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KNOWLEDGE ABSORPTION THROUGH CROSS-BOUNDARY INTERACTIONS IN A HIGH-TECH SME

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1 INTRODUCTION

In this study, we draw on organizational learning and absorptive capacity literature to examine how cross-boundary interactions and coordination may enhance external knowledge absorption in high-tech small and medium organizations (SMEs). The basic assumption in this research is that organizational learning through cross-boundary interactions and coordination among different actors fosters development of absorptive capacities in the context of high-tech SMEs. Findings from empirical data obtained from a case study in an SME from the aerospace sector, highlighted the cross-boundary interactions and multilevel knowledge sharing coordination as a core element for the company to absorb up to date knowledge to support its innovation endeavor. There are two main contributions of this study. First we advance the evaluation of learning modes related to organizational absorptive capacities by suggesting cross-boundary interactions and collaboration as a vital element in this scenario. Second, we bring insights to practitioners at high-tech SMEs on acquisition, assimilation and exploitation of valuable external knowledge.

2 RESEARCH PROBLEM AND OBJECTIVE

As knowledge being recognized as a relevant asset to support strategy implementation, companies engaged in the development of learning practices may leverage newly valuable knowledge absorbed to their strategic advantage (Lei, Slocum, & Pitts, 1999). Such practices involving multiple actors are dependent upon company ability to deal with cross-boundary interactions and knowledge-sharing coordination among distinct actors (Carlile, 2004). For instance, differences in meaning, norms and interests among actors might pose several challenges for an effective knowledge absorption obtained from these interactions. Although various approaches have been proposed to deal with such differences (Kellogg, Orlikowski, & Yates, 2006; Carlile, 2002), little attention has been given to interactions and knowledge sharing coordination to enable absorptive capacities development in companies.

The selected field of study is also relevant for this research. Although the impact of business model dynamics leveraged by digital technologies encompasses all company sizes and sectors (Nambisan, 2016), specific high-tech SMEs companies experience the challenges related to the continuous technological development and digital infrastructure platforms transformation at the core of their product and services offers (Liao, Welsch, & Stoica, 2003). Based on the above considerations, we draw on absorptive capacity literature to examine how cross-boundary interactions and coordination may enhance external knowledge absorption in high-tech SMEs. In order to accomplish our intent, we obtained empirical data from a high-tech SME operating in the aerospace sector.

3 THEORETICAL BACKGROUND

3.1 Absorptive Capacities

Although the term "absorptive capacity" had already been used previously (Volberda, Foss, & Lyles, 2010), the contribution of Cohen and Levinthal (1990) is widely accepted as a

seminal work on the subject. The authors define ACAP as the organizational ability to recognize the value of new external information, assimilate it and exploit it for commercial purposes. The authors also reinforce the relevance of the individual absorptive capacity as forming the ACAP at the organizational level, arguing that both are cumulative and prior knowledge dependent. From the initial proposal of Cohen and Levinthal (1990) indicating connection of the ACAP with relevant topics such as innovation and organizational learning, several other proposals for concept validation or dimensions followed.

Many authors agree with the multidimensionality of the ACAP construct (Cohen & Levinthal, 1990; Zahra & George, 2002; Todorova & Durisin, 2007) although there is some disagreement regarding its meaning and quantity of dimensions or sub-capacities. Cohen and Levinthal (1990) proposed three dimensions based on their ACAP definition. Recognition of the value of new knowledge depends on the existing previous knowledge, individual ACAP and previous investments in R&D. Once value has been recognized, the organization must set efforts on how to internalize and assimilate this knowledge. Finally, the organization must be able to pursue ways to commercialize products or services based on such new knowledge. This last dimension is a specific element of organizational ACAP when compared to individual ACAP.

In a complementary approach, Zahra and George (2002) define the ACAP as an organizational dynamic capability (Teece, Pisano, & Shuen, 1997) and propose four dimensions as per the explicit phases of their model. For the authors, the ACAP is a set of organizational routines and strategic processes, through which organizations acquire, assimilate, transform and exploit knowledge to produce organizational dynamic capability. The acquisition refers to the ability to identify and acquire external knowledge, which is critical to the organization. In assimilating, the organization's goal is to understand this external knowledge through specific routines. In order to assimilate external knowledge, the organization endeavor is to interpret it and understand it so that the learning process may have a sequence. Transformation means internalization and conversion of the acquired and assimilated knowledge. This dimension can be understood as the ability to recognize non-matching data sets and combine them to reach new cognitive structures. The fourth stage is the exploitation. This dimension is strategic for the organization since it generates results from the efforts in the earlier stages. Development of knowledge application routines for the creation of new products, systems and processes to improve existing skills or even absorbing new skills is at the core of this exploitation phase.

Todorova and Durisin (2007) suggest a new definition and model with some important changes on Zahra and George (2002) proposal. The authors bring back attention to the first skill proposed by Cohen and Levinthal (2002) which is the recognition of value on external information for the organization. They understand this phase as a crucial step in the acquisition of new external knowledge. They also complement their understanding of the transformation phase proposing this step as an alternative to rather than subsequent to assimilation phase. According to Todorova and Durisin (2007), previous knowledge with high similarity to the newly acquired knowledge, enables the organization to move directly from assimilation to exploitation without the need to exercise transformation routines as a proper preparation first. As per Todorova and Durisin (2007) understanding, transformation occurs only if the acquired knowledge is somehow different from the current organizational knowledge to be assimilated as they are. With these arguments in mind, the dimensions defined by the authors are recognition, acquisition, assimilation and/or transformation and exploitation (Todorova & Durisin, 2007).

Cohen and Levinthal (1990) emphasize the importance of prior knowledge and prior investments in research and development (R&D) as essential background to be able to engage in a collaborative relationship. Hence, companies are invited to search at the same time for partners with diverse and complementary knowledge and with a certain level of common knowledge base. Actually, little is known about the nature, level and evolution of the common knowledge in a collaboration and its effect in terms of ACAP efficiency.

3.2 Cross-Boundary Interations and Coordination with Common Knowledge

As high-techs SMEs struggles for new sources of external knowledge for their innovation projects, one is clear that they must manage the alliances, partnerships or networks when the new knowledge comes from their relationship with other organizations. Efforts to assess and share valuable knowledge through these external boundaries is at the core of cross-boundary interactions and coordination literature (Carlile, 2004; Kellogg, Orlikowski, & Yates, 2006).

The definition of "common knowledge" still lack precision. Some authors such as Cohen and Levinthal (1990) consider this common knowledge as a pre-requisite "database" to start a collaboration. Then, the notion of common knowledge is assimilated to shared values and practices that will facilitate the collaboration. Other authors consider the "common knowledge" as the material that is being transformed among the different partners all along the collaboration, called "interlaced knowledge" by Tuertscher, Garud and Kumaraswamy (2014). In this perspective, Carlile (2002) consider common knowledge as a boundary artefact that companies uses to communicate across different knowledge domains. Acknowledge specific and common knowledge is an important step towards a better understanding of the challenges of valuable knowledge sharing (Carlile, 2004). Carlile (2004) proposed a framework for managing knowledge across boundaries which is based on the capabilities of knowledge transfer, translation and transformation. Knowledge transfer firstly considers boundaries as syntactic: companies need to develop a common lexicon to be able to share and access knowledge at a boundary. Secondly, knowledge transfer considers boundaries as semantic: companies are then searching to develop shared meanings and provide adequate means of sharing (sometimes with objects such as agreements or legal contracts) and accessing knowledge at boundaries. Thirdly, knowledge transfer considers boundaries as pragmatic: common knowledge then becomes the output of practical and political efforts that will initially create common interests. Kellogg et al. (2006) describe the arrangements among partners to move from a common knowledge to new ones as a "trading zone" where actors develop several practices such as displaying (render work visible), representing (rendering work legible through use of projects tools) and assembling (juxtaposing existing work through modification and recomposition) to favour cross-boundaries interactions.

3.3 Common Knowledge: Facilitator or Trouble Maker of an Efficient ACAP?

Common knowledge is not always considered as an imperative for knowledge transfer (and then ACAP) if social cohesion and strong third-party ties are present. Network structure can affect knowledge transfer among participants independent of the presence, nature and structure of common knowledge (Reagans & McEvily, 2003). When common knowledge is considered as a pre-requisite to start the collaboration, it is generally considered as a facilitator of the relationship. According to Ko, Kirsch and King (2005), higher levels of prior knowledge

determine more successful knowledge transfer. Bruns (2013) precise that the more diverse the knowledge in terms of expertise, the lower the common knowledge, the most difficult it is to exchange knowledge.

When common knowledge is considered during the collaboration, Kellogg et al. (2006) highlight that it generates several types of troubles such as identity, control, power and accessibility. Marabelli and Newell (2019) interestingly assert that when prior-related common knowledge is lacking, then it is created to facilitate efficient ACAP. They highlight how far power relations have at the same time the ability to constrain (or control) as well as to promote knowledge. In an attempt to link knowledge absorption capacity with inter-organization collaboration, Xiao and Qingpu (2013) defined team ACAP as the ability of coping with increasingly challenging boundaries in order to make better use of other domains' knowledge. The authors suggested common knowledge as the bridge between syntactic, semantic and pragmatic processes and the so-called boundary spanners absorptive capacities. In spite of the studies mentioned above, there are not a comprehensive set of works that address conflicts in the field aiming to identify difficulties in these inter-organizational knowledge sharing processes (Kellog et al., 2006).

4 METHODOLOGICAL PROCEDURES

ACAPs and cross-boundary common knowledge are complex and dependent upon the context in which they are observed. They are firm specific and potential sources of sustainable competitive advantage (Argyres and Zenger, 2012; Carlile, 2004). To achieve research objectives, we chose a qualitative, exploratory methodology with a single case study as an appropriate approach when the boundaries between the phenomenon (ACAP and cross boundary common knowledge) and the context are not well defined (Yin, 2003).

According to Yin (2003), data collection for case studies may rely on many sources of evidences. The most important are: documentation, archives records, interviews, questionnaires, direct observation, participant observation and physical artifacts. A qualitative research allows interpretation from the meanings that the observed phenomenon has to participants (Denzin & Lincoln, 2005). For this research, the sources of evidence will include semi-structured interviews and secondary data review. Since the proposal is to examine empirically how cross-boundary interactions and coordination may enhance external knowledge absorption in high-tech SMEs, we draw on the perception of the participants in this process supported by secondary data sources of evidences. Two board directors, a senior manager and a professional were interviewed. As secondary data, we examined explicit processes and operating procedures along with documents related to specific innovation projects shared with external stakeholders (customers, suppliers, partners, research centers and government). For analysis and interpretation of collected data, we engaged in a validation strategy through triangulation of data obtained from the distinct data sources (Creswell, 2007).

Our case, from now on named company A is a medium sized technology solutions organization based in Brazil, with more than 25 years of operations. Company portfolio includes high-tech products, services and solutions for aerospace and defense targeting worldwide markets. We collected data during more than seven hours of interviews with two senior executives and two operational managers. See table 1 for reference. Company formal presentations and reports were among secondary source of data.

Table 1
Interviews in company A

Job role	Time
Executive VP of Operations	150 min
Director of Research, Development and Innovation	68 min
Executive VP of Sales	63 min
Technical Leader of Research, Development and Innovation	101 min

5 RESULTS AND DISCUSSION

Since its foundation, company A targeted local and foreign markets for new opportunities and orientation to the research and development initiatives. Adaptability was at the core of company initiatives from the very first beginning of operations due to a crisis period in Brazil. Company value proposition is to provide excellence as a technology integrator. Due to technology dynamics, project requirements and resources allocation are not stable. It means experimentation and inter-organizational partnership to share risks and knowledge is a top priority. As an integrator of a multidisciplinary project, knowledge sharing among partners is crucial to deliver project results.

Due to market requirements and fierce international competition, project deadlines are extremely low considering aerospace and defense industry benchmarking. At the internal perspective, company A leaders appropriate cutting-edge technology artifacts and employ knowledge sharing practices and routines to manage their projects using an 'overlap' concept among the project phases. Such overlap is achieved through continuous assessment of previous and next phase of the development work. Internal areas involved in solution development includes groups with expertise (knowledge) related to electrical systems, mechanical systems, software development and production engineering. Each area anticipates what has to be done before previous area finish their own part of the job. By doing this, internal knowledge sharing among different specialized areas (i.e. internal boundaries) allow for a recursive and systemic learning eventually leading to faster and more effective project cycles. Since it enables productivity, reinforcement through management direction (power) is an important enabler here.

At the external perspective on organizational learning and eventually knowledge absorption, company A business model is inherently dependent upon inter-organizational network. As an example, company A leads a multi-organizational innovation network comprising eight different actors across industry and geographic boundaries. Innovation process usually starts with project requirements from one of the network members, a large foreign multinational company from aerospace sector. Company A leads the network interaction among members in order to define, develop and transfer knowledge required to meet such requirements. Processes include regular meetings for network members and shared common workplaces with daily open interaction located in Brazil and abroad**.** On top of company A and the aerospace multinational, the network comprises international research

institutions, foreign technology companies within aerospace sector, a local university and local research promotion institutions as well. Common knowledge might range from low to medium depending upon the specific innovation requirement. So far, no formal limits are applied at the value recognition stage of the relevant knowledge. Nevertheless, there is a document signed-off by all participants engaged in such network. When it comes to the exploitation phase of the innovation process, new business arrangements are employed to support production and commercialization of the product or solution.

All in all, evidences of knowledge transfer, translation and transformation could be verified at company A across internal and external boundaries. Common knowledge assessment is important at the early stages of the network collaboration but it evolves as the relationship matures. Although relatively easy at the internal boundaries, knowledge development and sharing among external parties was found to be highly dependent upon a strong third-party ties and social cohesion. On the other hand, exploitation was found to be the phase where power due to resource appropriation is one of the barriers of collaboration among network members.

6 CONCLUSIONS AND CONTRIBUTIONS

Knowledge is widely accepted as a valuable resource for the organizations (Grant, 1996, Nonaka & Takeuchi, 1995). However, in organization partnerships or networks this may be diffuse and even idiosyncratic for each participant. Therefore, knowledge coordination and alignment to achieve a common goal poses significant managerial challenges for companies (March & Simon, 1958). In this line, the main focus of this paper lies in the relevance of organizations cross-boundary interactions and coordination to enhance external knowledge absorption for each network participant. Our case study is a high-tech SME. Balance between the level of distinctiveness, complementarity and commonality of the knowledge across boundaries drives the innovativeness and effectiveness for the network and partnership (Bechky, 2003; Carlile, 2004; Okhuysen & Bechky, 2009).

This is an on-going research. We aim to contribute with knowledge management field of study by combining cross-boundary interactions and ACAP imperatives to foster effective knowledge sharing between parties engaged in a partnership and/or network. By developing a knowledge sharing in a partnership, each actor seeks to understand the actions and motivations of the others and may integrate or not these behaviors in their own practice and learning. Therefore any collaboration leveraged by the recognition of the potential value of a partner must begin with the sharing of a pooling of points of view, visions and knowledge to carry out a larger construction. Project management practices in company A, involving different players with diverse stock of knowledge might be an evidence of such construction. Understanding the micro foundations of these effective knowledge sharing artifacts employed to develop a common knowledge might be an interesting avenue for future investigations in these high-tech SMEs.

Finally, examination of the common knowledge development between high-tech SMEs nowadays, where market dynamics and expertise are increasingly sophisticated, seems a promising and valuable line of research for managerial purposes. Practitioners in these specific organizations struggle to access valuable resources to survive and thrive. Partnering to access complementary and diverse knowledge might be an important alternative. Balance common and diverse knowledge across boundaries with sharing artifacts and proper interaction may be the challenge for these organizations.

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