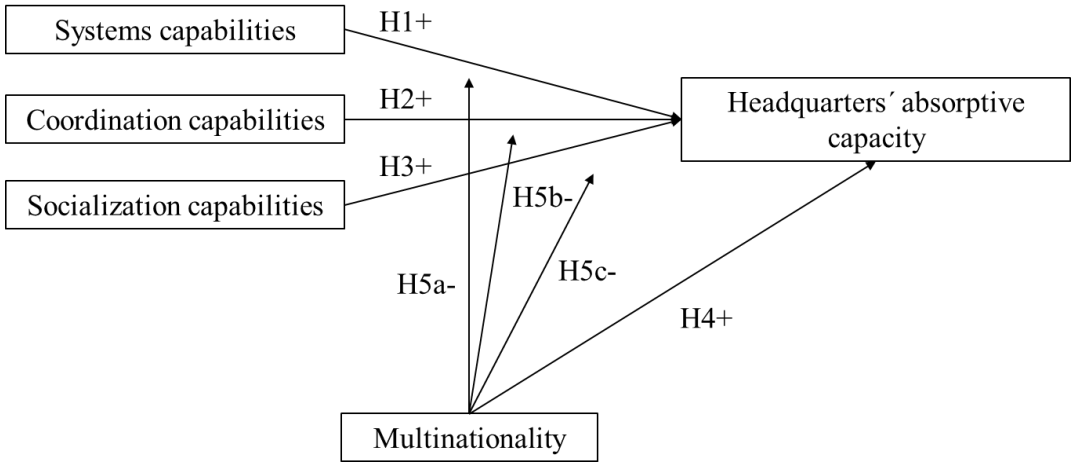
Topic	Authors	Main contribution to this paper	Gaps of interest for this paper
Absorptive capacity	Cohen and Levinthal (1990)	Concept of absorptive capacity (AC) and proposed trade-off between inward-looking and outward-looking AC.	Does not test the trade-off nor discusses in detail the interplay between inward-looking and outward-looking AC.
	Lane et al. (2006); Zahra and George (2002); Lane and Lubatkin (1998)	Reconceptualizations of AC.	Do not discuss nor test the trade-off between inward-looking and outward-looking AC.
	Ambos et al. (2013)	Raises the importance of clarifying to what extent the knowledge overlap is valuable for AC.	Does not test the trade-off per se.
	Ambos et al. (2013); Volberda et al. (2010); Pedersen et al. (2020)	Call for more studies on the trade-off between inward-looking and outward-looking AC.	Do not test the trade-off empirically.
	Burcharth et al. (2014)	The Non-Invented-Here (NIH) Syndrome negatively affects learning and innovation.	Does not account for the trade-off with diversity of knowledge.
	Lane and Lubatkin (1998)	Too much diversity hinders the absorption of knowledge as it becomes too distant from the firms' existing knowledge base.	Does not account for the trade-off with commonality of knowledge.
Knowledge management capabilities (in conjunction)	Van den Bosch et al. (1999)	Systems, coordination, and socialization capabilities are organizational determinants of absorptive capacity.	Does not consider specifically the context of international knowledge transfers.
	Jansen et al. (2005)	Different effects of systems, coordination, and socialization capabilities on potential and realized AC.	Does not consider specifically the context of international knowledge transfers.
Systems capabilities	Gupta and Govindarajan (2000); Rabbiosi (2011); Crespo et al. (2014)	Systems capabilities positively affect the level of reverse knowledge transfer.	Do not test the effect on absorptive capacity.
Coordination capabilities	Argyres and Silverman (2004)	Organizations with centralized R&D structures are better able to generate innovations that have a broader impact on subsequent technological evolution.	Does not test the effect on absorptive capacity.
	Lane et al. (2001)	Learning structures and processes positively impact international joint ventures´ (IJVs) ability to assimilate new knowledge from parent firms; training competence positively impact IJVs´ ability to apply the assimilated knowledge.	Conventional knowledge transfer as opposed to reverse knowledge transfer.
	Lyles and Salk (1996)	Establishing explicit goals for knowledge sharing help IJVs to acquire knowledge from their foreign parents.	Conventional knowledge transfer as opposed to reverse knowledge transfer.

table continues...

Topic	Authors	Main contribution to this paper	Gaps of interest for this paper
Socialization capabilities	Gooderham, Minbaeva, & Pedersen (2011)	Social relations positively impact firms' social capital, which in turn facilitates the transfer of knowledge.	Does not test the effect on absorptive capacity.
	Bresman et al. (1999)	Extended visits and technical meetings are particularly important to transfer more tacit forms of knowledge (e.g. technological know-how).	Does not test the effect on absorptive capacity.
	Ghoshal et al. (1994); Ghoshal and Bartlett (1988)	The importance of interpersonal relationships stimulated by extensive travel, joint work assignments, joint task forces, meetings, communities of practice for enabling subsidiary-headquarters integration.	Do not test the effect on absorptive capacity.
Multinationality	Barkema and Vermeulen (1998); Hitt et al. (1997); Jiménez-Jiménez et al. (2014)	International diversification leads to greater knowledge outcomes (e.g. richer knowledge structures, more robust technological capabilities, and increased knowledge transfer and innovation).	Do not test the effect on absorptive capacity.
	Denison et al. (1996)	Larger international experience increases CEO´s perception that foreign direct investment is an opportunity.	Does not test the effect on absorptive capacity.
	Barkema and Vermeulen (1998); Hitt et al., (1997); Meyer et al. (2011); Gomes and Ramaswamy (1999)	Multinational diversity may increase complexity, create additional managerial challenges and increased information-processing demands that may hamper its benefits.	Do not test the effect on knowledge outcomes nor on absorptive capacity.

Source: The authors

Figure 1. Proposed conceptual model



3. Methods

3.1. Data collection and sample

We collected firm-level, cross-sectional data on Brazilian and Portuguese MNCs to test our hypotheses. There are some considerations when selecting samples from these two countries. Brazil and Portugal vary on institutional, economic, and cultural dimensions. Internationalization motives and subsidiary roles also differ across MNCs from these countries, as emerging market MNCs tend to focus on acquiring new capabilities and sources of competitive advantage instead of exploiting existing headquarter-level advantages (Guillén & García-Canal, 2009). These context dissimilarities could affect the benefits that headquarters derive from reverse knowledge transfers (Ambos et al., 2006). Thus, given the difficulty of measuring intangibles, such as knowledge management capabilities and absorptive capacity (Chetty, Johanson, & Martín Martín, 2014; Hitt, Hoskisson, & Gimeno, 1998), we analyzed these two empirical settings in order to increase the cross-country validity of the measures and findings.

An international research team with members from both countries co-designed the survey procedure and data collection instruments. Members of the research team were trained using uniform protocols to ensure consistency in the measurement items, sampling, data collection, and coding procedures. An initial dataset of 176 MNCs (87 from Brazil and 89 from Portugal) was selected from business directories and professional networks, guided by the following criteria: (i) firms engaged in

FDI activities (e.g. commercial office, assembly, distribution center, production, research and development, and services); and (ii) capital controlled by domestic entities. As the official language of Brazil and Portugal is Portuguese, the same questionnaire with 22 indicators was used with adaptations to reflect local terminology. The questionnaire consisted of two sections covering questions related to the international managers' perceptions of their MNCs' knowledge management capabilities and absorptive capacity. It also included objective measures of firms' activities (i.e. total and international revenues, assets, and employees). The latter set of information was collected through the survey because our sample included several medium-sized and unlisted enterprises that rarely publish financial and operational information. The respondents were mainly senior managers in charge of the MNC's international operations. They were asked to answer the questions on their firms' knowledge management capabilities and absorptive capacity, and to collect financial and operational data from internal sources. The research team conducted follow-up calls to respond to concerns and stimulate answers. Data collection took place from May through August 2017.

The use of perceptual measures to operationalize knowledge management capabilities and absorptive capacity may entail common method bias. To address this issue, we followed Podsakoff, MacKenzie, Jeong-Yeon, and Podsakoff (2003) recommendation of ensuring respondent and firm anonymity, thereby reducing the propensity for acquiescent or socially acceptable responses. Also, the use of objective measures for the multinationality construct reduces the potential impact of common method bias. We could further control for common method bias by using separate samples for explanatory and explained variables, or different data sources. However, separate samples might lead to information loss and spurious results due to sample-size constraints. In addition, we could not identify alternative data sources that would provide a valid representation of the variables.

The final convenience sample comprised 106 MNCs (52 from Brazil and 54 from Portugal), which gives an overall response rate of 60.2% (59.7% in Brazil and 60.7% in Portugal). The high response rates were due to the follow-up efforts in the data collection phase. The sample size raises no generalizability or statistical power concerns in light of the 96 degrees of freedom (106 observations – 10 estimated parameters) and the ratio of observations to independent variables of 11.7:1 (106 observations/9 independent variables), which exceeds the threshold of 5:1 that is considered appropriate for multiple regression analyses (Hair, Anderson, Tathem,

& Black, 2005). A maximum of two missing values were found in 7 of the 22 indicators, with 9 "no responses" out of 2,332 data points (0.39%). This is unlikely create limitations in statistical tests. A Little's MCAR test showed that the missing values were randomly spread (chi squared = 74.766, DF = 80, Sig. = 0.644). We therefore replaced them with the item's mean, as suggested by Hair et al. (2005).

3.2. Measures

We used both objective and subjective measures. The measures were based on validated scales and indexes found in the extant literature, and adapted to the context of interest (international reverse knowledge transfers) following qualitative interviews with international managers of seven MNCs (four in Brazil and three in Portugal).

Dependent variable. *Absorptive capacity* was measured using a four-item scale that reflected the ability of the MNC headquarters to absorb knowledge from its foreign subsidiaries. Given calls for more studies adopting a capabilities approach to AC (Lane et al., 2006), we consulted previous literature (Jansen et al., 2005; Zahra & George, 2002) and made adaptations to the existing scales based on interviews with the companies and the context of the study (i.e. reverse knowledge transfers). The respondents answered the questions using a seven-point Likert-type scale, ranging from 1 (completely disagree) to 7 (completely agree). The items reflected the dimensions proposed by Zahra and George (2002): "The headquarters frequently interacts with foreign subsidiaries to acquire new knowledge" (acquisition); "Our company easily assimilates opportunities in the international market identified by our foreign subsidiaries" (assimilation); "Our company systematically grasps the knowledge generated in foreign subsidiaries" (transformation); and "Our company constantly tries to better exploit knowledge from foreign subsidiaries" (exploitation). The final scale displayed good reliability (Cronbach´s alpha = 0.92) (Nunnally, 1978). Therefore, the items were averaged to compute overall AC.

Independent variables. Knowledge management capabilities were measured using a five-point scale focused on the extent to which the MNCs used several mechanisms globally to transfer knowledge from its subsidiaries. We adapted the measures of systems, coordination, and socialization capabilities proposed by Van den Bosch et al. (1999) and Jansen et al. (2005). To build our scales, we also considered other literature on knowledge transfers (Ambos et al., 2006; Argyres & Silverman, 2004; Cabrera & Cabrera, 2005; Lane & Lubatkin, 1998; Lane et al.,

2001; Lyles & Salk, 1996; Minbaeva et al., 2012; Rabbiosi, 2011). Systems capabilities were measured in terms of the global use of three mechanisms to transfer knowledge internationally: webcasts (online speeches), social networks for knowledge sharing, and virtual platforms for knowledge sharing (Cronbach´s alpha = 0.79). Coordination capabilities were measured as the extent of global use of three mechanisms to foster international knowledge transfers: R&D department, training on innovation and knowledge sharing, and goals for innovation and knowledge sharing (Cronbach´s alpha = 0.72). Socialization capabilities were measured in terms of the global use of four mechanisms to transfer knowledge internationally: meetings, communities of practice, international trips, and international project teams (Cronbach´s alpha = 0.71).

Individual items captured the extent of global implementation (as opposed to mere existence) of each knowledge management mechanism. The scales ranged from 1 to 5 (1 = "The company does not use"; 2 = "Under development"; 3 = "Only the headquarters use OR only the foreign subsidiaries use"; 4 = "The headquarters and some foreign subsidiaries use"; 5 = "The headquarters and all foreign subsidiaries use").

We conducted an exploratory factor analysis (EFA) to confirm that the scale was multi-dimensional and that items presented factor loadings in the expected dimension. The EFA resulted in three factors that explained 63.77% of the variance (Kaiser-Meyer-Olkin: KMO = 0.803/Bartlett's test of sphericity: chi squared 343.625, df = 45, $p < 0.000$). As the items used in these three dimensions are not necessarily correlated and cannot be treated as interchangeable, we operationalized coordination, systems, and socialization capabilities as formative constructs (Jarvis, Mackenzie, Podsakoff, Mick, & Bearden, 2003). As such, our final variables accounted for the corresponding factor loadings resulting from each EFA dimension.

Multinationality was measured using a composite index focused on the intensity of foreign activities and geographical diversity. The index is the weighted average of two items: i) the ratio of foreign assets to total assets, which mainly captures global production (Daniels & Bracker, 1989; Ramaswamy, 1993) and ii) the ratio of foreign employees to total employees, which captures the global workforce. The items were averaged and weighted by the number of countries in which the MNC operates in order to account for its geographical diversity. Given that multinationality is a multidimensional construct (Gomes & Ramaswamy, 1999;

Sullivan, 1994), these measures serve to encompass the various forms of internationalization among companies from different industries. The final scale ranged from 0 to 1, with values closer to 0 reflecting lower degrees of multinationality and values closer to 1 reflecting higher degrees of multinationality. Similar composite measures have been used in research that assesses the level of internationalization of firms (Barakat, Cretoiu, & Ramsey, 2011; Ietto-Gillies, 1998; Tuselmann, Allen, Barrett, & McDonald, 2008).

We conducted a confirmatory factor analysis (CFA) to further check for construct validity and model fit (Bagozzi, Yi, & Philips, 1991; Hair et al., 2005). For the reflective constructs (i.e. AC and multinationality), we added the corresponding items used to measure them. For the formative construct of knowledge management capabilities, we added the three variables (systems, coordination, and socialization) resulting from the EFA (for model fit purposes). The item loadings of the reflective constructs of AC and multinationality were all greater than 0.500 and significant ($p < 0.000$) in their respective dimensions, which provides evidence of convergent validity. We also calculated construct reliability (CR) and all constructs presented values higher than 0.70 (AC = 0.93, multinationality = 0.89). With regard to average variance extracted (AVE), the values were higher than the recommended threshold of 0.50 (AC = 0.76, multinationality = 0.74) (Fornell & Larcker, 1981; Hair et al., 2005). The AVEs were also higher than the constructs´ bivariate correlations, which indicates that the constructs differ from each other. Thus, the assumption of discriminant validity between AC and multinationality is confirmed. Finally, the results indicate that the model fits the data well (chi squared = 37.858, df = 32, $p = 0.219$, goodness-of-fit index (GFI) = 0.936, comparative fit index (CFI) = 0.991, root-mean-square error of approximation (RMSEA) = 0.042). For the tests of the hypotheses, which included interaction terms, all independent variables and interaction terms were standardized (Field, 2013).

Control variables. We controlled for several firm characteristics to minimize spurious effects. We included a control for the effects of *firm nationality* (0 = Brazilian; 1 = Portuguese), as the benefits of reverse knowledge transfers may vary due to contextual differences (Ambos et al., 2006; Gaur et al., 2019). As previously mentioned, controlling for firm nationality also plays a role in determining whether our findings are country specific. *Firm industry* was included to measure the value added by the firm's activities (1 = natural resources; 2 = manufacturing; 3 = services), as industries vary in knowledge intensity and dynamics (Cho &

Padmanabhan, 2005; Gupta & Govindarajan, 2000). *Firm size*, which is also a determinant of knowledge transfer (Van Wijk et al., 2008), was measured in terms of the MNC's total revenue in the previous year (i.e. 2016). We also controlled for firms' *international experience*, as firms that operate internationally for longer periods may accumulate a larger knowledge base (Johanson & Vahlne, 1977, 2003), which could affect their absorptive capacity. We measured this variable as the number of years since the firm established its first international subsidiary. Finally, we controlled for whether firms were *listed* on a stock exchange (0 = not listed; 1 = listed), as listing requirements may lead to greater formalization of knowledge and transparency (Hoskisson, Eden, Lau, & Wright, 2000).

4. Results

In order to test our hypotheses, we estimated a series of multivariate ordinary least squares regressions. Prior to this estimation, we performed the usual diagnostics tests in order to examine the distribution properties of the data and produce reliable estimators. The results were satisfactory, as no substantial deviations from homoscedasticity, normality, or linearity were detected. Table 2 presents descriptive statistics for the variables. Table 3, which displays the correlations, indicates that all correlations among predictor variables were less than 0.5. Correlations above the 0.8 threshold would be problematic (Field, 2013). We also checked for possible multicollinearity issues and the results were acceptable. The maximum variance inflation factor (VIF) was 8.4 and all but two variables had VIFs of less than 3.5, which is below the cut-off of 10 recommended for multiple regression analyses (Neter, Wasserman, & Kutner, 1985; Wooldridge, 2003).

Table 2. Descriptive statistics

	N	Range	Min	Max	Mean	S. D.
1. Absorptive capacity	106	5,75	1,25	7,00	5,30	1,43
2. Systems capabilities	106	4,17	-2,43	1,74	0,00	1,00
3. Coordination capabilities	106	5,00	-3,14	1,86	0,00	1,00
4. Socialization capabilities	106	4,32	-2,82	1,50	0,00	1,00
5. Multinationality	106	24,50	0,01	24,51	2,94	3,89
6. Firm nationality	106	1,00	0,00	1,00	0,51	0,50
7. Listed firm	106	1,00	0,00	1,00	0,32	0,47
8. Firm industry	106	2,00	1,00	3,00	2,47	0,62
9. Firm international experience	106	129,00	2,00	131,00	20,37	17,06
10. Firm size[1]	106	80690,47	0,90	80691,37	3019,78	10591,21

[1]Firm size was measured in millions in local currency and converted to Euros for the case of Brazilian multinationals using the exchange rate of the end of 2016 (1 Euro = 3,4379 Brazilian Reais).

Table 3. Correlations

	1	2	3	4	5	6	7	8	9
1. Absorptive capacity									
2. Systems capabilities	0.215*								
3. Coordination capabilities	0.354***	0.000							
4. Socialization capabilities	0.538***	0.000	0.000						
5. Multinationality	0.155	0.066	0.114	0.152					
6. Firm nationality	-0.100	0.008	-0.362***	-0.024	-0.080				
7. Listed firm	0.046	0.016	0.170	0.100	0.151	-0.417***			
8. Firm industry	-0.049	0.191*	-0.250**	0.108	-0.015	0.322**	-0.296**		
9. Firm international experience	0.043	-0.035	0.066	0.208*	0.361***	-0.001	0.159	-0.034	
10. Firm size	0.178	-0.049	0.065	0.093	0.113	-0.266**	0.357***	-0.067	0.120

*** Significant at 0.01 level, ** Significant at 0.1 level, * Significant at 0.5 level

With regard to the control variables, firm nationality is significantly and negatively correlated with coordination capabilities, which suggests that Brazilian MNCs make greater use of these mechanisms to transfer knowledge internationally than Portuguese MNCs. In addition, firms in higher value-adding industries (e.g. services) adopt systems capabilities more intensively, while firms in lower value-adding industries (e.g. natural resources and manufacturing) rely on coordination capabilities to manage knowledge internationally. Finally, firms with more international experience tend to exhibit higher multinationality and to rely on socialization mechanisms across their global operations.

To compute the regressions, we used hierarchical entry of the independent variables, starting with a base model with controls (Model 1). The main and interaction effects of each independent variable were entered in Models 2 to 4 respectively. The fifth model included all direct effects. The three interaction effects were then added to the full model (Model 6). Our hierarchical models were analyzed as indicated in Table 4.

Table 4. Results of hypotheses tests

Headquarters' absorptive capacity												
	Model 1		**Model 2**		**Model 3**		**Model 4**		**Model 5**		**Model 6**	
	Stand. Beta	p. value	Stand. Beta	p. value	Stand. Beta	p. value	Stand. Beta	p. value	Stand. Beta	p. value	Stand. Beta	p. value
Intercept (unstandardized)	5.519***	0.000	6.125***	0.000	5.170***	0.000	6.315***	0.000	6.134***	0.000	6.191***	0.000
Firm nationality	-0.068	0.547	-0.084	0.435	0.036	0.739	-0.051	0.595	0.080	0.355	0.045	0.590
Listed firm	-0.059	0.611	-0.160	0.160	-0.098	0.361	-0.121	0.225	-0.134	0.117	-0.189*	0.027
Firm industry	-0.032	0.760	-0.095	0.354	0.047	0.633	-0.121	0.180	-0.122	0.132	-0.093	0.231
Firm international experience	0.031	0.761	-0.036	0.722	-0.080	0.420	-0.116	0.203	-0.115	0.147	-0.167*	0.031
Firm size	0.175	0.104	0.208*	0.042	0.227*	0.024	0.149	0.100	0.181*	0.022	0.229**	0.003
Multinationality			0.279*	0.018	0.202	0.052	0.112	0.222	0.057	0.463	0.183*	0.042
Systems capabilities			0.191	0.051					0.241**	0.001	0.233**	0.002
Coordination capabilities					0.317**	0.002			0.364***	0.000	0.309***	0.000
Socialization capabilities							0.561***	0.000	0.565***	0.000	0.562***	0.000
Systems capabilities*Multinationality			-0.289*	0.010							-0.068	0.474
Coordination capabilities*Multinationality					-0.249*	0.014					-0.247**	0.002
Socialization capabilities*Multinationality							0.025	0.778			0.034	0.689
F-value	0.793	0.557	2.460*	0.018	3.422**	0.002	6.318***	0.000	11.220***	0.000	10.282***	0.000
R-square	0.038		0.169		0.220		0.343		0.513		0.570	
Adjusted R-square	-0.010		0.100		0.156		0.288		0.467		0.515	

*** Significant at 0.01 level, ** Significant at 0.1 level, * Significant at 0.5 level

The results of Model 6 support H1, which predicts that systems capabilities positively affect MNC headquarters' absorptive capacity ($\beta = 0.233$, $p = 0.002$). The interaction term was in the hypothesized direction but not significant ($\beta = -0.068$, $p = 0.474$), which leads us to reject H5a. When analyzed separate from the other capabilities, systems capabilities have an insignificant direct effect ($\beta = 0.191$, $p = 0.051$) but a significant negative interaction with multinationality, as shown in Model 2 ($\beta = -0.289$, $p = 0.010$).

With regard to coordination capabilities, Model 6 offers support for H2, which proposes a direct effect on MNC headquarters' absorptive capacity ($\beta = 0.309$, $p < 0.000$). The interaction with multinationality is also significant, thus providing support for H5b ($\beta = -0.247$, $p = 0.002$), which proposes a trade-off between this inward-looking determinant of AC and the outward-looking determinant. We also found support for both hypotheses when testing coordination capabilities separately from the others, as shown in Model 3 ($\beta = 0.317$, $p = 0.002$ for the direct effect; $\beta = -0.249$, $p = 0.014$ for the interaction effect).

For socialization capabilities, we find a strong positive direct effect on MNC headquarters' absorptive capacity ($\beta = 0.562$, $p < 0.000$), as depicted in Model 6, which provides support for H3. The interaction term is insignificant ($\beta = 0.034$, $p = 0.689$), which leads us to reject H5c. The results of Model 4, which excludes other capabilities, indicate that socialization capabilities increase MNC headquarters' absorptive capacity without the trade-off effect with multinationality ($\beta = 0.561$, $p < 0.000$ for the direct effect; $\beta = 0.025$, $p = 0.778$ for the interaction effect).

Multinationality has a positive, direct effect on MNC headquarters' absorptive capacity, as shown in Model 6. This supports H4 ($\beta = 0.183$, $p = 0.042$). Therefore, diversity of knowledge, as expressed by MNCs' international operations, increases MNC headquarters' absorptive capacity when accounting for all three capabilities. The direct effects of multinationality differ across Models 2 to 5, as multinationality is only significant in the model accounting for systems capabilities ($\beta = 0.279$, $p = 0.018$).

All models provided significant solutions, as shown by the F values ($p < 0.000$) (except for Model 1 with controls only). Model 6, which comprises all variables (controls, three capabilities, multinationality, and interaction effects), explains more of the variance in MNC headquarters' absorptive capacity. The values of R^2 and adjusted R^2 are the highest among the six models ($R^2 = 0.570$; adjusted $R^2 = 0.515$).

In order to assess the validity of findings across Brazil and Portugal, we controlled for firm nationality (Model 6), which had no significant effect. As for the other control variables, the results of Model 6 indicate that listed firms and firms that have more international experience tend to have lower absorptive capacity at the headquarters level. Conversely, larger MNCs exhibit greater AC at the headquarters level when accounting for the other variables in the study.

5. Discussion

In this article, we have explored the influence of inward-looking and outward-looking determinants of absorptive capacity (knowledge management capabilities and multinationality, respectively) on the ability of MNC headquarters to absorb knowledge from foreign subsidiaries. We have elaborated theoretically on the nature of the trade-off effect proposed by Cohen and Levinthal (1990) between the inward-looking and outward-looking determinants of AC, and we have empirically analyzed the interactions between them. Our approach and findings are novel as, to our knowledge, no previous studies have explored this trade-off effect and no other studies have explicated the characteristics of the interplay between these drivers of AC (Volberda et al., 2010). Overall, our conceptualization and operationalization of this contingent effect have useful research implications.

Our results confirmed our hypothesis that systems capabilities improve the AC of MNC headquarters in relation to knowledge generated by foreign subsidiaries. This finding extends the literature on the influence of systems capabilities on AC (Jansen et al., 2005; Van den Bosch et al., 1999) to the context of international knowledge transfers. It also adds to the emerging discussion of how systems mechanisms influence the reverse knowledge transfer process (Crespo et al., 2014; Gupta & Govindarajan, 2000; Rabbiosi, 2011) and advances that line of research by showing the direct link with AC. Although the interaction between systems capabilities and multinationality was not confirmed in the main model (Model 6), the results of Model 2 indicated a significant, negative effect, signaling a potential trade-off that deserves additional attention in future studies.

Our findings also confirmed that coordination capabilities increase the ability of MNC headquarters to absorb knowledge generated by foreign subsidiaries. This result is in line with previous studies that have shown a direct effect of coordination capabilities on AC (Jansen et al., 2005; Lane et al., 2001; Lyles & Salk, 1996; Van den Bosch et al., 1999) and extends them to the context of international reverse

knowledge transfers. It also diverges from Argyres and Silverman (2004) by suggesting that globally widespread (as opposed to centralized) R&D structures can enhance knowledge outcomes. However, we found a significant negative interaction effect of coordination capabilities and multinationality on headquarters' AC. This finding is novel in the knowledge management literature. By explaining the nature of the interrelations between knowledge management capabilities and multinationality as drivers of AC, this study sheds light on the fact that highly internationalized MNCs that extensively deploy coordination capabilities throughout their global operations tend to absorb less of the knowledge generated by foreign subsidiaries. For instance, if an MNC is highly internationalized and dispersed across several countries, it may miss opportunities to benefit from external knowledge sources if it becomes too embedded in its own coordination mechanisms as a result of the NIH syndrome (Antons & Piller, 2015; Katz & Allen, 1982). A high level of multinationality may also create additional challenges for internal communication due to difficulties of transferring tacit knowledge among different languages and cultures (Ambos & Ambos, 2009; Martin & Salomon, 2003). As developing absorptive capacity is about adding knowledge to the firm's existing knowledge pool (Cohen & Levinthal, 1990), knowledge coming from subsidiaries of highly internationalized firms might become too distant from the existing knowledge base, thereby hampering the absorption process (Lane & Lubatkin, 1998).

Of the knowledge management capabilities we analyzed, socialization capabilities had the strongest direct effect on MNC headquarters' AC. Notably, we found no significant trade-off in this regard. As such, socialization capabilities may be particularly effective in increasing the ability of MNC headquarters to learn from foreign subsidiaries regardless of the firm's level of multinationality. These results are in line with extant literature indicating a positive relationship between socialization capabilities and AC (Jansen et al., 2005; Van den Bosch et al., 1999). They also extend previous literature that discusses the importance of social interactions and personal mechanisms for subsidiary-headquarters transfers (Bresman et al., 1999; Ghoshal & Bartlett, 1988; Ghoshal et al., 1994; Gooderham et al., 2011; Rabbiosi, 2011) by highlighting the direct link with headquarters' AC.

Our findings also suggest that multinationality helps increase AC at the headquarters level, which may relate to these firms' greater international experience and accumulated learning (Bilkey, 1978; Eriksson, Johanson, Majkgard, & Sharma,

1997; Johanson & Vahlne, 1977, 2009). Cohen and Levinthal (1990) stress the importance of knowledge diversity for AC, while other studies explore the contribution of international diversity to knowledge outcomes (Barkema & Vermeulen, 1998; Hitt et al., 1997) and CEOs´ perceptions of FDI (Denison et al., 1996). Our study extends this stream of research by exploring the specific relationship between multinationality and the AC of MNC headquarters.

Interestingly, our results showed that MNC headquarters' AC did not vary significantly across firm nationality or industry, signaling some initial support for the cross-country and cross-industry validity of our findings. We found a positive relationship between the size of MNCs and AC at the headquarters level, suggesting that larger firms are better able to learn from their foreign subsidiaries because they control more advanced resources and enjoy more opportunities to access local market knowledge (Petersen et al., 2008).

5.1. Theoretical implications

This study has several important implications for theory. First, we empirically examine the trade-off between inward-looking and outward-looking determinants of AC proposed by Cohen and Levinthal (1990). As such, we provide initial insights into the manifestation of this trade-off in the context of international reverse knowledge transfers when both the inward-looking determinant (i.e. coordination capabilities) and the outward-looking determinant (i.e. multinationality) are high. The AC literature following Cohen and Levinthal (1990) has thus far neglected this conceptual aspect of the construct (see the studies from Lane et al., 2006; Lane & Lubatkin, 1998; Volberda et al., 2010, for some excellent reviews of absorptive capacity; Zahra & George, 2002). Therefore, we respond to recent calls for more clarification on the amount of knowledge overlap that is beneficial to the firm (Ambos et al., 2013), and for a deeper investigation of the trade-off between inward-looking and outward-looking AC (Pedersen et al., 2020; Volberda et al., 2010).

This study also adds to research on intra-organizational learning by suggesting that the limited complementarity between coordination capabilities and multinationality may affect the speed of AC development (Schleimer & Pedersen, 2014). Furthermore, by suggesting that a diverse international setting may reduce the effects of coordination mechanisms on the AC of MNC headquarters, this paper contributes to other emerging streams of research. In particular, it adds to the contingency approach for international reverse knowledge transfers, as called for by

Ambos et al. (2006). It also attempts to address calls for more studies exploring the role of multinationality and the ways it may constrain learning and innovation (Barkema & Vermeulen, 1998; Hitt et al., 1997). In addition, our study contributes to the literature on AC as a dynamic capability (Zahra and George, 2002). Finally, this study helps integrate the organizational learning and knowledge management perspectives, as we considered the interdependencies of the knowledge creation, acquisition, and transfer processes (Castaneda, Manrique, & Cuellar, 2018).

5.2. Managerial implications

Taken together, the arguments in this article have implications for management practice in relation to the ways headquarters learn from subsidiaries. Headquarters absorb more knowledge from subsidiaries when they develop superior knowledge management capabilities. In this regard, our study suggests some practical knowledge transfer mechanisms that MNCs can implement regardless of their international footprint. For instance, companies can deploy systems tools that support webcasts, social networks, and virtual platforms for knowledge sharing. They can also make use of coordination mechanisms, such as R&D departments, training on innovation and knowledge sharing, and goals for innovation and knowledge sharing. Socialization mechanisms, such as meetings, communities of practice, international trips for knowledge sharing, and international project teams, are particularly effective in promoting the transfer of knowledge from subsidiaries to headquarters.

Our findings also suggest that as MNCs advance along their internationalization paths, it makes sense to emphasize socialization capabilities. Expansion to geographies with different cultures adds complexity, which renders the exchange of tacit knowledge through formal coordination mechanisms less effective. Moreover, the adoption of coordination capabilities throughout most or all foreign subsidiaries may lead to excessive knowledge overlap among subsidiaries. For instance, if all subsidiaries of an MNC have their own R&D department and share similar training and goals for innovation, communication may be improved but the range of ideas may be reduced. Thus, the headquarters of highly internationalized MNCs should foster interpersonal relationships when absorbing knowledge generated by subsidiaries is a key objective. Personal interactions help to reduce the cultural and linguistic barriers that stem from high levels of multinationality while promoting openness to new external knowledge. In other words, socialization mechanisms may help headquarters´ managers create awareness of new knowledge that is distant

from their existing knowledge base, thereby avoiding the NIH syndrome. Over time, they should also help managers mobilize internal resources in order to assimilate strategically-relevant knowledge that would otherwise not emerge from structured coordination mechanisms.

5.3. Limitations and future research

Some limitations of this article should be mentioned. First, our study is largely exploratory, as it is based on a sample of MNCs registered in two countries—Brazil and Portugal. Conditions for international reverse knowledge transfers in these countries may differ from those in other settings. Despite the absence of country differences in our results, caution is warranted when generalizing to other contexts. Subsequent studies in other national settings should be conducted to further test the robustness of our findings.

Second, we examined the context of reverse knowledge transfers given the increased relevance of the knowledge generated by subsidiaries for MNCs (Blomkvist et al., 2017; Yang et al., 2008), especially for their headquarters. Future studies can explore the proposed determinants of absorptive capacity in other types of knowledge flows, such as from headquarters to subsidiary or among subsidiaries.

Third, we did not investigate the influence of knowledge management mechanisms on the ability of MNCs to transfer and absorb different types of knowledge (Apriliyanti & Alon, 2017; Kenney & Gudergan, 2006). However, recent research suggests that organizations that have knowledge management mechanisms are able to share knowledge regardless of its type (Balle, Steffen Mário, Curado, & Oliveira, 2019).

Fourth, our multinationality variable did not take the types of subsidiaries into account. As subsidiaries of different types should use different mechanisms to promote reverse knowledge transfers (Rabbiosi, 2011), future studies may focus on this consideration.

Fifth, as our study is based on cross-sectional data, inferences regarding the causality of the relationships are not advisable. This highlights the importance of continued longitudinal research focused on investigating causality in our hypotheses, as past knowledge management capabilities may influence the absorptive capacity of MNCs in the future.

Finally, we acknowledge the limitations of using perceptual instruments to measure knowledge management capabilities and absorptive capacity. This also highlights the need for research that tests the proposed relationships using objective measures and, thereby, checks the consistency of our results.

5.4. Concluding remarks

The research advanced in this paper adds to recent developments in the literature on knowledge management and international business. In particular, we demonstrate that the ability of MNCs to absorb knowledge from their subsidiaries can be explained by the complex interplay among inward-looking and outward-looking determinants consisting of direct and interactive effects between firm-level knowledge management capabilities and multinationality. Our study unveils the limited complementarity between these determinants, particularly in instances where the MNC is highly internationalized and possesses advanced coordination capabilities. In such cases, we found a detrimental effect on the absorptive capacity of headquarters. Beyond the optimal level, the advantages of operating with superior coordination mechanisms in various geographies are reduced, perhaps due to the excessive embeddedness of subsidiaries in the similar types of knowledge and the complexities of managing dissimilar settings. As such, we contribute to the ongoing discussion by recognizing and empirically demonstrating that the optimal levels of absorptive capacity are not equal to the maximum possible levels of absorptive capacity (Volberda et al., 2010). Hopefully, future studies will build on these findings to add to and enhance our understanding of how MNCs can learn from foreign subsidiaries and create international value.

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Chapter 4

Teams and Project Performance: An Ability, Motivation, and Opportunity Approach

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Abstract

This paper analyses the relationships between project performance and the team's ability, motivation, and opportunity (AMO). We contribute to bridge the human resource management on work performance and the project management literatures by exploring which combinations of AMO factors are best for project performance at different levels of complexity. We test our hypotheses on a sample of 285 projects. Our study shows that in simple projects, ability is the key factor both as a main effect and as a constraining factor that acts as a bottleneck for project performance. In the case of complex projects, motivation has a pivotal role as it moderates the relationship between ability and project performance and between opportunity and project performance.

Keywords: Team performance, project performance, ability, motivation, opportunity, project complexity

Introduction

Firms use team-based projects to manage activities and resources in an integrated way, and to share knowledge and best practices internally (Gupta & Govindarajan, 2000; Sydow et al., 2004). Project teams are associations of employees with varied knowledge, expertise, and experience who work together over the lifespan of a project to achieve a common objective of either developing an incrementally or radically new concept, service, product, activity, or generating change (Chiocchio, 2015). As such, team members are interdependent in the performed tasks (Gladstein, 1984; Guzzo & Dickson, 1996). However, the temporary and discontinuous character of projects can impose barriers to learning if abilities, motivations, and opportunities are not properly managed (Bartsch et al., 2013). Therefore, an

understanding of the antecedents of project performance on the team level is particularly important, especially given the increasing performance pressures faced by project managers (Zimmerer & Yasin, 1998).

When examining the factors that contribute to a project's success, scholars have pointed to the resources and competences held by team members, the human resource management (HRM) practices applied, and the characteristics of the performed task (Floricel et al., 2016; Popaitoon & Siengthai, 2014; Tabassi et al., 2017). As Huemann, et al. (2007, p. 315) argue, "human resource management (HRM) can be viewed as core processes of the project-oriented company, affecting the way the organization acquires and uses human resources, and how employees experience the employment relationship." With that in mind, a recent review concludes that "by drawing on theoretical and methodical resources from the HRM field, project studies can benefit from a more refined focus on levels of analysis and practices" (Keegan et al., 2018, p.129).

We respond to this call by bringing together the HRM literature on work performance and the literature on project performance. Individuals working in project teams need the proper set of abilities, motivations, and opportunities to perform effectively. The HRM literature has widely explored such factors in the context of high-performance work systems. In this perspective, work performance is seen as a function of an employee´s ability (A), motivation (M), and opportunity (O), which together form the AMO framework (Appelbaum et al., 2000; Blumberg & Pringle, 1982; Boxall, 2003). The HRM literature has mainly used AMO as a guiding framework in studies of human resource (HR) practices and their effects on individual employee performance (Andreeva & Sergeeva, 2016; Beltrán-Martín & Bou-Llusar, 2018; Siemsen et al., 2008).

At the team level, ability, motivation, and opportunity may facilitate intra-project learning, and contribute to organizational learning as well as performance (Argote et al., 2003; Bartsch et al., 2013). However, in general, the project management literature has not explored the contribution of AMO factors to team and project performance. A notable exception is the study by Raidén et al. (2006), who recognized that the combination of the three factors may provide a better understanding of project requirements in line with organizational priorities, employee needs, and employee preferences. Nevertheless, the authors do not test the model or the interplay among the AMO factors. We aim to introduce the AMO framework to the project management literature by testing the combined effects of

teams´ abilities, motivations, and opportunities. We also examine combinations of AMO factors at the team level to find the combinations that best predict project performance.

Several studies have focused on the reinforcing effects of ability, motivation, and opportunity (Kim et al., 2015; Reinholt et al., 2011), while others have highlighted that one of the three factors might be a constraining factor that creates a bottleneck for performance (Siemsen et al., 2008). However, the exact interplay among the AMO factors is still an open issue (Argote et al., 2003), especially in the project management literature, which has ignored the three factors when studying the antecedents of project performance. As Keegan et al. (2018, p. 127) note, testing whether "the outcomes found in non-project contexts that are linked to HRM practices are replicated in a project context" might be of value. We address this gap in the literature by comparing three competing models of interplay among the AMO factors (an additive, a multiplicative, and a constraining factor model) in terms of their effects on project performance.

As events in more complex projects are not always predictable, they require different problem-solving responses and more intense knowledge generation than less complex projects (Turner et al., 2014). Therefore, we also consider differences in project complexity and suggest that the AMO factors interact differently in simple projects and in complex projects. In this regard, we answer calls in the project management literature for a deeper understanding of the capabilities needed to perform given different levels of project complexity (Rezende et al., 2018).

Moreover, while most studies have been conducted on the individual level with a focus on individual performance, we conduct our analysis at the team level with a focus on team performance. One cannot simply aggregate from the individual level to the team level and expect the AMO factors to work in the same ways on both levels (Klein & Kozlowski, 2000). In fact, the team level involves interactions that introduce a different dynamic. As such, we respond to the call to extend AMO research to the team level (Bouwmans et al., 2019; Jiang et al., 2013). Our research questions are the following: In what ways do a team's ability, motivation, and opportunity affect project performance? How do these factors interact? To what extent does the effect depend on the complexity of the project?

We conducted our study at InterCement, a multinational producer of cement, lime, and special mortars headquartered in Brazil. InterCement is a project-based

organization (PBO) (Hobday, 2000) that is particularly suitable for this study because of its predominant focus on team-based process- and management-innovation projects. In fact, it was recognized by Strategy&Pwc as one of the five most innovative companies in the construction materials and decoration sector in the *Valor Brazil Innovation Yearbook* (*Prêmio Valor Inovação Brasil 2018*). We tested our hypotheses on 285 projects.

We contribute to the literature in three ways. First, we introduce insights from the HRM literature on factors that can enhance project performance to the project management literature. Second, we explore the predictive capacity of the AMO framework and compare three models of the interplay among these factors at the team level. By examining the predictive capacity of the such competing models, we shed light on the mechanism through which ability, motivation, and opportunity impact team performance in the context of continuous improvement projects. As such, we extend the literature, which has mostly focused on the individual level and on the linear effect of each factor. Third, we introduce project complexity as a contextual variable that affects the optimal combination of AMO factors. By advancing our understanding of the antecedents of project performance at different levels of complexity, we hope to help managers to more efficiently allocate their teams' competences and resources.

AMO Models and Project Performance

Firms make extensive use of teams as a way of integrating and recombining knowledge in order to reach project goals. Previous research has analyzed variables like the team's size and composition, its motivation, the difficulty of achieving goals, and the type of leadership as predictors of project performance and effectiveness (Gladstein, 1984; Guzzo & Dickson, 1996; Keller, 1986; Tabassi et al., 2017). HRM practices have been found to affect project organization and performance in multiple ways (Belout & Gauvreau, 2004; see Huemann et al., 2007, and Keegan et al., 2018, for reviews on the cross-fertilization between HRM and project management).

For instance, the project management literature highlights the importance of education, technical competences, and leadership skills for conducting successful projects (Rumeser & Emsley, 2019; Zimmerer & Yasin, 1998). It also shows that the motivational climate in which teams operate is highly relevant in determining project managers´ behavior and performance (Caniëls et al., 2019; Seiler et al.,

2012). Other aspects explored by project studies are the role of situational factors, such as project complexity (Lechler et al., 2012; Rezende et al., 2018; Rumeser & Emsley, 2019), and the importance of managerial support (Gardner et al., 2011; Srivastava et al., 2006).

However, the factors that might contribute to project teams' performance are scattered throughout the project management literature and links to HRM theories are limited. On the one hand, as Huemann et al. (2007, p. 317) note, "in the project management literature, a limited amount of research has considered HRM." On the other hand, "the leading HRM literature neglects projects as a new working form and the specific implications of project-oriented work for HRM" (Huemann et al., p. 318). We bridge these two streams of literature by taking a closer look at HRM theories and their relevance for project performance at the team level.

The HRM literature proposes that performance is an outcome of three factors—ability (A), motivation (M), and opportunity (O) - which together form the AMO framework (Appelbaum et al., 2000; Blumberg & Pringle, 1982; Boxall, 2003). Ability, which refers to the capacity to perform, is closely connected to the knowledge base and skills. Motivation includes attitudinal variables and refers to an individual's willingness to perform. Opportunity reflects the means through which abilities and motivation can be converted into outcomes (Jiang et al., 2013). Several empirical studies have adopted and validated this conceptual framework (Batt, 2002; Liao et al., 2009; Subramony, 2009). For instance, Bailey et al. (2001) found that high performance work systems (HPWS), which are characterized by incentives to encourage employee participation, and human resource practices that ensure a skilled work force and opportunities to participate in decisions, positively affect earnings in several industries.

The reasoning for including these variables together is found in Gestalt psychology - their combined effects may be greater than the isolated effects of each element (Rock et al., 1990). For instance, previous studies suggest that the AMO model is more effective for predicting organizational outcomes than the three individual practices on their own (Obeidat et al., 2016; Subramony, 2009).

While there is empirical evidence of the positive impact of the AMO factors on performance (Caligiuri, 2014), less is known about their complementarity or whether one factor is more important under certain conditions (Kim et al., 2015; Siemsen et al., 2008). Therefore, scholars have called for empirical explorations of

how ability, motivation, and opportunity work together to create value (Argote et al., 2003).

This is particularly important at more aggregated levels, such as the team level, because of the dynamics and interactions among team members (Popaitoon & Siengthai, 2014). Team ability is different from the sum of the individual members' abilities, as it includes the synergies and interdependencies of members' skills (Zhao & Anand, 2009). In fact, in many cases, a team is more than the sum of its parts, such as when people with technical and business knowledge collaborate, or when players on a sports team have different skills that complement each other to create a team ability that is greater than the sum of each player's ability. The same is true for team motivation and team opportunity, which relate to complementarity and variation among team members rather than just the sum of the individuals. Notably, the very reason for forming the teams is that some synergies are created by putting individuals together. This approach, which is referred to as the "jigsaw puzzle approach," considers whether team members complement each other to achieve the team's highest potential based on particular combinations of several variables associated with each member (Allen & O'Neill, 2015). Also, HRM policies, processes, and practices in project-oriented companies are expected to be different from those in traditional organizations where the emphasis is on routine products and services (Huemann et al., 2007). Therefore, the most effective combination of AMO factors at the team level might be distinct from the most effective AMO combination at the individual level.

The three competing models on the AMO factors

Assembling teams with an optimal combination of characteristics is a difficult task for organizations with implications for the project´s success or failure (Allen & O'Neill, 2015). Therefore, understanding which combination of AMO factors better leads to team performance may help managers better compose teams and more efficiently allocate resources for projects.

Initial research on these issues utilized an additive or linear model in which an increase in one of the three factors was assumed to have a direct, positive effect on performance (Boxall, 2003; Cummings & Schwab, 1973). In an additive model, each factor has instant, linear, and independent effects on performance (Cummings & Schwab, 1973). One implication of this model is that the absence of one factor can be offset by an increase in the other two factors. However, in most cases, this

model does not accurately reflect how the AMO factors determine project performance simply because the three factors are rarely independent of each other. See Appendix 1 for a summary of how empirical AMO literature has thus far operationalized the model, and which research gaps of interest to this study.

Team members need the right skills to perform tasks that are generally characterized by (sequential or reciprocal) interdependencies. A lack of these abilities can seldom be offset by willingness or organizational support. Instead, the tasks will be delayed or performed poorly, thereby affecting the performance of the entire project (Garud & Kumaraswamy, 2005; Gladstein, 1984). Similarly, we expect the team's motivation to be a factor that cannot be offset by the other two factors. A high level of team motivation is related to trust and collaborative behavior in which individuals strive to achieve collective outcomes (Cabrera & Cabrera, 2005; Collins & Smith, 2006). Low levels of motivation might imply that team members trust each other less or they may not be committed to the project's goals, resulting in relationship conflicts and poorer performance (Liang et al., 2007; Liu et al., 2011). With regard to the opportunity factor, extant research offers empirical evidence of the importance of the individual's positioning (Reinholt et al., 2011) and organizational support (e.g., empowered leadership and management's commitment) for project performance (Gardner et al., 2011; Srivastava et al., 2006). Beyond these direct effects, we expect organizational support to reinforce team members' abilities and motivation by strengthening their knowledge base through internal knowledge sharing and by reinforcing their self-confidence. The concept of absorptive capacity also sheds light on the complementary nature of ability, motivation, and opportunity. When solving problems, individuals need to be exposed to relevant prior related knowledge and diversity of background (Cohen & Levinthal, 1990), in this case brought up by the other team member´s prior education and experience (i.e. ability) and the managerial support received (i.e. opportunity). Cohen & Levinthal (1990, p. 131) argue though that "To develop an effective absorptive capacity, whether it be for general knowledge or problem-solving or learning skills, it is insufficient merely to expose an individual briefly to the relevant prior knowledge. Intensity of effort is critical". Thus, intensity, expressed by time and effort spent on continued practice (in this case, motivation) may interact with ability and opportunity to create solutions in projects.

Consequently, models that account for complementarities among the AMO factors might better predict performance at the team level. Thus, our first set of hypotheses

(H1a and H1b) highlight the likely superior predictive power of two competing models - the multiplicative model and the constraining factor model - relative to that of the additive model. In fact, some investigations point to specific conditions that might have either a reinforcing effect between factors (i.e., the multiplicative model; Kim et al., 2015; Reinholt et al., 2011) or a constraining effect (i.e., the constraining factor model).

The multiplicative model claims that the three factors reinforce each other (Jiang et al., 2012). The team's ability is expected to positively interact with the team's motivation by reducing role confusion and increasing feelings of efficacy and commitment (Gardner et al., 2011). High levels of efficacy are positively related to team performance (Srivastava et al., 2006). As mentioned earlier, the opportunity factor also has reinforcing reciprocal effects with ability and motivation. First, opportunities like training and professional recruitment enhance the team's abilities. Second, when leaders are supportive and involved, team members can learn from their tactical and managerial skills, and obtain guidance on how to apply their knowledge (Gardner et al., 2011; Srivastava et al., 2006). Along the same lines, a team with a richer knowledge base has more opportunities to find solutions internally, thereby promoting knowledge exchange, which also strengthens the development of a collaborative climate (Jiang et al., 2012).

We also expect a reinforcing effect between motivation and opportunity in relation to project performance. First, members who perceive that their contributions are highly valued by others or that others might help in their future career development feel obligated to reciprocate, which enhances the collaborative climate (Cabrera & Cabrera, 2005; Gagné & Deci, 2005) and affective commitment (Gardner et al., 2011). Second, highly supportive teams with empowered leaders raise the level of intrinsic motivation by allowing individuals to be autonomous. In addition, these contextual conditions allow individuals to share their own ideas and potential solutions.

Therefore, a multiplicative model that includes interactions among the three factors might better explain projects' performance. Accordingly, we hypothesize:

H1a: The multiplicative model is a better predictor[1] of project performance than the additive model.

[1]A model is a "better predictor" when it explains a greater portion of the variance of the dependent variable.

However, teams do not always benefit from the complementarities among the three factors. The dynamics and characteristics of teamwork (e.g., the complexity of the project, the tacitness of the knowledge being shared) might call for a different model. At the individual level, Siemsen et al. (2008) apply the notion of resource constraints to the AMO framework for individuals' knowledge sharing and they propose a constraining factor model. They identify cases in which the value of one factor (i.e., the minimum for ability, motivation, or opportunity) acts as a bottleneck, such that unless a minimum is reached, the other factors have a limited effect. For example, in a context without any motivation, motivation may act as a behavioral constraint in relation to improving project performance, even in the presence of high ability and opportunity.

The constraining factor model proposes that the factor that is present to the least extent has the greatest effect on the team's performance because it constrains the effects of the two other factors if it is too low. Therefore, increasing the level of the lowest factor will strengthen the other factors as well (Siemsen et al., 2008). In fact, project teams establish a division of labor based on abilities, especially when their members are already specialized and accustomed to handling certain tasks. For these reasons, a failure to achieve a minimum level of one of the factors (e.g., lacking a certain ability needed to perform a task) postpones, at least in the short term, the achievement of potential synergies related to the other factors and affects the project's performance. Therefore, we hypothesize:

H1b: The constraining factor model is a better predictor of project performance than the additive model.

The effect of project complexity

Once established our hypotheses that both the multiplicative model and the constraining factor model are superior to the additive model, it is relevant to investigate under which circumstances each of these two combinations of AMO factors has a greater impact on project performance. Previous literature has raised the importance of understanding such situational factors that may affect project performance (Lechler et al., 2012; Hobbs, 2015).

A key characteristic that might illuminate which of the combinations of AMO factors is the most appropriate is the project's complexity, which is a relevant source of uncertainty and risk (Floricel et al., 2016; Nuhn et al., 2018) and can lead to project failure (Butler, Vijayasarathy, & Roberts, 2019).

In this paper, we focus on short-term projects that aim to improve efficiency. These projects are more exploitative of extant knowledge, and their level of complexity varies depending on factors like the institutional environment's complexity or organizational complexity (Floricel et al., 2016). Rezende et al. (2018) show that project complexity has structural, uncertainty, novelty, dynamics, pace, socialpolitical, and regulative dimensions that require different team and organizational capabilities. Thus, we differentiate between simple and complex projects (Baccarini, 1996; Geraldi et al., 2011).

Simple projects are characterized by less variety, fewer tasks, and lower technological and structural complexity (Baccarini, 1996). Therefore, the interdependencies in simple projects are straightforward and easier to manage (Geraldi et al., 2011). It is possible to identify and foresee the tasks that must be undertaken and plan how to perform them, and there is more certainty (Geraldi et al., 2011) about potential problems. If problems do occur, the team members are expected to possess the abilities and experience needed to address them. In this case, the work can be managed with an emphasis on *execution as efficiency* (Edmondson, 2008; Turner et al., 2014).

In contrast, complex projects are characterized by high levels of structural complexity owing to interactions among a large number of elements. Team members managing complex projects often confront confusing and unpredictable situations in which present knowledge and experience might be of little use (Baccarini, 1996; Geraldi et al., 2011). In these projects, it is more difficult to identify and define possible courses of action, and to manage interdependencies among team members. In such cases, projects can require new knowledge interactions to be managed as *execution as learning* (Edmondson, 2008; Turner et al., 2014). Therefore, as project complexity increases, more intense efforts and diversified knowledge may be needed in order to develop an absorptive capacity for problem solving (Cohen & Levinthal, 1990). Team absorptive capacity is thus in the interface between individual learning and organizational learning (Açıkgöz, Günsel, Kuzey, & Seçgin, 2016).

Based on Baccarini (1996)´s definition of project complexity in terms of its task differentiation and interdependency, we suggest which model would be more appropriate at each level of complexity, as shown in Table 1:

Table 1. Project complexity and AMO models

Overall level of complexity	**None**	**Simple**	**Complex**
i) Differentiation	Only one organizational structure involved; None or very few inputs needed to perform the tasks; One or very few steps to conclude the tasks.	Few units or departments involved; Few inputs needed to perform the tasks; Few steps to conclude the tasks.	Many units or departments involved; Several inputs needed to perform the tasks; Several steps to conclude the tasks.
ii) Interdependency	Tasks are independent from each other.	Pooled or sequential interdependency among tasks.	Sequential or reciprocal interdependency among tasks.
Most appropriate AMO model	**Additive model**	**Constraining factor model**	**Multiplicative model**

In projects entailing no complexity at all, teams manage one or very few tasks and steps, which are usually held within the same department. We argue that in such cases, any level of ability, motivation, and opportunity will have a linear contribution to project performance and so the additive model would be the most appropriate model. For instance, teams with low ability can achieve good performance at zero complexity if they have motivation and opportunity, as they could access the knowledge they lack by interacting among them or with their superiors. These interactions will be easily carried as such projects are carried within the same unit or department, with few and interdependent tasks.

However, projects in the construction industry generally involve some level of complexity (Baccarini, 1996; Kermanshachi & Safapour, 2019), so this would be an unrealistic scenario. In such contexts, we expect the two competing AMO models - the multiplicative model and the constraining factor model - to be superior to the additive in terms of their ability to predict performance (as stated in H1a and H1b).

In projects entailing little complexity (i.e. simple projects), team-members deal with few inputs and steps to perform the tasks, which generally involve a few units or departments. In such cases, interdependencies among tasks are pooled or sequential (Baccarini, 1996; Thompson, 1967). Hence, we argue that a minimum level of certain AMO factors is needed to cope with the relatively low levels of differentiation and interdependencies. For instance, the absence of motivation will

not be offset by an increase in ability and opportunity, as team members will need to engage and interact at some level to achieve the project´s objective and expected performance. Thus, we expect the constraining factor model to be the optimal model for simple projects, as it reflects the idea that minimum levels of ability, motivation, and opportunity are required for the effects of the AMO factors to unfold. This model enables us to examine which AMO factors plays a more important role in promoting project performance. The investment of more resources in the other factors does not provide significant complementary benefits because of the simplicity of the tasks and the low level of uncertainty. For these reasons, we hypothesize:

H2a: When teams undertake simple projects, the constraining factor model is a better predictor of project performance than the multiplicative factor model.

On the other hand, in projects characterized by high complexity (i.e. complex projects), team members have to deal with several inputs and steps to perform the tasks, which usually involve interactions among many units or departments. In such cases, interdependencies among tasks are sequential or even reciprocal (Baccarini, 1996; Thompson, 1967). In fact, teams working with such diversity develop higher levels of absorptive capacity, which will help them deal with high complexity to achieve the projects´ success (Açıkgöz, Günsel, Kuzey, & Seçgin, 2016). This has important implications for team composition and management.Team members allocated to complex projects generally have a certain level of ability, as they are assigned to projects based on their abilities (Allen & O'Neill, 2015). They may also have some initial level of motivation related to possibilities for career development (extrinsic motivation) or task identification (intrinsic motivation). We also expect these teams to have some organizational support, as their projects are more likely to be of strategic relevance. Besides the original team composition, high levels of complexity may also call for strategic improvisation to make adjustments and changes, focusing on project effectiveness and performance (Mamédio & Meyer, 2020). Such need for adaptation characterize complex projects as non-linear, and as such what determines project performance is the effect of the interactions between several components (Mamédio & Meyer, 2020). Under these conditions, investments in one AMO factor trigger synergic effects in at least one other factor. Therefore, we expect the multiplicative model to be a better predictor of performance for complex projects. For instance, the implementation of training programs aimed at augmenting team members' knowledge should enhance feelings

of competence and increase members' motivations (Lee-Kelley, 2006). Similarly, increasing the frequency and strength of communication among members should enhance members' knowledge and help them adjust to unexpected environmental changes (Floricel et al., 2016). Because of the structural complexity and uncertainty, complex projects require that all three AMO factors complement each other along the entire scale in order to achieve the project goal. Thus, we hypothesize:

H2b: When teams undertake complex projects, the multiplicative model is a better predictor of project performance than the constraining factor model.

Critical AMO factors at each model

Complexity has important implications to the selection of an appropriate project organizational form (Baccarini, 1996) and for team composition decisions (Higgs, Plewnia, & Ploch, 2005). Thus, the identification of the factor that matters most for each type of project is highly relevant, as it helps managers better allocate resources. As discussed earlier, we expect the constraining factor model to be a better predictor of project performance when teams undertake simple projects whereas we expect the multiplicative model to a better predictor of project performance when teams undertake complex projects. We herein develop hypotheses regarding which is the critical AMO factor in each subsample of project (subsample of simple projects vs subsample of complex projects).

In the case of simple projects, we argue for the existence of a constraining factor - team ability - that acts as a bottleneck for the two other factors. Simple projects require less specializations (Baccarini, 1996), less diversity of ideas (Higgs, Plewnia, & Ploch, 2005), and less need for interventions in team dynamics besides original planning (Mamédio & Meyer, 2020). In such cases, the project's success is mainly determined by team members' cognition (Bell, Brown, & Weiss, 2018). Individual cognition is related to the knowledge the individual possesses as well as the processes of knowing, attending, remembering, and reasoning (Helfat & Peteraf, 2015). When individuals face routine or familiar tasks, their responses can be quasi-automatic if they retrieve the knowledge needed from their memories (Helfat & Peteraf, 2015). In this sense, education and experience represent the prior related knowledge needed to develop absorptive capacity for problem solving (Cohen & Levinthal, 1990). Education and experience are valuable inputs for individuals making decisions on simple projects, as they can lead to heuristic processes and speed in mental processing. As the level of uncertainty in simple projects is expected

to be low, individuals should not need to engage in more sophisticated information processing in order to create new, innovative solutions. Instead, they need to apply their extant knowledge and experience to specific tasks. Therefore, we suggest:

H3a: When a team undertakes simple projects, the constraining factor is the team's ability.

When teams manage complex projects with difficult, highly interdependent tasks and in which unforeseen problems might arise, their performance is determined by complementarities among the three factors. As complexity increases, more prior related knowledge must have been accumulated through greater intensity of effort for effective learning to occur (Cohen & Levinthal, 1990). This calls for continued practice through higher participation and engagement of team members in projects (motivation). In fact, Moore, Payne, Autry, & Griffis (2016) showed that the frequency of collaboration in teams reduced the negative relationship between project complexity and performance. Schmid & Adams (2008) argue that "How I motivate my team members?" is the obvious question managers ask when engaging in a complex project. Thus, we argue that motivation is the key moderating variable in the case of complex projects.

Team's motivation interacts with ability in several ways. From self-efficacy theory (Ajzen, 1991; Bandura, 1977), we know that individuals' perceived self-efficacy (ability) depends on their own judgments regarding how well they can execute the courses of action required to deal with specific situations. Gagné and Deci (2005) argue that self-efficacy is directly related to intrinsic motivation, as it triggers feelings of competence and autonomy. Teams with the right knowledge and experience might feel more confident when facing complex and difficult tasks. Moreover, they can perceive such complexity as interesting and challenging, which promotes feelings of autonomy and intrinsic motivation. For instance, Rumeser and Emsley (2019) show that experience with project management work improves team decision-making performance in highly complex situations.

Along the same lines, a team's motivation interacts with organizational support (opportunity). Like individual behavior, a team's actual behavior depends on its perception of control—the extent to which it believes that, in general, its performance is determined by that behavior (internal control) and by other contingencies (external control) (Ajzen, 1991; Lee-Kelley, 2006). In simple projects, teams might believe that most things are within their control, such that they

depend less on external circumstances. However, as complex projects are characterized by high levels of uncertainty and ambiguity, the locus of control would be viewed as more external. Therefore, the more confident and motivated the team, the more it will be able to convince the organization to provide the required training, financial support, and extra time needed to conduct the tasks (Lee-Kelley, 2006). Highly supportive organizations will accept part of the responsibility and stand by members. Managers can provide support by, for instance, providing up-to-date and relevant information that guides the team's behavior and by creating a supportive climate that reduces feelings of fear, anxiety, or stress (Srivastava et al., 2006). As argued earlier, the team's motivation plays a key role in releasing the complementarities among the AMO factors in complex projects. Hence, we hypothesize:

H3b: When a team undertakes complex projects, motivation moderates the team's opportunities and its ability to perform by increasing the positive effects of team ability and team opportunity on performance.

Methods

We test our hypotheses in the context of the Brazilian multinational corporation, InterCement. InterCement produces and sells cement, lime, and special mortars all over the world. It has 40 business units spread across eight countries: Brazil, Argentina, Paraguay, Portugal, Mozambique, Cape Verde, Egypt, and South Africa. It exports to 17 countries, has 7,735 employees worldwide, and generates a total of EUR 1.9 billion in revenue (2016).

Knowledge management is a corporate function at InterCement, as the transfer of best practices across the organization is viewed as critical. One key initiative is the Continuous Improvement Program, which has directly affected the company's overall performance and contributed about EUR 2.5 million in savings per year.

The purpose of the program is to establish, monitor, and foster improvement projects. As InterCement is a commodity firm, these projects usually aim to reduce costs or increase sustainability by setting targets for energy efficiency, the use of alternative raw materials, and cost reductions (e.g., to develop new chemical substances to improve the cement's quality and to reduce the thermal consumption of the accumulated kiln). As such, the program encompasses projects that focus on improvements in existing processes (i.e., solution-oriented projects) rather than radical innovations.

Approximately 150-200 projects are launched within the program each year. Most projects last for one year and some for up to two years. Thus, the company typically has about 300 continuous improvement projects underway. In order to promote and keep track of these projects, InterCement uses a PDCA (plan, do, check, act) tool through which all information is entered into an online platform that all business units can access. The PDCA, also known as the Deming Cycle, is a management tool based on Lean Six Sigma/total quality management principles. Other studies, such as Chen and Belcher (2010) and Maruta (2012), cite the use of PDCA as important for a firm´s absorptive capacity, innovation, and improvement.

Typically, the corporate systems director defines the program's objectives for the year, which then trickle down into the organization. Each unit has its own systems manager, who proposes continuous improvement projects that fall within that unit´s responsibilities and are in line with the premises established by headquarters. The unit's systems manager assigns a project leader to handle the day-to-day work and operational issues for projects being undertaken in that unit. See Appendix 2 for a more detailed description of the workings of projects and the role of managers.

Each project has only one team in charge of its tasks and its specific goals, including expected financial results. Therefore, in this study we use the terms "project" and "project teams" interchangeably. A project comprises a project leader and team members (6.4 team members on average, with a range from 2 to 19). The project leader is responsible for assigning team members to the project. Once the project starts, the project leader continuously enters information on the project's performance into the online PDCA platform, which is monitored by corporate management. Realized financial gains are reported when the project is finalized.

Measures

In this paper, we use data on projects finalized in 2015 and 2016, which we combine with HR data on each project-team member. The project data is based on the project level, while the HR data is based on the individual level. The project data capture the workings of the project and include information on each project´s goals, level of complexity (simple versus complex), links to corporate strategic objectives, team composition (number of people and team members), average participation in meetings, reported problems, and performance (see Appendix 3 for additional information on the distribution of team-level variables). The HR data provide basic information on all employees of InterCement, such as hierarchical position,

function, department, and level of education (see Appendix 3 for additional information on the distribution of individual-level variables).

By matching the names of employees in the HR data with the names of team members in the project-team data, we are able to calculate the composition of team members in terms of different dimensions. This enables us to aggregate the individual-level information to the project level not just by calculating the means for the individuals but also by using the diversity among team members to construct compositional measures at the team level. Recall that the team-level variables are not just the sum of the individual features. Instead, they are compositional measures of the individual features that capture the synergies and add a team-level component. As such, all variables are tangible measures rather than intangible, latent constructs. Also, the operationalization of the AMO variables at the team level aims to shed light on actionable measures from a managerial perspective. As we are able to use the HR data to calculate the compositional features of project teams (the team-level measures), these two data sources allow us to examine interactions among the team members' skills (ability), the team's behavior (motivation), and contextual factors (opportunity) in relation to project performance. Therefore, the data are particular suitable for testing our hypotheses regarding the effects of team-level AMO factors on project performance. The data are unlikely to suffer from common method bias, as we draw from two separate data sources that are relatively objective (data reported in the online system and monitored at higher levels in the company, and fact-based HR data). All of the applied variables are single-item measures that are calculated based on one of the two data sources (project data or HR data).

Dependent variable

Our dependent variable is *project performance*, which is measured as the financial gains obtained at the end of the project and reflect the actual cost savings or revenue increases that result from each project. Similar measures which account for the increase in productivity or costs reduction have been used by previous AMO studies (Bailey et al., 2001). The financial gains are reported by the project leader and monitored by corporate management, which checks the accuracy of the uploaded information. Although project performance has different dimensions and can be measured in various ways, we follow Dvir et al. (2003) suggestion of focusing on the key stakeholder's objectives. In this case, the key stakeholder is corporate management, which initiates projects and sets financial goals, which are reported in

terms of the financial gains at the end of each project. Nevertheless, we conducted different robustness checks with alternative specifications of project performance, including time spent, delays, gaps between financial targets and final results, and goal achievement (as a percentage). None of these alternative specifications provided more robust results.

Independent variables

The independent variables are the AMO factors: ability, motivation, and opportunity. *Ability* is measured as the percentage of team members in each project with a university degree. Education is described by Blumberg and Pringle (1982) as one of the variables related to the ability component. Minbaeva et al. (2003) also emphasize the importance of education for building up employees' abilities. Ultimately, education enhances employees' absorptive capacity and innovative capabilities (Leiponen, 2005). We obtained information on the educational level (i.e., elementary school, high school, technical education, or university degree) of all project members from the HR data, and then calculated the share of project members with a university degree for each project (average of 8% for all projects). Highly skilled team members are typically the critical factor in realizing complementarity among the individual skills of team members. A similar measure of team ability was applied by Bailey et al. (2001).

Team participation serves as a proxy for *motivation*, as it measures the percentage of project members actually engaged in the team's meetings with the monitoring body (average of members taking part in each meeting relative to the total number of members in the project; reported in the project data; average of 72% for all projects). As attendance at meetings is not mandatory at InterCement, team participation indicates that the team is motivated and engaged with the projects. High team participation in these meetings reduces free riding, enhances the cross-fertilization of ideas, increases the generation of solutions, and leads people to act (e.g., fewer delays that might affect costs). High participation implies that team members collectively affect the team's knowledge, mindset, and motivation (Keegan et al., 2018). This form of team motivation can, in turn, inspire, encourage, and stimulate individuals to achieve common goals through teamwork (Peterson, 2007). As such, we follow Bailey et al.'s (2001) logic of measuring the tangible behavioral outcome of motivation in terms of engagement and commitment rather than attempt to measure intangible aspects of the minds of individuals. Employee

participation in problem solving and decision making has previously been used to operationalize the motivation to collaborate and share knowledge (Kim et al., 2015).

Opportunity is measured as the percentage of project members in management positions. The HR data for each project member include information on hierarchical position, which spans eight levels from blue-collar workers (lowest level) to CEO (highest level). The three highest levels (i.e., CEO, directors, and managers) hold management responsibilities. For each project, we calculate the share of project members with management responsibilities (average of 3% for all projects). As participation in projects is voluntary at InterCement, a higher share of managerial involvement reflects an opportunity, as it implies that the decision makers are close to the project. As such, they may provide more direct access to resources and be more aware of external circumstances that might hinder the project's success. Managerial involvement is also important for increasing knowledge sharing and innovation (Le & Lei, 2019; Park, 2011). Other AMO studies operationalize opportunity as the situational support received from the corporation (Bos-Nehles et al., 2013; Bouwmans et al., 2019). Similarly, we operationalize opportunity as the support and involvement of management in each project.

Control variables

We include three control variables. The *size of the project team*, which is measured as the number of members within a team (average of 6.4 for all projects), is a structural variable that reflects the amount of knowledge that a team has as well as its ability to handle the job (project data). The premise is that the bigger the team, the more knowledge it has and the easier it will be for the team to carry out more actions. The need to further explore the effect of team size on project outcomes has been raised by studies pointing to the critical effect of team membership on knowledge sharing (Bakker et al., 2006).

The share of *overloaded project members* is measured as the share of project members involved in more than 10 projects at the same time. This variable controls for the possibility that team members may struggle to complete the focal project because they have too many commitments (Oppenauer & Van De Voorde, 2018). While there is no consensus in the literature on the number of projects that leads to overload (Gustavsson, 2016; Zika-Viktorsson et al., 2006), interviews with members of InterCement's corporate management team suggested that more than 10 projects would be "too many." As described in Appendix 2, members are

expected to meet twice per month for each project, regardless of the project's complexity. This implies more than 20 meetings per month (roughly daily meetings) for overloaded members. As shown in Appendix 3, 14% of all project members meet this overload threshold (i.e., team members for more than 10 projects). This also implies that most projects have some project members who are overloaded. We ran robustness checks with alternative thresholds of 5, 7, or 15 projects, but the results were qualitatively similar to the results obtained with the threshold of 10 projects.

The number of *problems identified* captures unforeseen difficulties in the project (project data; average of 5.1 for all projects). When hidden problems are discovered, a certain amount of reworking—with implications for costs and scheduling—can be expected (Browning, 2019). Therefore, the identification of a problem implies an escalation to a higher level, which leads to additional actions. Awareness of this likelihood reduces over-confidence and allows for early action to be taken.

In addition, we undertook a split-sample analysis in which we divided the sample into *simple and complex projects* to account for project complexity. This distinction is based on the systems manager's classification using the guiding criteria of the project's complexity (this is a dummy variable obtained from the project data). In simple projects, the solution is typically known, while one does not have enough knowledge or control to establish the outcome in complex projects. As the systems manager supervises all projects in his or her unit, he or she is well positioned to identify simple versus complex projects.

Model Specification

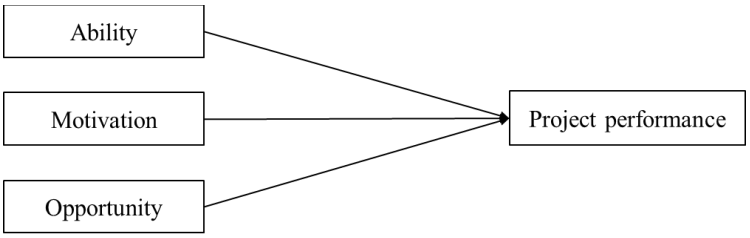
Three models—additive, multiplicative, and constraining factor—are used to test the relationships among the three factors of ability (A), motivation (M), and opportunity (O) and project performance.

The additive model claims that the three AMO factors are independent of each other and that they all affect project performance separately. The specification comprises the main effects:

$$\text{Project performance} = a_0 + a\text{A} + a_2\text{M} + a_3\text{O} + \varepsilon.$$

The next figure illustrates the additive model:

Figure 1. Additive model



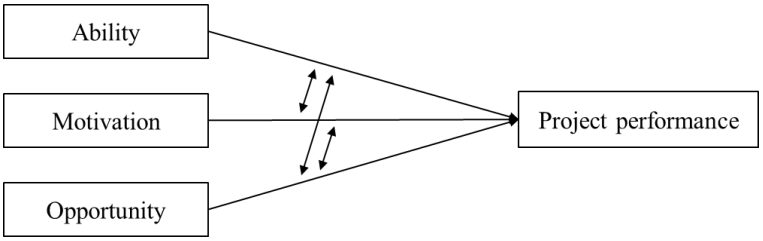
The multiplicative model suggests that the three factors are interdependent and that they reinforce each other. It adds three interaction terms to the specification:

$$\text{Project performance} = a_0 + a_1\text{A} + a_2\text{M} + a_3\text{O} + a_4\text{AM} + a_5\text{AO} + a_6\text{MO} + \varepsilon.$$

The logic here is that the three AMO factors are complementary in driving project performance and that the complementarity is across the entire scale—a lower level of one factor will reduce the reinforcing effect of the other factors, while a high value for one factor will strengthen the amplifying effect of the other factors. As such, it imposes a continuous change in the size of the reinforcing effect over the whole scale.

The next figure illustrates the multiplicative model:

Figure 2. Multiplicative model



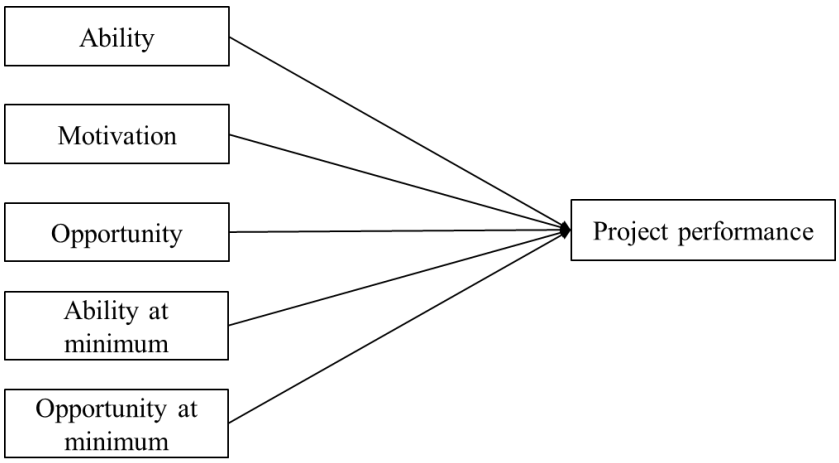
The constraining factor model also proposes complementarity among the three factors. However, it only does so at the extremes rather than across the entire scale. A factor with a low value might act as a bottleneck and have a deterring effect on the two other factors without having an amplifying effect at the other end of the scale. This model is specified as follows:

$$\text{Project performance} = a_0 + a_1\text{A} + a_2\text{M} + a_3\text{O} + \Theta_A(a_7 + a_8\text{A} + a_9\text{M} + a_{10}\text{O}) + \theta_O\,(a_{11} + a_{12}\text{A} + a_{13}\text{M} + a_{14}\text{O}) + \varepsilon.$$

Θ_A and θ_O are dummy variables that are set equal to 1 if **A**(bility) or **O(**pportunity), respectively, are the minimums of the A, M, and O values, and 0 otherwise. Here, **M**(otivation) is the omitted variable, which implies that the effect of motivation if motivation is at the minimum is given by a_2, but the effect of ability if ability is at the minimum is given by a_1+a_8. Similarly, the effect of opportunity if opportunity is at the minimum is given by a_3+a_{14}. If, when a factor is at the minimum, these effects are greater than the coefficients obtained for the same factor in the additive model, then that factor is a constraining factor that has a stronger effect when it is at the minimum than otherwise. When calculating the dummies Θ_A and θ_O for when ability and opportunity, respectively, are at the minimums in our dataset, we find that ability is at the minimum in 33% of the projects and opportunity is at the minimum in 30% of the projects, while the omitted category of motivation is at the minimum in 37% of the projects.

The next figure illustrates the constraining factor model:

Figure 3. Constraining factor model



Results

We obtained full information (no missing values) on 285 projects that were finalized in either in 2015 or 2016. As the variables were measured using different scales, we standardized them (mean = 0; standard deviation = 1). We took this step because we apply interaction effects and compare the minimum values across the three AMO factors, which only makes sense if all variables are on the same scale. The correlation matrix is shown in Table 2. None of the independent variables have correlations that indicate problems of multi-collinearity, as all correlations among the independent variables are below the commonly accepted threshold of 0.4. The

highest correlation of 0.36 is between team size and overload, which is expected. We also ran the model without team size and the results remained qualitatively the same. In addition, both motivation and opportunity are positively correlated with project performance, while ability is uncorrelated.

Table 2. Correlation matrix (n = 285)*

	1	2	3	4	5	6	7	8
1) Project performance	1.00							
2) Ability	-0.01	1.00						
3) Motivation	0.27	-0.08	1.00					
4) Opportunity	0.17	0.01	0.14	1.00				
5) Overload	0.11	-0.16	0.11	-0.03	1.00			
6) Problems	0.08	0.01	0.15	0.01	0.08	1.00		
7) Team size	0.17	-0.34	0.34	0.05	0.36	0.17	1.00	
8) Complexity	-0.06	0.03	-0.13	-0.10	-0.07	0.15	-0.06	1.00
Min. values	-0.31	-3.22	-1.39	-0.28	-3.01	-1.26	-0.92	0
Max. values	8.97	1.26	3.35	5.07	1.28	5.54	2.61	1

*All variables are standardized with mean = 0 and std. dev. = 1, except for complexity (which is a binary variable). Values above |0.12| are significant at the 5% level.

The results of the three alternative specifications of the impact of the AMO factors on project performance are listed in Table 3. The table includes nine models, as each of the three alternative specifications is conducted for "all projects" (Models 1-3), "simple projects" (Models 4-6), and "complex projects" (Models 7-9).

Table 3. Models of the effects of AMO on project performance

	All projects (N = 285)			Simple projects (N = 166)			Complex projects (N = 119)		
	Additive model	Multiplica-tive model	Constraining factor model	Additive model	Multiplica-tive model	Constraining factor model	Additive model	Multiplicative model	Constraining factor model
	1	2	3	4	5	6	7	8	9
Ability (A) - a_1	0.05	0.01	-0.03	0.15*	0.07	0.08	-0.01	0.10	0.03
Motivation (M) - a_2	0.21***	0.21***	-0.01	0.09	0.14	0.05	0.26**	0.21**	0.05
Opportunity (O) - a_3	0.17*	0.11	-0.02	0.08	0.10	0.03	0.27**	0.19	0.02
A * M - a_4		0.02			0.10			0.34**	
A * O - a_5		0.23*			0.15			0.06	
M * O - a_6		0.24***			0.05			0.41**	
Min_{ab} - a_7			0.17			0.19			0.15
Min_{ab} * A - a_8			0.16			0.28*			0.04
Min_{ab} * M - a_9			0.40*			0.14			0.33**
Min_{ab} * O - a_{10}			0.22			0.16			0.26*
Min_{op} - a_{11}			-0.20			-0.16			0.19
Min_{op} * A - a_{12}			0.20			0.23*			-0.03
Min_{op} * M - a_{13}			0.31*			0.17			-0.09
Min_{op} * O - a_{14}			-0.03			-0.02			0.28*
Overload	0.07	0.08	0.09	0.07	0.07	0.09	0.03	0.05	0.04
Problems	0.03	0.02	0.01	0.01	0.01	0.01	0.01	-0.06	-0.05
Team	0.10	0.11	0.09	0.24*	0.23*	0.24*	-0.01	0.03	0.01
Intercept	0.01	-0.02	-0.11	0.02	0.03	-0.02	0.04	-0.17*	-0.24
R-squared	0.10	0.17	0.15	0.11	0.13	0.16	0.15	0.44	0.33
Adj. R-squared	0.09	0.14	0.11	0.08	0.08	0.09	0.10	0.40	0.24
d.f.	6	9	13	6	9	13	6	9	13
F-value	5.41***	6.25***	3.56***	3.31**	2.69**	2.31**	3.29**	9.62***	3.92***

*, **, and *** indicate significance at the 5%, 1%, and 0.1% levels, respectively.

The significance of the solutions and explained variances of Models 1-3 comprising "all projects" indicate that the multiplicative model offers the best solution with an

F-value of 6.25 and an adjusted R-squared of 0.14, while the constraining factor model (CFM) has an F-value of 3.56 and an adjusted R-squared of 0.11. The additive model is almost as good as the CFM - it has a higher F-value but a lower adjusted R-squared. Therefore, we reject Hypothesis 1b, which suggests that the CFM is superior to the additive model, while we find support for Hypothesis 1a, which proposes that the multiplicative model is superior to the additive model. In the multiplicative model, the main effect of motivation, and the interaction effects between opportunity and motivation and between opportunity and ability are positive and significant.

When considering the simple projects (Models 4-6) and the complex projects (Models 7-9) separately, a richer picture emerges. For complex projects, the multiplicative model clearly provides the best solution with an F-value of 9.62 and an adjusted R-squared of 0.40, which is in line with Hypothesis 2b. This indicates that the AMO factors are complementary and that they reinforce each other not just at the extremes but across the entire scale. For simple projects, the results are more ambiguous, as the CFM has a slightly higher adjusted R-squared but a slightly lower F-value than the two other models. Therefore, Hypothesis 2a is only partially supported.

When we compare the two additive models (Models 4 and 7), we find that ability is significant for simple projects but not for more complex projects. On the other hand, motivation and opportunity seem important for complex projects but less so for simple projects. This is confirmed in the multiplicative models (Models 5 and 8), where the interaction effects for motivation and ability and for motivation and opportunity are highly significant for complex projects, while no interaction effects are significant for simple projects. Therefore, we can further qualify our initial findings—the complementarity among the AMO factors for the complex projects is closely related to motivation, which amplifies the two other factors across the whole scale (and not just at the extremes). This supports Hypothesis 3b.

The CFM adds to these findings in the sense that ability turns out to be a constraining factor in the case of simple projects (Model 6), while the coefficient for ability is 0.36 (0.28 + 0.08) when ability is the lowest of the three factors. This is clearly higher than the coefficient of 0.15 in the additive model (Model 4), which indicates that ability is more important for simple projects when it has a lower value than motivation and opportunity. Both motivation and opportunity have lower values in the CFM (0.05 and 0.01, respectively) than in the additive model (0.09

and 0.08, respectively), which indicates that they are not constraining factors. Therefore, Hypothesis 3a is supported.

In the case of complex projects (Models 7 and 9), only opportunity has slightly higher coefficients in the CFM (0.28 + 0.02 = 0.30) than in the additive model (0.27). However, this increase in the coefficient is not significant.

In the simple projects, the effect of increasing ability is greater than the effect of increasing the two other factors. In fact, when ability is the lowest, raising it by one standard deviation increases project performance by 0.36 of a standard deviation (Model 6), while it otherwise increases project performance by 0.32 of a standard deviation (Model 5). This is greater than the effects of increasing motivation or opportunity in simple projects. In complex projects, increasing motivation by one standard deviation improves project performance by 0.96 of a standard deviation (Model 8), while the effects of increasing opportunity and ability by one standard deviation are 0.66 and 0.50, respectively.

Discussion

Studies of the application of AMO factors to individual performance are hardly new. However, this paper aimed to bring together the HRM literature on the effect of the AMO factors and the literature on project performance by scrutinizing how ability, motivation, and opportunity interact at the team level to determine project performance. While numerous studies show that all three factors affect work performance at the individual level, we had little knowledge about how they affect each other in determining performance at the team level.

An understanding of the mechanisms that promote project performance at the team level can guide managers' allocations of resources to teams. Our logic is based on the "jigsaw puzzle approach" which poses that team's highest potential arises from particular combinations of several variables associated with each member (Allen & O'Neill, 2015). In order to account for the complementarities among ability, motivation, and opportunity, we thus analyzed three different AMO models and discuss their implications.

While the majority of the AMO literature has focused on the linear effect of each AMO factor on performance (the additive model), emergent studies have introduced and tested the multiplicative model (Beltrán-Martín & Bou-Llusar, 2018; Reinholt et al., 2011), and the constraining factor model (Kim et al., 2015; Siemsen et al.,

2008). We agree with such studies that the multiplicative and the constraining factor models are superior to the additive model to predict performance, and we provide additional evidence from the project-team context. We extend the studies from Beltrán-Martín & Bou-Llusar (2018) and Reinholt et al. (2011) by comparing the multiplicative model and the constraining factor model. Most importantly, our study extends Kim et al. (2015) and Siemsen et al. (2008), by examining the circumstances (i.e. project complexity) under which each of these two competing models is a better predictor of project performance. We also answer calls in the literature for a deeper understanding of the role of complexity and the fit among individuals in knowledge sharing contexts (Argote et al., 2003; Van Wijk et al., 2008). Thus, we show that when teams work in simple projects (low complexity), the constraining factor model is a better predictor of their performance. On the other hand, when teams work in complex projects, the multiplicative model is more appropriate to capture the variations in project performance. This is due to the different levels of differentiation and interdependency in simple versus complex projects. Simple projects entail few tasks and steps that are relatively independent (Baccarini, 1996). Thus, a model that takes into account the minimum level of certain AMO factors to achieve performance is more appropriate (constraining factor model). On the other hand, complex projects entail many tasks and steps that take place in an interdependent way (Baccarini, 1996). Thus, a model that accounts for the synergistic effects among AMO factors is more appropriate (multiplicative model).

Our study also shows that the team's work context (simple vs complex projects) affects which AMO factors plays a more important role in determining project performance, taking into account the most appropriate model in each context. In simple projects, ability seems to be the key factor both as a main effect and, if it is too low, as a constraining factor acting as a bottleneck for project performance. Ability is related to cognition, which is key in contexts of low complexity (Bell, Brown, & Weiss, 2018). When individuals face routine or familiar tasks, their responses can be quasi-automatic if they retrieve the knowledge needed from their memories (Helfat & Peteraf, 2015). Firms undertaking simple, routine projects should prioritize those interventions aimed at achieving the minimum level of knowledge and skill needed within the team, so that members can apply their cognitive capabilities and efficiently make decisions. This has important implications for team composition decisions (Allen and O'Neill, 2015), as other interventions aimed at increasing the team's motivation by augmenting team members' participation through the involvement of top managers (opportunities)

will have an insignificant effect unless the team has the minimum level of ability. Ability is focused on the educational background and skills of employees, so in this case it may bring to projects the prior related knowledge that is needed to develop absorptive capacity for problem solving (Cohen & Levinthal, 1990). As learning in simple project is relatively easy, not much intensity of effort is needed in terms of continued practice. In this regard, our results extend those obtained by Popaitoon and Siengthai (2014), who found a positive direct effect of teams´ realized absorptive capacity on short-term performance. In that study, HRM practices did not significantly moderate this direct effect. Our study shows a more nuanced view that distinguishes between simple and complex tasks. We agree with Popaitoon and Siengthai (2014) that teams working with simple tasks and under time pressure are more focused on solving the immediate tasks at hand. Therefore, having the right skills to exploit the absorbed knowledge is the key factor.

In complex projects, there is more scope for HRM intervention, as the multiplicative model seems superior with significant interaction effects over the entire scale. In particular, our results highlight the pivotal role of motivation when teams perform interdependent, complex tasks. In other words, strong team motivation positively moderates the relationship between ability and project performance and the relationship between opportunity and project performance. In this regard, our study responds to Keegan et al.'s (2018) claim that research on how employee participation benefits project-based organizations is needed. Complexity calls for more intense efforts to develop absorptive capacity (Cohen & Levinthal, 1990), which, in the context of project teams, reflects the need for greater interaction among team members for effective problem-solving. Our results are in line with Moore, Payne, Autry, & Griffis (2016) in that collaboration is critical to achieve project performance in complex situations. Indeed, we show that participation increases the sharing of tacit and explicit knowledge, and motivates team members by increasing their feelings of competence and their commitment to goals.

In addition, our study demonstrates how the dynamics associated with project complexity affect the efficacy of the main antecedents of project performance. We thus answer calls in the project management literature to explore dimensions of project complexity and the capabilities needed to perform at different levels of complexity (Rezende et al., 2018). While simple tasks require managers to provide the team with the required cognitive capabilities, complex and uncertain tasks put the team's motivation at the center of its knowledge-sharing processes.

Consequently, our research is in line with recent theoretical developments that call for a better understanding of how contextual heterogeneity affects knowledge processes at lower levels of analysis (Foss et al., 2010).

In this study, we introduced team-level measures of the AMO factors, as collective team factors are fundamentally different from the aggregation of individuals within the team. A team is not just a group of independent individuals. It encompasses complementarities, synergies, and interdependencies that go beyond the simple aggregation of its members. In fact, these collective features of teams are at the core of their existence.

Likewise, our research contributes to the HRM literature (Jiang et al., 2013) by examining how differences in teams' dynamics require different combinations of abilities, motivation, and opportunities. Teams are a relevant work context for employees. However, in efforts to increase a team's effectiveness, contextual factors should be considered. Such factors include uncertainty and task interdependencies that might require greater organizational support in order to release team members from the responsibility of coping with complex project tasks. Thus, it is necessary to implement HRM practices that effectively operate at the team level.

Our results have several notable implications for managers. In simple projects, the greatest improvement in project performance can be obtained by enhancing the team's ability, which can be achieved by selecting team members with the required knowledge and skills, or through training, communication, and incentives. In complex projects, the greatest improvements in project performance can be achieved by increasing motivation. In addition to its own positive effect, this will amplify the effects of ability and opportunity.

Our paper suffers from some limitations. First, even though we gathered our data from two sources, our measures are based on single items. Single-item measures may not adequately represent conceptually complex constructs and they do not allow for the calculation of internal consistency estimates (Fisher et al., 2016). However, single-item measures may be good substitutes for multi-item measures in circumstances where administering large surveys is unfeasible (Dolbier et al., 2005). Additional research must explore other potential measures for capturing collective aspects of the workings in teams. In addition, future research could advance our study by exploring to what extent the team composition is influenced

by the project performance expectations. Finally, while our focus on one firm provided data on a large number of projects and teams, and enabled us to compare projects that varied in terms of complexity, it limits the generalizability of our conclusions. One way to extend our knowledge and derive a better understanding of the underlying mechanisms would be to conduct field experiments involving interventions related to teams' abilities, motivations, and opportunities.

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Appendix 1. Operationalization of the AMO model by empirical literature

Reference	Level of analysis	Operationalization of AMO	Gaps of interest for this paper
Andreeva & Sergeeva (2016)	Individual	Multiplicative model	Does not compare with alternative models.
Bailey, Berg, and Sandy (2001)	Individual	Additive (aggregated factors)	Do not test the factors separately.
Batt (2002)	Organizational	Additive model	Does not compare with alternative models.
Beltrán-Martín & Bou-Llusar (2018)	Multilevel (individual and organizational)	Additive and multiplicative models	Does not test the constraining factor or consider the project management context/ team level.
Bouwmans et al. (2019)	Team	Additive model	Does not compare with alternative models.
Chang, Gong, and Peng (2012)	Individual	Additive model	Does not compare with alternative models.
Jiang et al., 2013	Organizational	Additive model	Does not compare with alternative models.
Kim et al. (2015)	Organizational	Additive, multiplicative and constraining factor models	Does not consider the project management context or the team level.
Liao et al., 2009	Individual	Additive model	Does not compare with alternative models.
Reinholt et al. (2011)	Individual	Multiplicative model	Does not compare with alternative models.
Siemsen et al. (2008)	Individual	Additive, multiplicative and constraining factor models	Does not consider the project management context or the team level.
Subramony (2009)	Organizational	Additive model	Does not compare with alternative models.
Wu, Balasubramanian, & Mahajan (2004)	Individual	Additive model	Does not compare with alternative models.

Appendix 2. Workings of projects and the role of managers

Corporate Communication on the Continuous Improvement Program

- Focus on cost reductions, performance improvements, and enhanced productivity.
- Planning phase to be concluded in two months.
- Minimum of two people (technical staff) on each team for projects aimed at technical improvements.
- Recommendation for project leaders: Meet with the team twice per month (no less than monthly) to monitor project performance. Recommendations for meetings:
    - Week 1: Spend 30 minutes per project. Revisit its goal, identify problems, establish action plans, and enter key performance indicators into the system.
    - Week 3: Spend 30 minutes per project and check action plans.
- Project leaders must be aware of the responsibilities they have and they must be committed to the results.
- Focus on getting to the root of the problem to ensure that the project can solve it.
- Projects can be either short term (less than one year) or long term (more than one year); long-term projects need approval from the corporate systems manager.
- Dedicate more time to complex problems that require deeper analysis.
- Each unit should request at least one consulting meeting with headquarters (i.e., the corporate systems manager), ideally before action plans are developed.

Roles and levels of responsibility

- The **project leader** is in charge of defining the team and scheduling meetings in order to check on the status and performance of the projects, identify problems, and develop action plans. He or she is also in charge of entering data into the online platform that creates the database. The project leader invites team members to every meeting.

- The unit's **systems manager** is in charge of defining the country's/unit's project for that year. He or she must submit projects for corporate approval before delegating them to project leaders. The systems manager is also in charge of assigning project leaders and motivating them to derive the best results from their projects.

- The **corporate systems manager** is in charge of following up on the results of the projects with each unit's systems manager every three months through virtual meetings. He or she is also in charge of auditing two projects per country per month, and auditing all projects at the end of the annual cycle.

Appendix 3. Descriptive statistics

Descriptive Statistics on the Individual Level (3,530 project members)

Number of projects that project members are part of

Number of projects	Individuals	Percentage
1–2	1,184	34%
3–5	1,160	33%
6–10	708	20%
10–34	478	14%

Distribution of education levels for project members

	Individuals	Percentage
Elementary school	212	6%
High school	847	24%
Technical education	494	14%
University degree	1,977	56%

Descriptive statistics on the project level (285 projects)

Participation in project meetings by project members

Share of participation	Projects	Percentage
0–50%	34	12%
51–70%	86	30%
71–90%	102	36%
91–100%	63	22%

Problems identified in projects

Number of problems	Projects	Percentage
1–3	91	32%
4–5	88	31%
6–9	77	27%
10–23	29	10%

Chapter 5

Conclusion

Summary

This thesis sought answers to the research questions: *Can (and which) knowledge management mechanisms promote innovation and performance outcomes? What is the role of absorptive capacity?*

In order to answer such questions, three studies were developed with specific research questions and hypothesis tested in the context of multinational corporations (MNCs) from an emerging market. Knowledge management mechanisms were broken down into: i) knowledge sourcing mechanisms (firm-level); ii) knowledge management capabilities (firm-level); and iii) project-team dynamics (team-level). The knowledge in question came from different sources in the MNC, including: i) the external environment; ii) the internal environment (foreign subsidiaries); and iii) the internal environment (individuals and teams). Also, this thesis´ overall conceptual model assumed that absorptive capacity (AC) has a key role in the relationship between knowledge management mechanisms and innovation and performance outcomes. Therefore, the studies embraced several theoretical aspects of AC: i) the diminishing effect on AC in environments where learning is more difficult; ii) the different roles of R&D investment and innovation training in fostering AC; iii) the trade-off between inward-looking and outward-looking determinants of AC; iv) the need for more intense efforts and diversified knowledge to develop AC for problem solving as complexity increases. Two outcomes were considered: i) innovation (local and global); and ii) performance. Innovation encompassed: i) exploratory innovation (e.g. product innovation); and ii) exploitative innovation (e.g. process innovation). Although the three studies were primarily focused on one emerging market, Brazil, different contexts were considered: i) reverse innovation from firms operating in Brazil; ii) reverse knowledge transfer (transfers from subsidiaries to headquarters) of Brazilian and Portuguese MNCs; and iii) knowledge sharing in projects in an Brazilian MNC, InterCement.

Each paper´s contribution to the literature

The results of the studies bring several contributions to the literature. First, **Paper 1** shows that firms achieve different innovation outcomes when employing knowledge management mechanisms. The study explored the moderating effect of two absorptive capacity enhancing practices, R&D investment and innovation training, on the relationship between knowledge sourcing mechanisms and local and global innovation, respectively. The hypotheses were tested on a sample of foreign MNC subsidiaries and national MNCs´ headquarters operating in an emerging market, Brazil. The results confirm that R&D investment has a positive influence on the relationship between knowledge sourcing mechanisms and *local* innovation and that training on innovation has a positive moderating effect on the relationship between knowledge sourcing mechanisms and *global* innovation. Such practices seem to impact innovation differently due to their different nature. While both enhance firms´ absorptive capacity, R&D investment focuses on developing new knowledge (Criscuolo, Haskel, & Slaughter, 2010; Grimpe, Sofka, Bhargava, & Chatterjee, 2017) and training focuses on disseminating existing knowledge (Cabrera & Cabrera, 2005; Minbaeva, Mäkelä, & Rabbiosi, 2012). By investing in R&D to develop new knowledge, firms increase their embeddedness with local networks (Cantwell & Mudambi, 2011; Scott-Kennel & Saittakari, 2020) and generate innovations that are highly applicable to the local environment (Cuervo-Cazurra, 2019). Additional constraints to convert R&D investments into global innovations may reinforce the "localness" of such investments. For instance, the global environment is deemed as an environment were learning is more difficult (Ambos & Ambos, 2009), so firms would need to invest more in R&D to achieve the same innovation outcomes (Cohen & Levinthal, 1990). Also, emerging market firms´ may lack an ability to protect its patented products globally due to weak regimes of appropriability (Zahra & George, 2002), especially from a country not much conducive to radical innovations (Fleury, Fleury, & Borini, 2013). On the other hand, by providing innovation training to disseminate existing knowledge, MNCs promote socialization among employees with different experiences and from widespread departments (Galbraith, Downey, & Kates, 2002; Van den Bosch, Volberda, & de Boer, 1999). By stimulating such interactions, training also opens their minds to potential innovation opportunities in the global environment, helping them overcome the liability of localness in innovation (Un, 2016). Thus, this study advances existing literature (Fallah & Lechler, 2008; Isaac, Borini, Raziq, & Benito,

2019) by testing empirically the different requisites to innovate locally and globally and showing the different nature of R&D investments and innovation training.

Paper 2 empirically examines the trade-off between inward-looking and outward-looking determinants of AC proposed by Cohen and Levinthal (1990). We elaborated and tested the direct and moderating effects of such determinants of AC in MNCs in the context of international reverse knowledge transfers. The inward-looking determinants of AC that promote internal communication efficiency are knowledge management capabilities, including systems, coordination, and socialization capabilities (Jansen, Van den Bosch, & Volberda, 2005; Van den Bosch et al., 1999). The outward-looking determinants of AC that provide access to knowledge from dispersed external sources are the magnitude and diversity of the MNC's foreign operations, or its multinationality, which affects knowledge outcomes (Barkema & Vermeulen, 1998; Hitt, Hoskisson, & Kim, 1997; Jiménez-Jiménez, Martínez-Costa, & Sanz-Valle, 2014). Our results show that headquarters of MNCs have their absorptive capacity increased when they use systems, coordination and socialization capabilities globally to learn from their foreign subsidiaries. The results on the direct effect of the three capabilities on AC extend previous literature (Jansen et al., 2005; Van den Bosch et al., 1999) by exploring such relationships in the context of international knowledge transfers. It also advances the systems capability (Crespo, Griffith, & Lages, 2014; Gupta & Govindarajan, 2000; Rabbiosi, 2011) and the socialization capability (Bresman, Birkinshaw, & Nobel, 1999; Ghoshal & Bartlett, 1988; Ghoshal, Korine, & Szulanski, 1994; Gooderham, Minbaeva, & Pedersen, 2011; Rabbiosi, 2011) literatures by showing a direct link with AC. As regards to coordination capabilities, our findings diverge from Argyres and Silverman (2004) by suggesting that globally widespread (as opposed to centralized) R&D structures can enhance knowledge outcomes. Still regarding the direct effects, this study showed that the more internationalized the MNC, the greater its absorptive capacity, which may relate to these firms' greater international experience and accumulated learning (Bilkey, 1978; Eriksson, Johanson, Majkgard, & Sharma, 1997; Johanson & Vahlne, 1977, 2009). Our study extends existing literature that stresses the importance of knowledge diversity for AC (Cohen & Levinthal, 1990) as well as international diversity to knowledge outcomes (Barkema & Vermeulen, 1998; Hitt et al., 1997) and CEOs´ perceptions of FDI (Denison, Dutton, Kahn, & Hart, 1996), by exploring the specific relationship between multinationality and the AC of MNC headquarters. In addition, we found support for the trade-off between the inward-looking

determinant (i.e. coordination capabilities) and the outward-looking determinant (i.e. multinationality) in the context of international reverse knowledge transfers. Such trade-off was supported for coordination capabilities and partially supported for systems capabilities. When MNCs have their coordination capabilities too efficiently widespread throughout their global operations and, at the same time are highly internationalized, AC may be diminished. In this case, units communicate very effectively with one another but may become unable to recognize and value knowledge from diverse external sources, in an example of the Not-Invented Here (NIH) syndrome (Burcharth, Knudsen, & Søndergaard, 2014; Katz & Allen, 1982). Correspondingly, excessive levels of multinationality can lead to difficulties in accessing, interpreting and translating new external knowledge into a form that is understandable by the firm as such new knowledge may become too distant from the firms' own knowledge base (Lane & Lubatkin, 1998). In such situations, it may be more difficult and costly to achieve coordination and synergy among units (Argyres, 1996; Gupta & Govindarajan, 1991) and organizational complexity may increase to a point at which learning is hampered by information overload (Barkema & Vermeulen, 1998). On the other hand, socialization capabilities are the type of knowledge management capability that are less susceptible to such trade-off and seem capable of overcoming the difficulties headquarters may face in establishing an effective learning process towards their foreign subsidiaries. Therefore, as MNCs advance along their internationalization paths, they should emphasize socialization capabilities in their interactions to absorb knowledge from foreign subsidiaries.

Finally, **Paper 3** explores knowledge sharing in project teams and for such it brings together the HRM and project performance literatures. We considered that team's highest potential arises from particular combinations of several variables associated with each member (Allen & O'Neill, 2015). Therefore, we compared three possible models of the ability-motivation-opportunity (AMO) framework (Appelbaum, Bailey, Berg, & Kalleberg, 2000; Blumberg & Pringle, 1982; Boxall, 2003) in terms of their ability to predict project performance: one focused on the linear effect of each AMO factor on performance (the additive model), one focused on the reinforcing effect of the three factors (the multiplicative model), and one focused on the need to reach a minimum of a certain factor in order for the other factors to have an effect on performance (the constraining factor model). Based on definitions from the project complexity literature (Baccarini, 1996), we proposed that in projects entailing no complexity, any level of ability, motivation, and opportunity will have a linear contribution to project performance and so the additive model

would be the most appropriate model; in projects entailing little complexity (i.e. simple projects), a minimum level of certain AMO factors is needed to cope with the relatively low levels of differentiation and interdependencies and so the constraining factor model would be the optimal model; and in projects characterized by high complexity (i.e. complex projects), investments in one AMO factor may trigger synergic effects in at least one other factor, so the multiplicative model would be a better predictor of performance. We also suggest that the multiplicative model and the constraining factor model are better predictors of project performance than the additive model. Our findings are in line with previous literature that shows a superior effect of the multiplicative model (Beltrán-Martín & Bou-Llusar, 2018; Reinholt, Pedersen, & Foss, 2011), and the constraining factor model (Kim, Pathak, & Werner, 2015; Siemsen, Roth, & Balasubramanian, 2008) on performance over the additive model. We extend such literature by examining the circumstances (i.e. project complexity) under which each of these two competing models is a better predictor of project performance. Therefore, we show that the interplay among project-teams´ ability, motivation and opportunity depends on the contextual factors that affect their absorptive capacity (simple x complex projects). When teams work in simple projects (low complexity), the constraining factor model is a better predictor of their performance. In such projects, ability is the key factor both as a main effect and, if it is too low, as a constraining factor, acting as a bottleneck for project performance. Firms undertaking simple, routine projects should prioritize achieving the minimum level of knowledge and skills needed within the team, so that members can apply their cognitive capabilities and efficiently make decisions. Ability is related to cognition, which is key in contexts of low complexity (Bell, Brown, & Weiss, 2018). When individuals face routine or familiar tasks, their responses can be quasi-automatic if they retrieve the knowledge needed from their memories (Helfat & Peteraf, 2015). Ability is also focused on the educational background and skills of employees, so in this case it may bring to projects the prior related knowledge that is needed to develop absorptive capacity for short-term problem solving (Cohen & Levinthal, 1990; Popaitoon & Siengthai, 2014). On the other hand, when teams work in complex projects, the multiplicative model is more appropriate to capture the variations in project performance. In such projects, complexity calls for more intense efforts to develop absorptive capacity (Cohen & Levinthal, 1990), which, in the context of project teams, reflects the need for greater interaction among team members for effective problem-solving. In this case, motivation has a pivotal role as it positively moderates the relationship between

ability and project performance and the relationship between opportunity and project performance. Our results are in line with Moore, Payne, Autry, and Griffis (2016) in that collaboration is critical to achieve project performance in complex situations. Indeed, we show that participation increases the sharing of tacit and explicit knowledge, and motivates team members by increasing their feelings of competence and their commitment to goals. This study answers calls in the literature for more research on how employee participation benefits project-based organizations (Keegan, Ringhofer, & Huemann, 2018); on the dimensions of project complexity and the capabilities needed to perform at different levels of complexity (Rezende, Blackwell, & Gonçalves, 2018); and on how contextual heterogeneity affects knowledge processes at lower levels of analysis (Foss, Husted, & Michailova, 2010).

Thesis´ overall contribution to the literature

Jointly, the three studies help to answer this thesis´ research questions by advancing our understanding of how knowledge management mechanisms affect innovation and performance and what is the role of absorptive capacity.

We provide further evidence that knowledge management mechanisms positively impact organizational *performance* and *innovation* and answer calls for more studies from different contexts (Lane, Salk, & Lyles, 2001; Van Wijk, Jansen, & Lyles, 2008). More specifically, we confirm our previous premise that exploitative innovation (e.g. process innovation) leads to performance outcomes while exploratory innovation (e.g. product innovation) leads to innovation outcomes (Cohen & Klepper, 1996; Jansen, Van Den Bosch, & Volberda, 2006; Levin, Klevorick, Nelson, & Winter, 1987; March, 1991). We also distinguish between local and global innovation and show that the requisites to innovate locally are different from the requisites to innovate globally. By doing so, we build on emerging literature that has discussed the challenges of turning local innovations into global innovations (Fallah & Lechler, 2008; Isaac et al., 2019).

The three studies also attest the benefits of employing proper knowledge management mechanisms for firm innovation and performance. We provide further evidence that more varied sources of knowledge from both external and internal environment can indeed lead to innovation (Huber, 1991; Laursen & Salter, 2006; Mudambi & Navarra, 2004) and add to such literature by empirically showing this positive effect on both local and global innovation. We also extend our

understanding of how and under which circumstances knowledge management capabilities (systems, coordination, and socialization) can foster absorptive capacity (Jansen et al., 2005; Van den Bosch et al., 1999) from the international reverse knowledge transfer context. Furthermore, we show that the interplay among project-teams´ ability, motivation and opportunity (Appelbaum et al., 2000; Blumberg & Pringle, 1982; Boxall, 2003) depends on the contextual factors that affect their absorptive capacity (simple x complex projects). Jointly, the studies answer calls in the literature for a deeper understanding of the antecedents of knowledge transfer in MNCs (Van Wijk et al., 2008) and on the importance of socialization mechanisms, on the fit between properties of knowledge, and on the role of diversity of knowledge and international experiences for knowledge management and its outcomes (Argote, McEvily, & Reagans, 2003). We bring new insights into the differences pertaining the generation of local and global innovation, as well as on the importance of developing proper knowledge management mechanisms in order to achieve the expected innovation and performance outcomes.

We also reinforce the critical role of absorptive capacity for MNCs when trying to achieve better performance and innovation from their knowledge management mechanisms. As operating globally entails different challenges and requisites compared to operating locally (Fallah & Lechler, 2008; Isaac et al., 2019), additional practices are needed to foster absorptive capacity. To foster absorptive capacity to generate product innovations locally, firms may use R&D investments. To foster absorptive capacity to generate product innovations globally, firms may use innovation training. To foster absorptive capacity to better learn from their foreign subsidiaries, MNCs may develop their systems, coordination and socialization capabilities, as well as continue its internationalization process. MNCs should be particularly careful though in adopting coordination capabilities globally when they are too internationalized in order not to face diminishing effects on their absorptive capacity. To foster absorptive capacity to generate better performance from process innovations, MNCs can focus on composing teams with a minimum level of ability in simple projects and high level of motivation in complex projects. Absorptive capacity is particularly important as complexity increases, which require more intense efforts and diversified knowledge to solve problems.

With this in mind, studies within this thesis contribute to deepen our understanding of absorptive capacity, extending the original work from (Cohen & Levinthal, 1990) by providing evidence to conceptual aspects that were underexplored by the authors

nor by subsequent literature (Lane, Koka, & Pathak, 2006; Lane & Lubatkin, 1998; Volberda, Foss, & Lyles, 2010; Zahra & George, 2002). We showed a circumstance where R&D investment is more effective in generating absorptive capacity, which is in environments where learning is easier, that is, the local environment. We also reinforced the importance of training for absorptive capacity, especially in environments where leaning is more difficult, that is, the global environment. In addition, to the best of our knowledge this is the first attempt to tested empirically the expected trade-off between inward-looking and outward-looking determinants of AC and, therefore, we contribute to the literature by showing that this trade-off manifests in the context of international reverse knowledge transfers, when both inward-looking determinant (e.g. coordination capabilities) and outward-looking determinant (e.g. multinationality) are high. Finally, we empirically confirmed the need for more intense efforts and diversified knowledge to develop absorptive capacity for problem solving as complexity increases in process innovation projects, since motivation is the key moderating variable in this case. By going so, we answer calls in the literature for a deeper understanding of what amount of knowledge overlap is needed to increase absorptive capacity (Ambos, Nell, & Pedersen, 2013), of the trade-off between inward-looking and outward-looking AC (Pedersen, Larsen, & Dasí, 2020; Volberda et al., 2010), and of the contextual variables affecting the development of AC (Minbaeva, Pedersen, Björkman, & Fey, 2014).

Also, the role of training in the generation of innovations (Beugelsdijk, 2008; Laursen & Foss, 2003; Zárraga & Bonache, 2003) is reinforced by the studies within this thesis. For instance training was found to positively moderate the relationship between knowledge sourcing mechanisms and global innovation, while also having a positive direct impact on both local and global innovation in Paper 1. While Paper 1 only assumed that training is an absorptive capacity enhancing practice, without measuring its direct relationship with AC, Paper 2 confirms this relationship. As part of the operationalization of coordination capabilities, training contributes to increase headquarters´ absorptive capacity in regards to the knowledge generated by foreign subsidiaries, in Paper 2. Finally, although not directly measured in Paper 3, training enhances employees´ knowledge and skills that represent the ability component of the AMO framework and was found to be particularly important for achieving better performance in simple process innovation projects.

Finally, the three studies reinforce the role of headquarters in providing appropriate knowledge management mechanisms to foster absorptive capacity, innovation and

performance of their teams and various units (Campbell, Goold, & Alexander, 1994; Chandler, 1962; Ciabuschi, Martín, & Ståhl, 2010; Ghoshal & Bartlett, 1988; Schleimer & Pedersen, 2014). We bring new insights into the innovative capabilities of headquarters and subsidiaries operating in and from emerging markets and therefore we build on current debate on such topics (Alcacer, Cantwell, & Piscitello, 2016; Awate, Larsen, & Mudambi, 2012, 2015; Casanova, 2009; Cuervo-Cazurra, 2019; Govindarajan & Ramamurti, 2011; Kumar, Mudambi, & Gray, 2013; Lynch & Jin, 2016). We show that emerging market MNCs can adopt a variety of knowledge management mechanisms to generate local innovations, global innovations and superior performance throughout their widespread operations, which contributes to inserting them more and more in the global competitive and innovative landscape.

Limitations and future research

Besides the limitations of each individual paper, this thesis has some overall limitations. For instance, the studies were carried predominantly in one market, Brazil. While some of the findings attest the consistency of previous research carried in other markets, and although we found no country differences in the study that included a sample of Portuguese MNCs, generalizations to other markets should be taken carefully. Also, each study was carried within a specific context, so extensions of such findings to other contexts should also be taken carefully. Therefore, future research would contribute to our understanding of the hypothesized relationships by testing them empirically in other contexts and with different variables. For instance, future studies could include other potential absorptive capacity enhancing practices and test their moderating effect on the relationship between knowledge sourcing mechanisms and local and global innovation. I believe the literature would greatly benefit from more studies on the different requirements to innovate locally versus globally. In addition, future research could test the trade-off between inward-looking and outward-looking determinants of AC in other types of knowledge transfer such as conventional knowledge transfers (transfers from headquarters to subsidiaries), transfers among subsidiaries or transfers to and from the external environment. Finally, future studies could further explore the different team composition requirements to generate better performance in project teams working with explorative innovation (e.g. product innovation).

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Appendix 1

Internationalization and knowledge management: The case of the Brazilian multinational InterCement

Lívia Lopes Barakat and Tiago Rangel Alves

About the company

Founded in 1968, InterCement began its history named as Camargo Correa Industrial. The first factory was the Portland Eldorado in the city of Apiai, Brazil with 0.8 million tons capacity. Its headquarters is currently located in the city of São Paulo.

InterCement´s strategic orientation is based on operational efficiency. Its growth strategy was historically based on acquisitions of competitors, both in Brazil and abroad. In general, the companies acquired are the same size or even larger. For example, in 2005, InterCement acquired the cement producer Cauê in Brazil, with 1.2 million tons capacity.

Today, InterCement has 10 integrated cement[2] factories to produce Clinker[3] and six grinding[4] factories in Brazil and 25 spread over seven other countries. It is ranked the third most internationalized Brazilian company, with 75.9% of its revenues, 63.9% of its assets and 72.1% of its employees abroad according to the 2018 Ranking of Brazilian Multinationals, by Fundação Dom Cabral. The firm exports to 17 countries, has about 1.9 billion euros of revenues, 5.1 billion euro assets and 7,734 employees worldwide in 2016. The firms´ current world production capacity is 47.3 million tons/year, which makes it one of the 20 largest cement producers in the world.

[2] The Integrated Factory besides the grinding has one or more kilns to produce clinker.
[3] Clinker is the crude cement, in its purest form without additives.
[4] The grinding add additives to grind clinker, mix and distributes the cement in bulk or packed.

The company began its internationalization process in 2000 in Paraguay. The purpose of its international strategy was to strengthen itself against global competition, to gain markets and to reduce the exposure to seasonality.

Next we describe the firms´ operations in each of the seven countries where it is located today.

Paraguay

InterCement entered Paraguay in 2000 by a greenfield commercial operation to support exports from Brazil. Soon after, they signed a shareholders' agreement for establishing the production subsidiary Yguazú Cementos. The construction of the new factory only actually started in 2009 and finished in 2014, when InterCement celebrated its 40th aniversary since foundation. The Inter-American Development Bank (IDB) approved a loan of 51.75 million dollars to support the construction of an integrated cement factory and the necessary quarrying infrastructure for extracting and crushing limestone, the basic raw material of cement. The factory was built in the city of Villa Hayes, an industrial pole near Asunción, which has good supply of electrical energy. The unit started with installed capacity of 0.4 million tons/year, but has been steadily increasing its local share. Today, Yguazú is second leader in the market with production capacity if of 0.8 million tons/year. This new factory helped InterCement reduce costs because it was no longer necessary to import clinker, resulting in increased global profitability.

Argentina

In 2005, InterCement further expanded in Latin America via the acquisition of the Argentinean Loma Negra. This was a slightly larger company than the original InterCement. Founded in 1926, Loma Negra had nine cement factories and was the leader in Argentina with 7 million tons/year capacity and 46% of local market share. Moreover, the company has eight concrete centers and Ferrosur Roca, a railway concession mainly used to dispose the production.

At the time, the acquisition increased the total net revenue of InterCement by 47.9%. The integration process was not easy due to cultural differences between Brazilians and Argentinians. As a result, InterCement organized a task force to lead the merge and achieve synergy. Two guidelines should be followed: i) to integrate the operational model and processes and standardize the indicators used to manage the daily routine, and; ii) to unify the IT processes related to its Enterprise

Replenishment System (ERP) and other important systems like Business Intelligence and Quality System.

Even after the acquisition, Loma Negra kept its headquarter in Argentina, which enabled great knowledge exchange between the engineering teams of both countries. Brazilian engineers learned with Argentinean engineers who were highly qualified, skilled and effective regarding project deadlines. By providing greater local autonomy to Loma Negra, InterCement aimed to keep the good practices from the acquired company and they became a source of benchmark for Brazil. Besides informal exchange of ideas and experiences between engineers of both countries, InterCement expatriated managers and engineers from Brazil to Argentina and from Argentina to Brazil in order to benefit from this knowledge exchanges. According to the company´s President "we never intended to get to an acquired company and impose what we know and forget about what they know, it would be silly to disregard this type of knowledge especially because they were more recognized in the market, they know much more. We joke here that we only truly became cementers when we acquired Loma Negra". Therefore, InterCement took their constant improvement culture and systems to Argentina while they acquired production and market knowledge at Loma Negra, for instance regarding equipment maintenance and relationship with clients.

While providing autonomy to the Argentinean subsidiary fostered reverse knowledge flows, it generated some sort of conflicts between leaders and areas of both countries. According to one interviewee, "Argentineans have a different mindset, although we are neighbor countries. This reflects on the way you deal with and retain your clients. Also, their leadership style is less hierarchical and more participative".

Today, most of the knowledge from Argentina has been transferred to InterCement and there are no longer Brazilian expatriates there. One of the ways to keep knowledge transfer nowadays is to have the corporate Business Intelligence department located at Loma Negra. This department is in charge of identifying areas of improvement in all units and recommending actions to increase productivity and performance.

Entry in Portugal and Africa

The great turnaround of the internalization process happened in 2012 with the acquisition of the Portuguese Cimpor´s entire capital for 2.9 billion euros total. At

the time of the acquisition, Cimpor was bigger than InterCement. Cimpor's acquisition was part of InterCement's strategic plan to be among the 20 largest cement companies in the world.

The negotiations started in 2010, when InterCement initially acquired 22.2% of Cimpor´s shares. Sometime later, it acquired about 10.0% more and became the greatest individual shareholder by paying 1.4 billion euros on the first phase. The final acquisition was in 2012, when Cimpor open its capital in the Lisboa stock exchange. It was a hostile takeover of 95.7% of Cimpor's voting shares done jointly by InterCement and another Brazilian cement producer Votorantim. The transaction amounted 1.5 billion euros (5.5 euros per share). After the acquisition, InterCement and Votorantim agreed on a division of the markets where Cimpor operated. InterCement became the controller of Cimpor´s operations in Brazil, Portugal, Egypt, South Africa and Mozambique, whereas Votorantim became the controller of Cimpor´s operations in the USA, Canada, India, Morocco, Tunisia, Turkey, Spain and China.

The acquisition process succeeded despite its hostile takeover. InterCement had an exponential increase jumping from being present in three countries in Latin America to 40 cement factories across eight countries in three continents. The net revenue increased 143%, from 2010 to 2011, while the margin EBTIDA reached 27.5% compared to 24.1% a year before.

The Portuguese operation is composed by five assets located from south to north. Leader in Portugal with 60% of the local market share, Cimpor has three integrated factories and two grinding totaling 9.07 million tons/year capacity (19% of InterCement´s global production). In 2015, the Portuguese market grew at a rate of 10% whereas exports slowed down due to the effect of the economic downturn in importing countries mainly in North Africa.

The acquisition process of Cimpor naturally faced challenges of integrating different organizational and national cultures. InterCement´s management is performance oriented and tends to make decisions collectively involving several levels of the organization. Cimpor´s management is more centralized and focused on technical skills and operational indicators. Also, InterCement is very much concerned with meeting safety requirements in manufacturing plants, which demanded new systems and higher compliance. The implementation of the new safety tools was done very fast and resulted in some level of resistance from the

local employees. According to one interviewee, “this resistance was mostly due to the fact that InterCement is smaller in size and less known in the global market than Cimpor, a traditional cement manufacturer in the market for more than 120 years and with more advanced technical knowledge”. After the acquisition, InterCement´s management had to focus on the integration process and left aside important practices such as visiting the manufacturing plants. InterCement has been addressing these difficulties by imposing more strict control over the implementation of safety rules and by adapting the systems to facilitate their use in the Portuguese subsidiary. Also, InterCement attempts to reduce the integration challenges by showing the advantages of the new processes. For instance, the headquarters provided the training “Leadership for Results” focused on the premises of leadership at InterCement and on the use of the management systems platforms. Furthermore, InterCement is trying to learn from the experience of Cimpor in the cement industry through several meetings with the executive committee.

Some other cultural differences became clear during the integration process. The Portuguese Cimpor has a more formal and vertical hierarchy and leadership is barely accessible. Although both countries are relatively high in power distance (House et al., 2004), the communication flows through hierarchy in the Brazilian InterCement are more flexible and the relationships between leaders and followers are more informal. For instance, before the acquisition, from the three elevators in Cimpor’s building, one of them was exclusive for the local CEO and directors. Today, employees from any level can use any elevator. Another change after the acquisition that illustrates this cultural difference is that now different positions in the hierarchy share the same working space and the country manager meets monthly with employees for birthday celebrations. Thus, the organizational cultures are gradually mixing and evolving to an optimal style.

InterCement has been going through a number of changes since it acquired Cimpor and the integration is not yet completed. That´s why some areas have a high degree of autonomy. According to one of the interviewees, “the headquarters is a consolidator of data rather than a policy disseminator”.

Mozambique

Mozambique, which was part of Cimpor, has five operational assets composed by four grinding and one integrated factory. The integrated factory and one grinding are in Matola, a neighborhood close to Maputo, Mozambique´s capital and

Cimpor´s main market. They are responsible for 54% of the produced volume. The brand *Cimentos de Moçambique* is the leader in the country. The other four grindings are spread in the cities of Dondo, close to Beira, in the center of the country and which has the third biggest population, and up north in Nacala, which is also an important harbor and strategic logistic point. Mozambique accounts for 6.5% of the global production capacity of InterCement (3.1 million tons/year) and 60% of the local market share according to the company´s annual report.

South Africa

South Africa is one of the most influential players in the African continent and has a fierce competition for market share in the cement industry. InterCement operates there through the plants of NPC (Natal Portland Cement), which was also part of Cimpor. NPC is located in the province of Kwazulu-Natal, being one of the main players leading the market in the province. NPC´s headquarter is in an industrial complex with a grinding station in Durban. The other assets are one grinding in NewCastle and one integrated factory in Simuma. The total production capacity of InterCement in South Africa is 1.8 million tons/year (3.8% of the global capacity).

Egypt

Up north in the surroundings of Saara desert and the Mediterranean is placed the Amreyah Cement Company in Borg Al Arab nearby Alexandria in Egypt. In 2015, the Egyptian economy grew 4% and attracted new competitors to the cement industry. This caused a general decline in prices, which, combined with an increase in energy costs by about 15% and the government cut in subsidies to the energy matrix, impacted negatively InterCement´s margin. Hence, in the second semester of 2016, the company started a new coal mill aiming to reduce costs and its dependence of the government. With a total capacity of 5.6 million tons/year, the Egyptian operations account for 11.8% of InterCement´s global production and continuously receive investments to consolidate its local competitiveness. Today, the Egyptian plant performance indicators are benchmark at InterCement.

Cape Verde

Cape Verde is the smallest structure of InterCement outside Brazil, with a bagging station and few retail shops. InterCement´s total sales in the archipelago is 0.2 million tons, less than 1% of the total. The unit´s sales are driven mainly by local housing programs and other infrastructure initiatives.

Brazil economic crisis

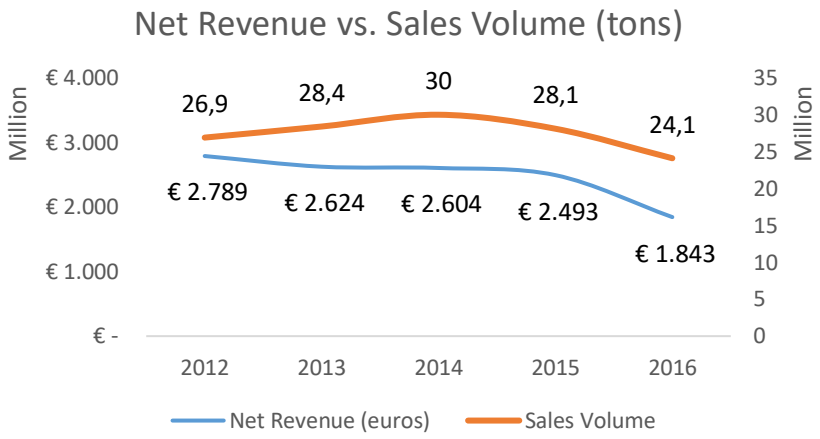
By the time this case was written (2016-2017), Brazil was going through a serious political and economic crisis with strong effects on the construction industry. The crisis started as a result of the world economic crisis of 2008/2009 in Brazil, in which the government used state banks to expand credit throughout the country. The government plan was based on five pillars: expansionary fiscal policy, low-interest rates, cheap credit, devalued exchange rates and increased import tariffs.

This plan raised governmental deficit and reduced international confidence. As a result, the exchange rate depreciated. The dollar went from R$1.70 in 2010 to R$3.25 in 2016. The inflation increased to 10.7% and unemployment rate rose to 12.0% in 2016. In 2015, Brazil went on recession, which resulted in a GDP of -3.8%. The same tendency continued and in 2016 the economy shrieked again with a GDP of -3.6%. The investment level also dropped critically in 2016 and Brazil was downgraded by Standard & Poor's credit rating. Meanwhile, the economy slowed down and a political crisis followed with the impeachment of President Dilma Rousseff. In 2017, there have been some signs of recovery with the inflation around 3.0% and expected GDP close to zero. Yet, the strong political crisis remains.

The cement industry has also been suffering the impact of the Brazilian economic slowdown. The sector registered a drop of 11.7% in 2016 totaling local sales of 57.2 million tons according to SNIC, the National Cement Industry Union. In the biennium 2015-2016, cement sales registered a decrease of 19.3% against 9.0% in 2014. The current economic crisis is considered the worst crisis Brazil has ever faced in the industry. While the idle capacity of the general manufacturing industry is, in average, of 27.5%, in the cement industry this percentage rose from 30% in 2015 to 43% in 2016, according to the president of SNIC, Paulo Penna.

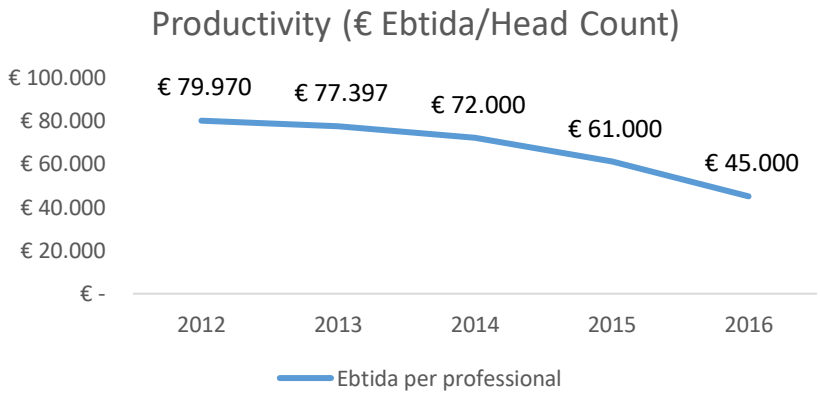
As the vice leader in the Brazilian market, InterCement needed to reinvent its management to minimize the impact of the crisis. Graph 1 shows the initial rise in sales volume and then slowdown of both sales volume and net revenue since the acquisition of Cimpor in 2012.

Graph 1 – Net Revenue and Sales Volume Evolution



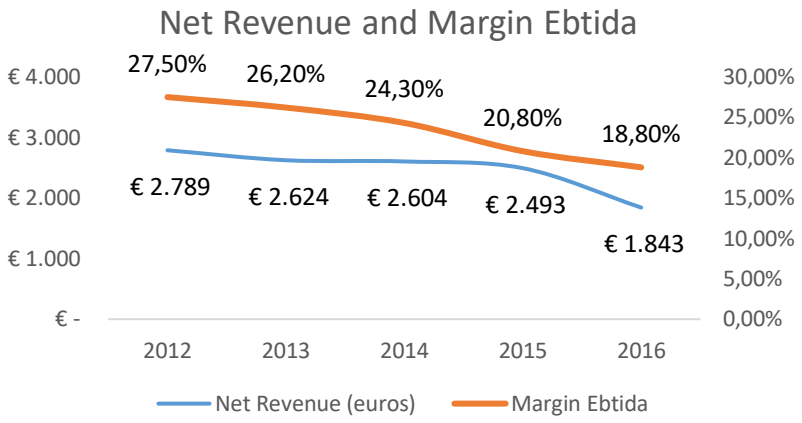
In 2013 and 2014, the sales volume grew up mainly because of: i) additional volume of Paraguay ii) the factories in Africa and iii) the exportation volume. Nevertheless, the poor result in Brazil and Argentina of 0.5% and -3.2% respectively directly influenced the overall results. Together, both countries are the most important markets in terms of revenue and sales volume. Furthermore, the sales volume in 2016 reached lower levels than in 2012 in particular due to the Brazilian economic crisis. The production capacity was higher than the demand and therefore the cement price decreased. Graph 2 shows that the revenues was not enough to support de overhead costs, reducing the company´s productivity.

Graph 2 – Productivity



Graph 3 shows the drop in net revenue and Ebtida Margins.

Graph 3 – Net Revenue and Ebtida Margin



In summary, new construction technologies as well as a constant search for cost reduction through adding value to products and decreasing raw material consumption became mandatory to thrive in this competitive market. The intense effort to equalize the costs with discipline and responsibility became fundamental.

International Governance

With the increasing internationalization of the company, in 2015, InterCement created the Executive Committee, a new structure to support its international governance. The purpose of the committee is to speed up the knowledge exchange and the decision-making through the various geographies where the company operates.

The Executive Committee is composed of C level members of each subsidiary as well as support areas to make the bridge between the corporate guidelines and the worldwide operations, assuring that transversal indicators and polices are met. Its nine members are:

- President of InterCement – Ricardo Lima
- Vice-president of Business Support – André Gama
- Vice-president of Finance – Paulo Diniz
- Vice-president of Engineering – Jorge Martinez
- Vice-president of Operations in Brazil – Nelson Tambellini
- Vice-president of Operations in Argentina and Paraguay – Sérgio Faifman
- Vice-president of Operations in Portugal and Cape Verde – Luiz Fernandes

- Vice-president of Operations in South Africa, Mozambique and Egypt – Ricardo Barbosa
- Director of Strategic Planning – Marcos Zangari

The Executive Committee has the challenge to unify the management model providing standardization of the decision-making process and alignment of policies, procedures, guidelines and goals for the whole company, reinforcing compliance. The international governance has been an important catalyzer of knowledge sharing generating internal benchmarking and certain level of implicit and constructive performance competition among various units. One example is the corporate department of Coprocessing, who collects numbers from all units and compares which unit coprocesses more. Once a year the management team for coprocessing gathers in a seminar to exchange best practices and as a result, the low coprocessing units try to catch up on the following year. Likewise, the Controlling and Finance department brings to the executive committee performance numbers from each unit so that the low performing units compromise on measures to enhance results. The Executive Committee meets virtually every two weeks and extraordinarily if needed. Part of the committee is in charge of analyzing markets and financial results whereas the other part is focused on strategic matters, such as new market entry. The committee also meets personally three times a year in Brazil. There is also sustainability and innovation workshops every three months in one of the countries. However, due to the Brazilian economic crisis most of those meetings were put on hold or have happened virtually for cost reduction reasons. Today, according to one interviewee, "the biggest challenge of the executive committee is to implement InterCement´s management systems throughout all units respecting local particularities".

Knowledge management

Knowledge management at InterCement is a corporate function. There is an area for *R&D, Innovation, Management Systems, Sustainability and Knowledge Management* in the headquarters. This area´s mission is to generate business-oriented knowledge that is applicable in the medium/long run and may directly impact the firm´s competitiveness, either through disruptive technologies or through improvements in existing technology.

There is also a corporate *Technology and Process* department, whose head is located in Portugal. The department counts with one person in each subsidiary in the various

countries to check all the units and look for improvements. When one unit needs a specific knowledge, the Technology and Process department suggests which subsidiary and person could share the knowledge with them. If needed, this person will travel for the subsidiary as an internal consultant. For instance, in Mozambique and South Africa there have been technicians to transfer knowledge on equipment maintenance during a few months; they constantly travel to the various units of InterCement. From the interviews, it was clear that this area has an important role in implementing projects from one unit to another. This is an integrating area, in charge of sharing and unifying technical standards.

While the R&D department fosters and generates innovations, the Technology and Process Department is the one in charge of spreading and implementing the innovations throughout the global operations. There is also a Communication department in charge of sharing best practices and good news internally.

There are several knowledge management initiatives at InterCement, which could be considered either external or internal. The table below illustrates the various knowledge management mechanisms used by InterCement.

Table 1. Knowledge management mechanisms at InterCement

	Program	Objective	Mechanism	Governance
External knowledge sharing	Joint projects with universities	Generate knowledge and innovation on products, raw materials and manufacturing procedures.	Research teams	R&D department
	Partnerships with clients	Share experiences and generate ideas.	Workshops	R&D department
Internal knowledge sharing	Continuous improvement	Establish, monitor and foster continuous improvement projects to reduce costs or increase the sustainability of the products.	PDCA online platform	Management Systems department
	Benchmarking and performance program	Benchmarking: identify, monitor and set improvement targets for key performance indicators (KPIs) in terms of use of resources, energy efficiency, and alternative raw materials. Performance: sets action plans for the improvements identified by the benchmarking program.	Industrial Statistics online platform	Technology and Process department
	Innovation and sustainability program	Launch challenges on key topics for employees from any level to put their ideas for sustainable product and process innovation.	Click Lab online platform	R&D department
	Top Improvement Award	Recognize the best projects coming from: i) the continuous improvement; ii) the benchmarking and performance; and iii) the innovation and sustainability programs.	Assessment committee and award ceremony	Internal committee from different departments
	Corporate TV	Share what's going on in the company and expose employees that have remarkable achievements or ideas.	Videos	Communication department

The external sources of knowledge are:

i) Joint projects with universities for knowledge generation and innovation in Brazil or abroad. On this regard, the interviews made clear that the internationalization process of InterCement has given access to local technical researchers and research consortiums. For instance, InterCement is the market leader in Argentina and has attracted renowned researchers because of that. The fact that InterCement is a large company also enabled it to access research structures

worldwide. The knowledge generated by these partnerships is formalized in reports in three languages as well as videos and lessons, when the budget affords.

ii) Partnerships with clients to share experiences and generate ideas. This is made through a series of workshops in which InterCement´s management gets together with key clients to discuss projects that can potentially increase production, quality and profitability, benefiting both sides. InterCement also sponsors management programs for clients (e.g. family business management) and mixes with its own managerial team to strengthen links with members from client companies. According to one interviewee, "it´s common to visit our clients and see a picture of them with someone from InterCement". The ultimate goal of this partnership is to increase customer loyalty.

The main internal formal mechanisms of knowledge management are: i) Continuous improvement program; ii) Benchmarking program; iii) Innovation program; iv) the Top Improvement Award, which annually recognizes the best cases in each of these programs; and v) Corporate TV. According to one interviewee, "sharing knowledge is in InterCement´s DNA". Next, we describe each one of these initiatives.

Continuous improvement

The continuous improvement program is under responsibility of the Management Systems Manager. Its purpose is to establish, monitor and foster continuous improvement projects. In order to do so, InterCement uses the PDCA (plan, do, check, act) tool. Also called Deming Cicle or Shewhart Cicle, the PDCA is a management tool based on the Lean Six Sigma (LSS)/Total Quality Management principles.

Employees from any level of all InterCement´s subsidiaries can propose continuous improvement projects. However, in almost all cases the origin is top down. There is an online platform in which the project leader enters the results of their project, which is monitored by the corporate management.

As a commodity firm, the projects usually aim to reduce costs or increase the sustainability of the products. In general, projects target energy efficiency, use of alternative raw materials, cost reduction. Two examples are "to develop new chemical substances to improve the cement quality" and "to reduce the thermal consumption of the accumulated kiln". Each project has a goal, a team in charge and at the end of one year, the financial gains of the project are measured. There are

roughly 150-200 PDCAs running at InterCement per year. Since some of them last more than a year, InterCement currently has about 500 continuous improvement projects going on.

The online platform has several key-performance-indicators (KPIs) which are used to measure the effectiveness of the projects, the team involvement, the level of implementation and financial results. According to the interviews, the KPIs facilitate absorption of knowledge from one unit to another because all subsidiaries can access the platform for benchmarking.

The three best projects in terms of operational results are awarded by the "Top Improvement Award" program. The continuous improvement project has shown a direct impact on the company´s overall performance, with about 2.5 million euros of financial savings per year. This platform is very useful for the formalization of continuous improvement projects and measurement of their results.

Benchmarking and performance program

The benchmarking program consists in identifying and monitoring key performance indicators (KPIs) in terms of use of resources, energy efficiency, and alternative raw materials. The numbers from each unit are registered in a platform called Industrial Statistics and the benchmarks are shared in an annual event with representatives from all the subsidiaries. The benchmarks become targets for other subsidiaries to achieve in the following year, providing opportunities for improvement. The performance program is complementary to the benchmarking program and sets action plans for the improvement identified.

One example is the KPI "kiln performance", from which the bechmarking program compares the numbers among units and identifies the best performing unit, which becomes a benchmarking for other units. The performance program then analyzes the improvements needed in other units in order to achieve or get closer to the performance goal set by the benchmarking. In some cases, new investments are needed; in some other cases, improvement measures are taken, considering the experience of the best performing units.

These programs are under the responsibility of the *Technology and Process* department and are important for knowledge absorption from one unit to another, according to one interviewee. However, as another interviewee points, there is certain level of overlap of this project and the continuous improvement project,

since both target on improvements and incremental innovations. This partially duplicates the work and reduces the effectiveness of the programs, as well as the motivation of employees to use different platforms for similar purposes.

Innovation and sustainability program

In a similar platform (Click Lab), the R&D department choses key subjects and launches challenges for employees from any level to put their ideas for sustainable product and process innovation. This system works like a social network in which one person can comment on the idea of another person and everyone can see the ideas posted.

Every year, each subsidiary (in Brazil or abroad) should register at least two ideas for innovation or sustainability cases that can be adopted by other units. There is a corporate goal that enforces units to register existing best practices into the system. This goal impacts annual bonuses of executives.

The three best ideas or cases of sustainability are awarded by the "Top Improvement Award" program and are implemented. There is an innovation committee that judges the ideas according to the criteria: degree of innovativeness within the firm, potential economic return, potential environmental impact. The more "implementable" the idea is, the higher the chances of being awarded.

One example of a project awarded is the "Mutirão" in Mozanbique, in 2015. The project aimed to maximize the results of the subsidiary through an improvement of the quality of life of the employees, their families and the community. At the time, the Mozambique cement market was growing at 14% rate a year, but InterCement´s subsidiaries had low productivity and could not supply for this increasing demand. To address the productivity issue, InterCement worked in two venues: the industrial and social. For industrial improvement, the company invested in new equipment and machinery. For social improvement, the company provided food for employees and their families, refurbished the canteen, the bath and dressing rooms and provided training to manufacturing staff. All these measures impacted five thousand people among employees, their families and community, given the country´s poor infrastructure, education, housing and living standards. As a result, the motivation and productivity of the employees increased by 12%. This project was not only recognized by InterCement at the corporate level, but also by the local government and press.

Another example is the project carried by the Argentinean subsidiary Lomax aiming to reduce the use of water in the concrete plant. In order to do that, the subsidiary installed a tank with 400m^3 capacity to collect water from rain from all over the plant´s surface with the help of collectors located in different levels of the land. This resulted in savings of 35.7% of the water consumption per year. Best practices and ideas come from any subsidiary regardless if it´s in Brazil or some other country. The ideas are available to all subsidiaries to access and implement if they wish. There are currently 8-10 initiatives being implemented worldwide by the R&D department. One example of an innovation project that will be implement in all the countries is the co-processing, which addresses the problem of residue while reduces energy costs. Another example is a project to change the composition of the concrete by adding chemical components to reduce the carbon footprint. This project is under development with another multinational and if proved feasible will be implemented not only in Brazil but also in South Africa.

Despite these notable cases, the subsidiaries rarely suggest more ideas than the ones enforced by the annual goal of top management. An interviewee estimates that only 3-4% of middle management and manufacturing staff engage proactively in giving ideas. This is partially due to lack of incentives and partially due to their excessive focus on routines and operational results. Another issue with this system is that manufacturing staff are not familiar with the platform, so they find it difficult and time consuming to interact, share knowledge and learn through the platform. Lack of ability in this case also hinders innovations. Therefore, some interviewees also suggest that InterCement should offer online tutorials and more training to foster knowledge sharing.

Top improvement award

The *Top Improvement Award* was first created to recognize most successful continuous improvement projects and later was extended to innovations and coprocessing. Today, the *Top Improvement Award* aims to annually recognize innovative ideas and projects coming from the continuous improvement, benchmarking and performance as well the innovation and sustainability programs.

There are three categories by which projects are awarded:

- Management and performance: recognizes the three best plants in terms of management, according to indicators of sustainability, safety, continuous

improvement and benchmarkings as well as the best plants in terms of operational performance;

- Sustainable ideas: recognizes the three best ideas from the Innovation and Sustainability program that have been implemented and generated positive results for the company;
- Best performance: recognizes the three best projects of continuous improvement and coprocessing, according to the evolution of results compared to the previous year and to the degree of sustainability.

The finalists present their project in an event in Brazil with the global CEO and get a symbolical award and a note on the company´s intranet.

In addition to examples already cited in previous sections, another example of an awarded project (category of Sustainable Ideas) is the idea to maximize limestone in cement, which was suggested by the Bodoquema unit in Brazil. The idea consisted in utilizing limestone with low saturation factor instead of regular limestone. This was made possible by reusing materials that would be discarded from mines. The project resulted in an increase in the level of limestone in the cement composition, reducing the consumption of clinker and saving over 100 thousand euros in nine months.

Corporate TV

InterCement has a corporate TV channel in which it shows what is going on in each unit worldwide, interviews employees and shares remarkable achievements and ideas. The purpose is to share knowledge and recognize outstanding employees. In every commercial or manufacturing unit of InterCement there is a TV showing the videos, interviews and news from all units. Employees also get access to the content by institutional newsletter. This is a constant and systematic process carried by the communication department. According to the company president “it stimulates employees because you take a photo of them; you make a video and then expose this person, showing ´this is the champion´”.

When this program was created, the communication department had to ask each unit to share their good news and best practices. Today, the department receives more information than they are able to publicize, so they have to filter and select which goes to the corporate TV and which goes to other internal communication tools such as the intranet, institutional newsletter, group on facebook and blog. Their main

challenge is to release information on three languages, Portuguese, Spanish and English.

Today, InterCement has a large stock of cases, best practices and innovation projects. The Top Improvement Award seems an effective initiative to recognize projects, however, very few of them are "copied" and implemented by other subsidiaries. Some are too context specific, such as the Mutirão project in the Mozambique subsidiary, but many could be perfectly applicable to other subsidiaries, such as the Lomax or the Limestone project.

Challenges to international knowledge transfer

Knowledge flows at InterCement happen mostly from the home country (not necessarily only from the headquarters, but all Brazilian subsidiaries) to the host countries. This is because Brazil has more advanced processes than the foreign subsidiaries, in particular Paraguay, Mozambique, Egypt, South Africa and Cape Verde, so it is expected that most of the transfer will occur from the home country to the host countries. Yet, there is clear evidence of reverse knowledge flows from the Argentinean and Portuguese subsidiary, given that at the time of the acquisitions they were larger, more experienced and had more advanced knowledge on certain production and market aspects. There are also knowledge flows from the Portuguese subsidiaries to the African subsidiaries, mainly because they have been originally part of Cimpor.

InterCement seems very open to learn from the more advanced subsidiaries. According to the president of the company "when you integrate operations too fast (in post-acquisition) there is nothing to be proud of, because you have missed the chance to learn with that company and you end up losing a lot of people who get the feeling that their knowledge was useless. People today want to share knowledge and make a difference".

The knowledge flows between Brazil and Paraguay, South Africa, Mozambique, Egypt and Cape Verde, aim mostly to train manufacturing employees and implement new systems whereas the knowledge flows between Brazil and Portugal and Argentina aim to learn new ways of doing things and transfer manufacturing technology. The transfer of knowledge from one subsidiary to another seems to depend upon the level of development of the subsidiary, which affects the direction of knowledge flows within the multinational.

In countries that lack qualified work force, such as Mozambique, they absorb more the knowledge from the home country. There are also Portuguese technicians in Mozambique and South Africa to share knowledge and help local technicians to solve specific problems (e.g. maintenance, safety, residue). This expatriation may last for a few months or even years, depending on the specific knowledge required. The corporate Technology and Process also helps to train staff and implement projects. Mozambique´s subsidiary seems to be in an initial stage of innovation and process development because the equipment performance is low and the management system is not completely implemented. Also, the need for training investment is higher and it takes longer to develop local manufacturing and management staff. That is also why there is a high number of Brazilian expatriates there to transfer knowledge. The management in Mozambique acknowledges that they should absorb as much knowledge as possible from the headquarters. There is a cultural issue in Mozambique because of the colony mindset and high power distance. According to one interviewee "the centralizing style of leadership combined with low qualification and proactiveness of operational staff, who are usually too submissive, hinders idea generation".

Although Mozambique is less developed in terms of product and process innovation, in 2015 the subsidiary won the prize for the best mill improvement. The improvements in productivity were applied in the other subsidiaries in Mozambique, but not transferred to other countries because in general those countries already have good production capacity. Mozambique´s subsidiary also won an innovation prize with the workshop program to explain and implement the "10 InterCement Attitudes", a series of norms and behaviors for InterCement employees (ex. The Thinking Safe attitude generated a number of actions to avoid accidents). The CEO recommended that other units adopt the same program, however, so far it hasn´t been implemented.

Despite the various knowledge management mechanisms used by InterCement, the true transfer and implementation from one unit to another still faces many challenges. Sometimes the headquarters explicitly recommends that some idea is implemented by another subsidiary, but that enforcement is also rare, which limits the effectiveness of these programs. According to one interviewee, "corporate control would help to leverage knowledge sharing among units". For instance, there is a Business Intelligence department at the corporate level to analyze operational and financial data from all units to support decision making. They recommend

projects (e.g. new pricing strategy) to increase overall performance but they do not follow up if the measures were actually taken by the units.

In addition, according to one interviewee, knowledge is shared only when its application in other contexts is really easy. The "easiness" of implementation seems to facilitate knowledge transfer and absorption. However, existing mechanisms, such as the online platforms, only seem effective to transfer more simple and codifiable knowledge.

Also, language differences hinders knowledge transfer among subsidiaries, because the projects are registered in the country´s own language. Therefore, there is information in Portuguese, Spanish and English mixed in the platforms. The company also lacks technical staff who can speak English, which makes it difficult to use only one language in the platform. The main constrain for knowledge implementation in the non-Portuguese/Spanish speaking countries, such as Egypt, is language, although the country´s subsidiary is very open to receive new knowledge.

However, transferring knowledge from one subsidiary to another is not just a cultural issue. Differences in the manufacturing process and raw materials (e.g. limestone) may hamper the implementation of best practices and innovations. According to one interviewee, "it´s not simple to replicate innovations from one country to another; it depends on the type of equipment being used". Nevertheless, another interviewee argued that "a cement factory is a cement factory anywhere in the world. It´s very easy to transfer technology for other units because you can buy the engines anywhere".

Another difficulty to implement projects in other units is that the R&D department is located in the headquarters. According to one interviewee, "ideally there should be an R&D person in each country". This points to the need for coordination to assure international knowledge transfer. The way they found to minimize this difficulty is to work closely with the Technology and Process department. Hence, the Corporate Director of Technology and Process has taken the responsibility to assure that each continuous improvement or innovation project works in the subsidiaries by having one person in each of the main markets (Portugal, Brazil and Argentina). According to one interviewee, "if we didn´t have someone from the headquarters coordinating the initiatives it would be difficult to assure that an idea in South Africa would be implemented in Brazil."

The interviews also point to an expected role of the Human Resource department in knowledge transfer in several ways. First, to assure less turnover at the company, which has been hindering the consolidation of knowledge in the organization. Second, the HR should work more closely to develop employees´ capabilities for knowledge sharing.

Finally, the Communications department also recognizes the knowledge sharing initiatives by exposing employees and their projects/ideas on the corporate TV and institutional newsletter. However, several people interviewed believe this exposure is not enough to incentivize new waves of knowledge transfer because the perceived benefit of being in the corporate TV or newsletter is low.

The effect of the Brazilian economic crises

The Brazilian economic crises that has strongly affected the construction industry between 2015 and 2017 has forced InterCement to restructure several areas and the team has been reduced. The Innovation, R&D, Knowledge Management and Management Systems areas themselves have been extinguished as a corporate function, although the systems still exist. Each country now has its own training and improvement projects. The headquarter believes the countries are mature enough to carry the knowledge management objectives on their own, without the need of control and coordination. The only area related to knowledge management that remained is the Technology and Process department, possibly because it is the only area who knows about the platforms and indicators. According to one interviewee, “this area adds a great value to other units for being internal consultants”. Today, the main concern of the firm is to solve the debt issue and overcome the crisis. According to the president of InterCement “our main challenge is not on knowledge management anymore, it is on the commercial side, since 40% of the cement demand decreased with the crisis”. Therefore, the local teams are now focused on achieving the commercial and financial goals.

However, one interviewee believes the restructuring of the firm may inhibit the innovation process. According to him, “people don´t share knowledge and best practices anymore because each one is focused on the short-term objectives. The knowledge is available but people lack the necessary time to implement the ideas. InterCement prioritized the short-term results. They over trusted the competence and maturity of the countries to carry on the projects”. According to another interviewee, “each country manager is pushed for short-term results, but if there

isn´t a structure to monitor, control, establish goals, the subsidiaries won´t do it". At the time of the crisis, the company was working on three tools to foster knowledge management: i) a map with information on how the firm should share and capture knowledge; and ii) a matrix of knowledge speed *versus* impact, in order to choose which actions/projects should be implemented; iii) communities of practice for micro knowledge management. These projects are now on hold. Therefore, it seems that goal conflict is hindering knowledge sharing nowadays and that coordination and long-term perspective would be important to generate new knowledge at InterCement.

For many of the managers interviewed, the restructuring of the firm has already been hindering knowledge generation and sharing. For instance, on the first year of the Top Improvement Award, InterCement promoted a face-to-face event in Brazil with the finalists and company leaders. On the second year, there was just an online ceremony for cost reduction reasons due to the economic crisis. According to one of the interviewees, on the third year, recognition ceremony will be extinguished. The main formal program of recognition of innovations is no longer used due to the financial constraints and short-term focus.

However, according to the company's president, the crisis has actually been contributing to knowledge sharing at InterCement since "all subsidiaries are struggling to find new ways of doing more with less so they talk more to each other to exchange best practices. People understand that now is a moment to seek for results and they help each other on that, we can't continue doing things as we have always done". Also, InterCement's president believes there is no longer the need for a knowledge management department because the units are proactive and engaged in sharing their knowledge with each other; and also because the Communications department has taken part of this role to share what has been generated and done in other subsidiaries; each one is mature enough to apply this knowledge to their own reality.

Interviewees and additional sources of information

- Ricardo Lima, President of InterCement (until 2018)
- Luís Fernandes, Vice-President of Intercement - Cimpor Portugal e Cabo Verde
- Francisco Leme, Head of Coprocessing
- Seiiti Suzuki, Corporate R&D Director

- Edney Vieira, Head of Supply Chain, Legal, Administrative and HR of South Africa subsidiary
- Maurício Anacleto, Industrial Director of Mozambique subsidiary
- Cláudia Fonseca – HR Director of Mozambique subsidiary
- Diego Carralbal – Business Intelligence Corporate Manager – Argentina
- Tiago Rangel, former Corporate Management Systems Manager
- Lívia Gandara Prado, former Innovation Manager
- Adriano Nunes, former Director of R&D, Innovation, Management Systems, Sustainability and Knowledge Management
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