The absorptive capacity of an SME embedded in a Collaborative Innovation Network : assessment through a maturity grid

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Extended abstract

(Original file can be downloaded from: https://tel.archives-ouvertes.fr/tel-01689138v2/document)

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At the Grenoble doctoral school of management

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Defended on October 17th, 2017, in front of the jury:

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1 Introduction

1.1 Research context

SMEs are considered as central actors in the socio-economic landscape. According to the OECD (2005), they represent 95% of the enterprises and are a major source of employability. In addition, SMEs contribute to the innovation promotion (Smallbone et al. 2003, Oakey 2007) for several reasons. On the one hand, they are characterized by a high agility and creativity (Julien and Carrier 2002) which incites European policies to set up several programs such as 'SME Instrument' in Horizon 2020 in order to capitalize on these SME's abilities. On the other hand, SMEs innovate constantly in order to cope with the dynamism of their sectors in terms of competitiveness, technological change or market opportunity (Baldwin 1995).

However, undertaking the innovation path can be compelling as it requires diverse and highly specific knowledge (Carlile 2002). Such elements are rarely present within an SME (Bougrain and Haudeville 2002). Hence, to access complementary knowledge and carry out the entire innovation process, SMEs adopt open innovation strategies (Van de Vrande et al. 2009). In particular, they integrate collaborative networks (Lee et al. 2010) made up of actors who work together in a climate of mutual trust and exchange in order to achieve a common objective (Camarinha Matos and Afsarmanesh 2005).

To make good use of external knowledge from an innovation perspective, organizations need to develop their absorptive capacity (Zahra and George 2002). The latter is defined as a firm's ability to identify useful external knowledge, assimilate it, and apply it for commercial ends (Cohen and Levinthal 1990). This capacity allows organizations to combine their prior knowledge with the ones newly acquired in order to accomplish performance objectives (Kogut and Zander 2002). Consequently, raising the awareness of organizations that are carrying out innovation projects regarding this capacity would stimulate their performance improvement.

1.2 Research question

The absorptive capacity (ACAP) has proven to be important in knowledge management and innovation research. Several authors explored its contingent factors (Nätti et al. 2014, Lane and Lubatkin 1998). Others operationalized it in intra-organizational contexts of innovation (Lewin et al. 2011, Chauvet 2014) or interorganizational ones, for instance strategic alliances (Jiménez-Barrionuevo et al. 2011) and joint ventures (Thuc Anh et al. 2006).

However, none of the existing operationalizations is meant to guide SMEs embedded in collaborative innovation networks (CINs), toward the practices to be implemented so as to foster the success of their contributions to such contexts. Moreover, the existing operationalizations are not perfectly transposable to this context. On the one hand, the intra-organizational ones do not take into account the differences between the partners in terms of their own objectives and their organizational cultures (Lubatkin et al. 2001). On the other hand, the interorganizational characterizations do not consider the need for one organization to absorb external knowledge in order to achieve an objective that is common to a set of partners, before being able to derive any individual benefit. It is a distinctive characteristic of collaborative networks compared to the other types of interorganizational relationships (Miles et al. 2005).

Therefore, the objective of this research is to propose an operationalization of the ACAP for an SME embedded in a CIN, which would guide it towards the practices that are relevant regarding its participation to the network. Hence, this objective covers a theoretical and also a practical need. These gaps gave birth to the ACIC (Absorptive Capacity for Innovation in Companies) project, within which this thesis was carried out. This project, funded by the ANR (National Research Agency) resulted from a shared motivation of researchers from different fields and industrial players in the Rhône-Alpes region. Its main objective was to explore the concept of absorptive capacity within SMEs embedded in CINs, with the ambition to develop operational tools to foster the innovation of SMEs in such knowledge-intensive configurations. Thus, our research question is as follows:

How to assess the absorptive capacity of an SME embedded in a collaborative innovation network?

This problematic includes two sub-questions:

• How to characterize the absorptive capacity of an SME embedded in a CIN through a set of practices that it could mobilize in such a context?

• How to operationalize this characterization of the absorptive capacity in order to guide the SME towards the appropriate practices to mobilize in such a context?

1.3 Research proposal

In order to answer this question, this research proposes an operationalization of the ACAP of an SME embedded in a CIN through a maturity grid (Maier et al. 2012). In fact, to support management, raise awareness of best practices and enable processes' improvement, maturity assessment models are commonly used (Maier et al. 2012). Although they are not intended to provide rigorous metrics, these models help identifying best practices and trouble spots, and stimulate discussion among practitioners to initiate activities for continuous improvement (Ramasubbu et al. 2005). In case of a

voluntary evaluation, organizations often look for assessments that do not take too long and do not cost too much, which makes maturity grid assessments especially attractive (Fraser et al. 2003).

The present research is organized as follows. First, an in-depth literature review regarding the main concepts that are used in this research is introduced. Secondly, the research design rooted on the critical realistic paradigm (Bhaskar 1989) and mobilizing a mixed method (Venkatesh et al. 2013) is depicted. The next section introduces the results of this research, underlining the characterization of the ACAP resulting from the qualitative phase and its operationalization resulting from the quantitative one. Finally, the discussion and conclusion highlight the main contributions and limitations of this study and refer to possible ways to extend its results.

2 Theoretical background

We first introduce our state of the art concerning the research context, i.e. the innovation of SMEs embedded in CINs. Next, we focus on our conceptual background, for instance the absorptive capacity (ACAP), considered as a dynamic learning capacity. Finally, we justify the choice of a maturity grid to operationalize the ACAP.

2.1 Positioning regarding the innovation concept

2.1.1 Innovation as an object

The concept of innovation is very broad and is the subject of a rich literature. However, these studies are marked by the lack of consensus to designate this term. Most definitions converge to central notions: novelty, idea, uncertainty, change, etc. In this research, we adhere to the complex conception of the innovation phenomenon and perceive it as a dynamic change, which takes place over time. It can come from a premeditated action or from chance. Innovation develops through the interaction of different interdependent actors, each one having its own objectives, motivations and interests. ***We define innovation as "a deliberate intra- and interorganizational process that leads to the proposition and adoption of a new product on a market or within an organization. The new product can be a physical good, a service, a process, a know-how, an organizational device or a combination of several of these elements. This process allows the organization to improve its strategic position (e.g. to gain or increase its market power) and/or to reinforce its key competencies and know-how (technologies, market, etc.)" (Fernez-Walch and Romon 2006, p.31).***

Innovation can be distinguished according to its nature: Product / service, process, marketing, organizational and social (OECD 2005). ***In this research, we have chosen to focus on commercially oriented innovations without limiting ourselves to a particular type.*** Innovation can also be characterized according to its intensity. Conventional approaches often contrast two aspects, namely radical and incremental innovations (Rahmouni and Yildizoglu 2011). However, this classification addresses the novelty simultaneously at two levels, for instance the market to which the innovation is addressed and the technology that it uses. In this regard, Rice et al. (2002) distinguish the discontinuity of innovation according to market and/or technology. ***In this research we are interested in innovations that induce discontinuity in technology and eventually in market as well.*** Indeed, they represent a strategic asset for the long-term growth of organizations, although their development requires greater effort given their costly and risky nature (Rice et al. 2002).

2.1.2 Innovation as a process

Similarly to many terms terminated by "action", innovation refers to both a process (innovation) and its outcome (what is new). This research seeks to focus on these two aspects. In this sense, we adopt the definition of the innovation process proposed by Garcia and Calantone (2002, p.112), who consider it as ***"an iterative process initiated by the perception of a new market and/or new service opportunity for a technology based invention, which leads to development, production, and marketing tasks striving for the commercial success of the invention"***

The innovation process can be differentiated according to its strategic logic. Brem and Voigt (2009) first distinguish the ***Demand Pull*** innovation process triggered by an existing or a potential opportunity in the market. Organizations therefore seek to "domesticate" innovation through the implementation of new product development processes (Le Masson et al. 2007). Then, Brem and Voigt (2009) introduce the ***Technology Push*** process, representing the organization's willingness to formalize an idea in order to transform it into an innovation, i.e. to make commercial use of new know-how. This process does not result from clearly identified needs at the market level. ***In our work, we will consider both types of innovation processes. In this regard, we investigate this process from the moment when innovating actors have a relatively clear idea of a concept that can lead to a commercial opportunity. The innovative idea may have emerged from a need expressed by the market (Demand Pull) or from an idea leading to a potential opportunity (Technology Push).***

2.1.3 Innovation, a choice of openness

In addition to the difference of the strategic direction that might impact the nature of the innovation process, another important dimension concerns the boundaries that the organization considers to delineate the operational scope of its innovation projects. The latter may choose to limit its activities to its own structure, or adopt an open-innovation posture.

Open innovation is defined by Chesbrough (2006, p.1) as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively". This type of innovation does not restrict the flow of ideas and knowledge. External ideas are accepted throughout the innovation process and internal ideas have the potential to be developed externally. This is precisely the conception of innovation that we adopt in this research.

Most of the studies distinguish two forms of open innovation based on the flows that they induce (Gassmann et al. 2010, Brunswicker and Ehrenmann 2013). ***Outbound open innovation*** involves innovation activities aimed at taking advantage of the organization's existing technological capabilities by implementing them outside its borders through appropriate business models (Patents, Ventures, Open Source, etc.). ***Inbound open innovation*** refers to innovation activities where the organization captures and benefits from external sources of knowledge to improve its current technological developments (networking, acquisition of patents, external participation, etc.). In addition to these forms, ***the coupled approach*** combines both flows (Gassmann et al. 2010). Such mechanisms exist in the case of cooperative relations (Spithoven et al. 2013). On the one hand, they offer the organization the opportunity to access complementary resources and knowledge from partners and intangible knowledge that cannot be easily contracted through commercial transactions (Katsoulakos and Ulph 1998). On the other hand, cooperative relationships can provide a mechanism to reduce overlaps of key knowledge by helping to contain it among a limited number of actors (Martin 2002). ***In this research, we are rooted in the coupled approach of open innovation. In this perspective, we will focus on the SME's innovation within collaborative networks. The characteristics of this unit of analysis will be introduced in the next paragraph.***

2.2 Unit of analysis: An SME embedded in a CIN

2.2.1 SME's innovation

This research focuses on innovation by SMEs. These entities are defined as ***companies employing fewer than 250 people, whose annual turnover does not exceed € 50 million, and / or whose annual balance sheet does not exceed € 43 million (European Commission 2006)***. Several studies highlight the important contribution of SMEs to the promotion of innovation (Oakey 2007, Pavitt et al. 1987). In this sense, they considerably participate to the development of radical innovations by maintaining technological diversity, mainly since large firms tend to innovate based on pre-established technological trajectories (Smallbone and (2003).

Innovation is a powerful tool to help SMEs improve their competitiveness (Schwalbe 2009). Indeed, they must constantly face changes in their external environment and innovate in order to prosper and survive (Van de Vrande et al. 2009). The dynamism of the external environment that can induce the need to innovate is often described through 4 criteria. It can be related to the ***level of market opportunity*** (Porter 1980), ***its level of competitiveness*** (Lieberman and Montgomery 1988), its ***level of regulation*** (Buddelmyer et al. 2010) and ***the rate of its technological evolution*** (Bower and Christensen 1995). ***Thus, the greater the uncertainty associated with these criteria, the more organizations activate their innovation efforts*** (Johnson 1995, Tornatzky and Fleischer 1990).

Accordingly, SMEs innovate in response to such stimuli in their sectors. These innovation initiatives are favored by the characteristics of SMEs (Julien and Carrier 2002). Their agility gives them a greater opportunity to solve internal problems and to adapt more quickly to external changes. Also, their proximity to the market allows them to detect the expectations of current or potential customers and guide innovation (Yap and Souder 1994). However, despite these properties facilitating the innovation of SMEs, these entities are often confronted with barriers that prevent the implementation of their creative ideas. In this sense, they suffer from a lack of financial resources (Freel 2000), the possible aversion of their employees to a risky innovation strategy (McAdam and McConvery 2004), but most importantly ***the lack of knowledge and skills to manage the entire innovation process*** (Edwards et al. 2005). Indeed, SMEs often have to develop relatively specific expertise in order to keep a stable position on the market (Urbonavicius 2005). They can maintain a sufficiently high level of internal competence in only a few, or even a single technological area (Muscatello et al. 2003, Narula 2004). Consequently, to access complementary knowledge, SMEs use alternative open innovation strategies (Lee et al. 2010).

While SMEs may adopt different open innovation strategies (Van de Vrande et al. 2009), ***a large number of studies indicate that engagement in cooperative relationships is a key strategy for SMEs*** (Hanna and Walsh 2002, Van de Vrande et al. 2009, Edwards et al. 2005, Baum et al. 2000). Indeed, these relationships allow them to focus on maintaining high levels of internal competence in a limited number of technological domains (Narula 2004). In this regard, SMEs can develop bilateral alliances with large enterprises that have the necessary assets to transform inventions into product or process innovations (Barney and Clark 2007). However, these alliances limit the opportunities and alternatives for the SMEs, as large companies can force them to share their technological skills with them, thus depriving these SMEs of an important competitive advantage. As a result, as SMEs associate with large firms, they lose opportunities to compete with them (Narula 2002). They could also be subject to considerable development constraints in their partnership with large powerful companies, which would hamper creativity and value creation through their innovation efforts***. A cooperative***

alternative for SMEs to these bilateral alliances with large firms is the collaborative innovation network (Wynarczyk 2013), which will be the subject of the next section.

2.2.2 Collaborative innovation networks

Cooperation involves communication, information exchange, activity adjustments, and resource sharing in order to accomplish compatible objectives (Camarinha-Matos and Afsarmanesh 2008). It is achieved through the division of activities among the participants and therefore requires a low level of joint work, the latter being limited to the moments when the results of one actor are transmitted to another (ibid). ***Collaboration is an extensive form of cooperation. It is a more demanding process in which entities share information, resources and responsibilities in order to jointly plan and implement a program of activities, so as to achieve a common goal, thus to jointly generate value (Camarinha -Matos and Afsarmanesh 2008). Collaboration is based on the mutual commitment of participants to solve a problem together, which implies mutual trust and therefore requires time, effort and dedication (ibid).***

This research focuses on interorganizational collaboration in an innovation perspective, in other words it focuses on ***collaborative innovation networks (CINs)***. However, none of the existing studies on interorganizational innovation proposes complete definition of a CIN. Loilier and Tellier (2004) introduce the notion of innovation network, which they consider as "a coordinated set of heterogeneous actors (private or public laboratories, companies, customers, suppliers, financial institutions, etc.) who participate actively and collectively in the design, development, production and dissemination of an innovation"(Loilier and Tellier 2004, p.280). Nevertheless, this definition omits an important aspect of the collaboration which is commitment and mutual trust, and focuses mainly on the nature of the actors and their mode of coordination.

Drawing on the work of Camarinha Matos (Camarinha Matos et al. 2009, Camarinha-Matos and Afsarmanesh 2005, 2006, 2008), we define a collaborative innovation network as "a wide variety of entities (organizations and individuals) that are largely autonomous, geographically distributed and heterogeneous in terms of operational environment, culture, social capital and objectives, and that work together to better achieve common or compatible objectives of innovation, in a climate of mutual commitment and trust".

2.2.3 Characterization of a CIN

SMEs can be integrated in CINs with completely varied profiles. Previous studies mobilized a multitude of criteria in order to establish typologies of these networks.

- Thoben and Jagdev (2001) proposed a typology of collaborative networks according to their structures. It includes star, ring, bus, tree and mixed networks.
- Another characteristic often used to distinguish these networks is their orientation according to the value chain. In this sense, Thoben and Jagdev (2001) distinguish horizontal, vertical and diagonal networks.
- Also, Peillon (2001) differentiates networks according to their assembly rationale. The author distinguishes grouping by similarity in an additive logic and grouping by complementarity. In addition to this distinction, Douard et al. (2003) propose to analyze collaborative networks according to the criterion of their created assets' specificity. The resulting typology includes buffer, transactional, orchestration and heuristic networks.
- Moreover, based on the notions of electronic and geographical proximity, Loillier and Tellier (2004) propose a matrix composed of four types of networks, medieval, dispersed, integrated networks and e-networks.
- Finally, several works have attempted to distinguish collaborative networks according to their modes of governance (Goldsmith and Eggers 2004, Imperial 2005, Jones et al. 1997, Provan and Kenis 2008, Markus and Bui 2012). These studies distinguish the informal mode of governance from formal ones for instance contracts, minority shareholder agreements, consortiums and ventures.

With the dawn of open innovation, it is now impossible to find a CIN that fits perfectly into one of the typologies previously mentioned. Indeed, these networks can be perceived as more or less complex combinations of actors interconnected by heterogeneous bilateral relationships. All these criteria do not describe an overall CIN, but are rather characteristic of the bilateral collaborative relationships that each actor can carry out within the network. Therefore, it seems necessary to go beyond these criteria and to investigate those characterizing an actor as a distinct unit within the network (i.e. our unit of analysis).

2.2.4 Characterization of an actor's contribution to a CIN

Durugbo et al. (2011) state that the structure of a collaborative network involves exploring and integrating the differences of its members. Their differences stem from their pre-established roles and their expectations with regard to the network (Durugbo 2015). ***We propose to characterize the participation of an SME in a CIN according to these two criteria.***

First, in an innovation project, an organization can be more or less involved in one or several boundary spanning roles. These actors coordinate and facilitate the innovation process (Hauschildt and Kirchmann 2001). Goduscheit (2014) proposes a typology of these actors in a CIN:

- The champion or the powerful promoter who is directly concerned with the results of the project
- The expert promoter who is responsible for the technical coordination aspects
- The process promoter that facilitates project management
- The relationship promoter who liaises with the market

The more the SME is involved in one or several of these roles, the more it provides efforts to ensure the successful progress of the innovation process (Goduscheit 2014, Hauschildt and Kirchmann 2001, Chatenier et al. 2010, Gassmann et al. 2010).

The second criterion characterizing the participation of an organization to a CIN is its expected objectives regarding the network (Durugbo 2015). Indeed, the latter can be encouraged to integrate a network in order to generate profits and also to acquire intangible resources that would provide it with a competitive advantage (Grant and Baden Fuller 2004). In this sense, Ahuja (2000) distinguishes three reasons that characterize the participation of an organization, in our case of an SME, to a collaborative network:

- Strengthen its commercial capital: The commercial constraint may force organizations to develop sharp knowledge often in a short period of time. Such development can be costly and risky (Mitchell 1989). Therefore, organizations can access this knowledge and achieve beneficial innovation objectives by collaborating with relevant partners (Mitchell and Singh 1996, Shan 1990, Inkpen and Tsang 2005, Ahuja 2000).
- Strengthen its technical capital: CINs enable organizations to improve their innovation performance by absorbing new knowledge (Simonin 1999). On the one hand, they are an alternative to investments in specific technologies or infrastructures aimed at acquiring new knowledge (De Man and Duysters 2005). On the other hand, these networks favor acquaintances which are considered as the main channel to the transfer of tacit knowledge (Lundvall 2010)
- Strengthen its social capital: In addition to being a vehicle for innovation development, collaborative networks are likely to increase the public credibility of an organization and improve its social capital (Stuart et al. 1999). The latter, representing the accumulation of the organization's previous relations with other entities, provides it with information and reputation advantages (Gulati 1999).

The more an organization aims to strengthen its commercial, technical and social capitals, the more it will be motivated to build and successfully conduct collaborative relationships that will provide it with these benefits (Ahuja 2000). The involvement of an SME in a CIN is therefore determined by its objective of generating one or several of these capitals.

2.3 The innovation of an SME embedded in a CIN from the perspective of the absorptive capacity

As explained in the introduction, this research aims at operationalizing the absorptive capacity (ACAP) of an SME embedded in a CIN. It consists of a set of mechanisms and routines that are based on knowledge creation and acquisition functions, which would enable organizations to generate a potential competitive advantage while adapting to changes in their environments (Zahra and George 2002). Such properties make the ACAP a dynamic capability (Teece et al. 1997). This dynamic characteristic seems relevant to our research context. Indeed, the SME takes part to a CIN in order to generate an expected benefit. Moreover, it innovates so as to respond to the stimuli of its dynamic environment (Tornatzky and Fleischer 1990). We introduce in this section our literature review of the dynamic approach to the absorptive capacity and its implications for our research question.

2.3.1 Definition and dimensions of the absorptive capacity

The absorptive capacity (ACAP) was first introduced by Cohen & Levinthal (1990) who defined it as the ability of an organization to recognize the value of new information, to assimilate it and apply it for commercial purposes. Since then, this concept has undergone two main theoretical revisions. The first one was proposed by Zahra & George (2002), who perceived the ACAP as a set of organizational routines and processes by which organizations acquire, assimilate, transform and exploit knowledge to produce a dynamic organizational capability. According to these authors, taken together, these 4 dimensions holistically describe the ACAP construct. The second revision of the ACAP was suggested by Todorova & Durisin (2007) who addressed some criticisms regarding the proposal of Zahra & George (2002) and suggested some adjustments and extensions as will be explained further. Parallel to this theoretical evolution, the concept has proven its supremacy and was widely used in empirical studies. But each author adjusted the ACAP construct's definition to its research context. Since these prior theoretical and empirical studies were unable to agree upon a unique representation of the ACAP, we explored the main differences of the theoretical propositions surrounding it so as to propose a suitable definition of its dimensions for an SME embedded in a CIN. This description of its dimensions constitutes the pre-requisite of the operationalization we are aiming to build.

- ***Recognize the value of and/or acquire external knowledge***: For Cohen & Levinthal (1990) the ACAP refers to the firm's ability to recognize the value of available external knowledge, to internalize it and to use it. The authors

considered recognizing the value of external knowledge as the first component of the ACAP and suggested that this capability is critical for the firm survival in dynamic environments. However, they consider this external knowledge as already available and thus omit the firm's efforts to search for it. Zahra & George (2002)'s proposition of acquisition as the first dimension puts focus on the importance of external knowledge quest. The authors define it as the firm's ability to identify and acquire externally generated knowledge that is critical to its operations. They suggested that this capability reflects the intensity and speed of the firm's efforts to recognize valuable knowledge but also to gather it. Hence, the authors congregate into one single dimension the firm's ability to identify externally generated knowledge that is potentially valuable to its operations and the effective access to it. Later Todorova & Durisin (2007) separated these identification and acquisition dimensions. Acquisition represented to them the firm's efforts to acquire a wide range of external knowledge that wasn't already identified by the firm as valuable. Hence, both representations seem applicable, but need a clear positioning regarding the meaning attributed to each dimension. In sum, we agree with the statement of Cohen & Levinthal (1990) regarding the importance for a firm to recognize the value of available knowledge so as respond to the changes in its dynamic environment. However, we argue that this knowledge is not guaranteed to be available and firms need first to deploy efforts to identify its sources and to effectively seize it. Following Zahra & George (2002), ***we introduce acquisition as the first component of the ACAP for an SME in a CIN and define it as the mechanisms by which it seeks and gathers valuable knowledge from external sources. Such knowledge is recognized as potentially useful to contribute to the network objectives.*** In fact, none "can a priori acquire knowledge if he does not identify it as important to him" (Dali 2008, p.4).

- ***Assimilate and/or transform external knowledge***: Zahra & George (2002) define assimilation as the analysis of externally acquired knowledge to comprehend it and assess its real potential. In fact, the authors argue that this knowledge might present a considerable distance regarding the firm's cognitive frames, which would hinder its comprehension and hence delay its internalization within the firm's knowledge base. This idea is congruent with Cohen & Levinthal (1990)'s definition of value recognition and not of assimilation. In fact, these authors confer a different connotation to assimilation and suggest it represents the firm's ability to internalize external knowledge recognized as valuable. For Zahra & George (2002), internalization happens at a subsequent dimension, for instance the transformation dimension, which they referred to as the firm's ability to combine its existing knowledge with the newly acquired and comprehended one. Todorova & Durisin (2007) consider a definition of assimilation that is similar to Cohen & Levinthal (1990)'s proposal. For these authors, assimilation refers to the effective integration of the new knowledge into the firm's prior knowledge base. This explains why their definition of transformation is also different from the one suggested by Zahra & George (2002). According to the authors, transformation is an alternative process that would take place when the firm is unable to assimilate (i.e. to internalize) the new knowledge. For these authors, transformation refers to the firm's need to accommodate its prior knowledge base in order to fit and integrate the newly acquired one. Hence, we agree with the proposal of Zahra & George (2002) regarding the definition of the assimilation dimension. ***We introduce it as a second component of the ACAP and we define it as the mechanisms by which an SME embedded in a CIN, interprets and understands the newly acquired knowledge in order to assess its potential value and decide whether or not to use it to contribute to the network objectives.*** As for the transformation dimension, either as defined by Todorova & Durisin (2007) or by Zahra & George (2002), we suggest that these two processes represent ways that an SME in a CIN might mobilize in order to effectively use the assimilated knowledge. Our conception of the exploitation dimension presented below justifies our choice regarding the transformation component.
- ***Apply (i.e. exploit) external knowledge***: Cohen & Levinthal (1990) introduce the firm's ability to apply external knowledge for its commercial purposes as the last dimension of the ACAP. This dimension reflects the amount of value a firm can generate from the use of newly acquired knowledge. Zahra & George (2002) agree with this statement and suggest that a firm needs to be able to «harvest» externally acquired knowledge. To generate and maintain this value, they suggest that firms should establish structural and systemic routines (Feldman & Pentland 2003) by which they would sustain the exploitation of knowledge over extended periods of time. They suggest that exploitation "is based on the routines that allow a firm to refine, extend, and leverage existing competencies or to create new ones by incorporating acquired and transformed knowledge into its operations" (Zahra and George 2002, p.190). It is embodied in all the processes and routines that underlie the integration of new knowledge into products and services, systems, processes, knowledge or new organizational forms. This dimension therefore represents the extraction of all the potential value that a new knowledge can bring. ***We consider that the application corresponds to the way the organization implements the assimilated knowledge to use it. We integrate in this definition the notion of transformation given by Zahra and George (2002), i.e. the combination of prior and new knowledge by the organization, but also the one proposed by Todorova and Durisin (2007), i.e. the accommodation by the organization of its knowledge base to integrate the new knowledge. Finally our application dimension also includes the exploitation which reflects for all these authors the possible uses of the new knowledge.*** In fact, although transformation is an essential prerequisite for exploitation which aims to prepare knowledge before its definitive use, we adhere to Schmidt's (2005, p. 3) assertion that "the dimension of transformation cannot be made explicit as it is an integral part of the exploitation component". ***Hence, we introduce exploitation as the third component of the***

ACAP and suggest it represents the mechanisms by which an SME embedded in a CIN will use the assimilated new knowledge to contribute in achieving the network objectives.

2.3.2 Determinants of the absorptive capacity

Several studies have identified the determinants of the ACAP (Zahra and George 2002, Lane et al. 2006, Todorova and Durisin 2007). A determinant acts as an activator of the organization efforts to achieve a desired performance (Bauman et al. 2002). In the sense of ACAP, the intensity of the knowledge absorption that is necessary for an organization to achieve its objectives will differ according to the presence of the following constructs:

- ***Characteristics of the useful external knowledge:*** Cohen and Levinthal (1990) argue that an organization's exposure to an environment with a high technological opportunity would enable it to achieve more R&D through the mobilization of its ACAP. In fact, a greater technological opportunity involves a greater amount of available external knowledge, which would push the organization to make greater efforts in order to integrate this relevant and accessible knowledge in order to generate valuable results (Lane et al. 2006). Moreover, the more diverse and non-complementary is the available external knowledge, the more efforts the organization will need to provide so as to understand it, assess its potential and integrate it into its own knowledge base (Zahra and George 2002). On the other hand, when critical knowledge is not readily available, the organization must intensify its efforts to acquire such knowledge (Zahra and George 2002).
- ***Dynamism of the external environment:*** Zahra and George (2002) argue that external activators such as high technological change or high frequency of innovation reflect uncertain environmental conditions that would push an organization to invest more in its ACAP. Other studies consider high levels of competitiveness and regulation as signs of environmental dynamism, which are likely to induce high levels of ACAP (Lane et al. al., 2006). In sum, the more dynamic is an organization's external environment, the more likely the organization would develop its capabilities to acquire and assimilate externally generated knowledge.
- ***Initiate a change in the strategic orientation:*** Zahra and George (2002) underline that activators of knowledge absorption can also be internal, for instance events that redefine the organization's strategy. As an example, the authors cite organizational crises and performance failures that would stimulate the absorption of knowledge by an organization. Kim (1998) argues that a crisis, although negative, can intensify an organization's efforts to develop new internal skills and acquire new external knowledge, which would increase its absorptive capacity.
- ***Importance of the role occupied by the organization:*** Tsai (2001) argues that the more central a unit is in a network, the more it has access to sources of knowledge, and the more it needs to develop its absorptive capacity to transfer that knowledge. Thus, the powerful role occupied by a unit in a network acts as a determinant of its absorptive capacity. Todorova and Durisin (2007) also point out that such power relations can have a contingency effect on the ACAP. Indeed, powerful actors can influence knowledge absorption processes to achieve their own goals (ibid). Thus, in line with our state of the art presented in 2.2.4, the involvement of the SME in a powerful role of innovation promotion within the CIN (Goduscheit 2014) would stimulate its efforts of innovation and hence of knowledge absorption.

2.3.3 Antecedents of the absorptive capacity

Several studies have identified the antecedents of the ACAP. An antecedent is a construct that can promote the success of an organization's objectives - in our case the success of its knowledge absorption - if managed correctly (Leidecker and Bruno 1984):

- ***IT capabilities***: They are defined as combinations of technical and human assets (Bingham et al. 2007) and routines based on information and communication techniques that coordinate functional activities (Day 1994) in order to generate an added value (Sambamurthy and Zmud 2000). Pavlou and El Sawy (2006) suggest that in the context of new product development (NPD), the ability of team members to efficiently utilize IT functionalities improves their absorptive capacity, which impacts the competitive advantage of the organization.
- ***System capabilities***: They reflect the establishment of written documents and formal systems to clarify the rules, procedures and instructions that guide communications and interactions. Individuals exchange and combine explicit knowledge through formal exchange mechanisms such as formal language, codes, work manuals, information systems, etc. (Van Den Bosch et al. 1999). These system capabilities hence include the previously introduced IT capabilities.
- ***Coordination capabilities***: They reflect the ability of an organization to manage dependencies between its various activities (Malone and Crowston 1994). These lateral means of coordination are explicitly conceived methods but can also emerge from an interaction process (De Leeuw and Volberda 1996). These capacities include interfacing, participation in decision-making and work rotation, which facilitate knowledge assimilation (Henderson and Cockburn 1994).
- ***Socialization capabilities***: They reflect the ability of an organization to produce a common ideology that provides its members with a collective understanding of knowledge (Van den Bosch et al. 1999). Hence, they create the necessary

conditions for knowledge exchange and combination (Nahapiet and Ghoshal 1998). These capacities represent the level of cohesion and shared social experience within an organization (Adler and Kwon, 2002) which is facilitated by the possession of objectives and vision that are common to all of its members (Henderson and Cockburn 1994).

- ***Collaborative capability***: It represents an organization's ability to build and manage interorganizational relationships based on mutual trust, communication and commitment (Blomqvist and Levy 2006) and is perceived as a prerequisite for absorbing and leveraging a partner's knowledge (Eriksson 2013). Trust is based on the belief in a partner's competence and behavior in risky relationships. Commitment is measurable in terms of concrete actions and material investment in the relationship (Nummela 2003, Cullen et al. 2000). Finally, communication facilitates the creation of an atmosphere based on support and respect between the collaborating parties (Morgan and Hunt 1994).
- ***External sources of knowledge:*** Several studies refer to external sources of knowledge as an antecedent of the ACAP (Cohen and Levinthal 1990, Zahra and George 2002, Todorova and Durisin 2007). These sources include acquisitions of licenses, contractual agreements (Granstrand and Sjolander 1990) and interorganizational relationships (Vermeulen and Barkema 2001). However, exposure to such sources of knowledge does not guarantee that an organization would increase its absorption level (Matusik 2000). Consequently, the impact of external knowledge sources is considered through the organization's openness in its quest for new knowledge (Laursen and Salter 2004). Openness reflects the organization's effort in acquiring a wide range of potentially useful knowledge from all possible sources (Laursen and Salter 2006).

Following this literature review, we retain the <u>coordination</u> and <u>system</u> capabilities as antecedents to the ACAP. Moreover, we propose the concept of <u>openness</u> to refer to socialization capabilities, collaborative capability and openness in terms of external sources of knowledge. The term openness was precisely suggested by Laursen and Salter (2006) to describe the attitude that an organization must have to gather useful external knowledge. However, this term seems also appropriate to describe the socialization and the collaborative capabilities. On the one hand, socialization capabilities aim at achieving a collective understanding of the knowledge exchanged between individuals by federating them around a common ideology (Van den Bosch et al. 1999). To adhere to this shared cognition, the individual must be open-minded to the ideas of others, their opinions and visions (Bonito 2004). Moreover, in an interorganizational context, collaboration also requires mutual commitment, respect and trust, which reflect "the openness of the [individual] to the potential creation of value through exchange and combination"(Nahapiet and Ghoshal 1998, p.255).

<u>2.3.4 Operationalizations of the absorptive capacity</u>

Since its introduction by Cohen & Levinthal (1990) and parallel to its theoretical evolution, the concept of ACAP has been widely used in empirical research which investigated it at an intra-organizational level of analysis with a special focus on individuals (Ter Wal et al. 2011), or on units (Flatten et al. 2011; Jansen et al. 2005), but also for an organization embedded in an interorganizational context (Lane & Lubatkin 1998). These studies fall into 3 different research streams. First, some researchers aimed at identifying its contingent contextual elements and its antecedents (Nooteboom et al. 2007; Lichtenthaler 2009; Roberts et al. 2012). Second, we distinguish those that demonstrated its effects on different types of performance (Tsai 2009; Stock et al. 2001; Vinding 2006). Finally, some studies solely tried to develop instruments to measure it (Jiménez-Barrionuevo et al. 2011; Gold et al. 2001). The diversity of the contexts and the methods used in these empirical studies induced different ways to describe the ACAP. There is no standard operationalization, especially since each study relies on a different theoretical framework.

- We first distinguish studies that used the ACAP in a ***qualitative manner***. Such approaches provide insights into the changes of the construct in different contexts. At a firm level, Kim (1998) focused on its role in the historical development of firms, changes over time as well as causes and consequences of these changes, while Jones (2006) adopted a routine-based perspective and emphasized on some of its specific processes that enhanced the firm's performance. Other researchers explored the effects of the ACAP in interorganizational collaborative projects, such as Easterby-Smith et al. (2008) who widely referred to some of its useful mechanisms for a successful interorganizational knowledge transfer, or Yang et al. (2012) who explained how its interactions with social capital fosters the success of a cross-organizational project.
- On the other hand, we distinguish two different types of approaches to the ACAP from a quantitative standpoint. This research stream includes large-sample empirical work, which estimates the significance and value of the ACAP. The first type encloses studies that considered the ACAP as ***a unidimensional construct and measured it using single item proxies*** (Evangelista & Mac 2016; Xie et al. 2016) or ***multiple-item ones*** (Pamukçu & Sönmez 2011). Nevertheless, the content of these proxies (R&D efforts, Professionalism of R&D, R&D human capital, patents etc.) contributed to conflicting and misleading findings about the nature of the ACAP. For example, companies differ in their propensity to patent their innovations and their patents differ greatly in terms of their knowledge content (Coombs & Bierly 2006). Hence, the use of this proxy underestimates the firm's ACAP.
- The other type of studies that followed a quantitative approach to operationalize the ACAP considered its definition as a ***multidimensional construct comprising different sets of capabilities***. Nevertheless, each author based his

operationalization on a different conception of what dimensions would holistically describe the ACAP. The majority of them rooted their studies in one of the theoretical frameworks proposed either by Cohen & Levinthal (1990), Zahra & George (2002) or Todorova & Durisin (2007). Others suggested personalized conceptions and even introduced new dimensions such as Lichtenthaler (2009), who conceived the ACAP as the combination of external knowledge recognition, transmution, assimilation, maintenance, reactivation and application. Within these studies, some authors proposed measures to all of their ACAP dimensions (Chauvet 2014; Flatten et al. 2011; Jiménez-Barrionuevo et al. 2011; Camison & Forés 2010), while others chose to restrict their analysis to specific ones (Fosfuri & Tribó 2008). Among these studies, few explored the ACAP of an organization in long term strategic relationships such as joint ventures (Thuc Anh et al. 2006) or strategic alliances (Jiménez-Barrionuevo et al. 2011), where the innovative benefits are perceived at an individual level. And none of them investigated the ACAP in interorganizational contexts where the innovative benefits can only occur if they are mutually reached, i.e. collaborative innovation networks (CINs). In fact, in these contexts, the ACAP is necessarily evaluated at the relationships' level, since none of the collaborating organizations will be able to generate any individual benefits unless it contributes in accomplishing the mutual one. In the other interorganizational contexts (Strategic alliances, joint ventures), the ACAP can only reflect each partner's ability to acquire the learnings stemming from the relationship and to exploit them for its own benefits regardless of the other partners.

All of the multidimensional studies developed valid and generalizable operationalizations that are adequate to their contexts, which were used by other researchers in their empirical investigations. Nevertheless, the inexistence of suitable ACAP operationalizations for interorganizational innovation contexts that require a collective contribution, i.e. collaborative innovation networks (CINs), compelled academics in this research stream to adjust measures that were developed and validated in other different contexts. In this sense, we might cite Fayard et al. (2012) who studied the ACAP in a collaborative supply chain and used the measures developed by Tu et al. (2006) at an intra-organizational level. But sometimes the adapted measures are not suitable for the new context and might ignore aspects of knowledge mobilization that are critical. For example Monferrer et al. (2015) used the intra-organizational generic scales of Chen et al. (2009) in a CIN context and didn't consider the role of boundary spanners (Tushman 1977) who are central in interorganizational contexts, as they facilitate the exchanges that take place among their actors (Peng & Sutanto 2012). ***Consequently, the ACAP depends on the context in which it is deployed and should be operationalized in this regard, as stated by Lane et al. (2006, p.858): "Absorptive capacity should be empirically explored in non-R&D contexts using metrics that capture each dimension of the absorptive capacity process in a manner appropriate for that contexts". This is mainly due to the fact that both knowledge (Galunic & Rodan 1998; Nonaka et al. 2000) and organizational practices (Lewin et al. 2011) are context specific. In this mindset, and since the previous operationalizations are not adequate to our context as they lack a crucial collective aspect of the ACAP, this research aims at uncovering this theoretical gap and proposes a comprehensive ACAP operationalization for an SME embedded in a CIN, through the construction of a maturity grid.*** The literature background related to these grids will be presented at a further section (2.5).

Although these multidimensional measures are not completely applicable to our research object, they suggest practices that can be mobilized. ***Therefore, we carried out an analysis of the 420 practices proposed by all these studies:***

- As explained in paragraph 2.3.1, the authors of these measures do not agree on the dimensions that holistically represent the ACAP. ***Therefore, to analyze the practices they propose, we classified them according to our 3 retained dimensions (Acquisition, Assimilation, Application) previously introduced.***
- In addition, for each dimension, ***we categorized the practices that compose it according to the ACAP antecedents that we identified in the literature, namely system capabilities, coordination capabilities and openness.***
- Finally, a new category of antecedents, namely ***alertness*** regarding the types of knowledge to be acquired, regarding critical assimilation aspects and regarding the necessary knowledge applications emerged from this analysis. ***We have therefore integrated this fourth category of antecedents.***

We will introduce in section 5 the results of the analysis of the existing measures in the literature and will highlight the practices that were adapted from previous studies, describing each dimension and each category.

2.4 The innovation of an SME embedded in a CIN from the perspective of interorganizational learning

This thesis is based on the conceptual framework of the absorptive capacity, that stems from the dynamic capability approach and the knowledge based view. Indeed, several studies have apprehended the ACAP from a cognitive perspective, considering it as a learning capacity (Kim 1998, Cohen and Levinthal 1990, Lubatkin et al. 2001, Lane and Lubatkin 1998). More particularly, studies in this research stream that focus on interorganizational contexts such as the CINs develop a contextual approach. In fact, they argue that the ACAP is a relative concept, which depends on the characteristics of the dyads involved in the absorption process (Nooteboom et al. 2007, Kim and Inkpen 2005, Reagans and McEvily 2003). We introduce in this section the contributions of the conceptual framework of interorganizational learning to our research question.

2.4.1 Definitions and types of interorganizational learning

While several studies have focused on organizational learning, there is little research on interorganizational learning or what Lane (2001) calls external learning. This lack has also been identified by Crossan et al. (1995) and Easterby-Smith et al. (2008), which led them to propose a fourth level of learning, in addition to the perspectives centered on the individuals, the group and the organization, which they called interorganizational. Since then, this concept was gradually established among the research community. Lubatkin et al. (2001) propose four types of interorganizational learning relationships:

- ***Vicarious learning relationships:*** They are defined as arrangements that involve learning through observation in order to acquire relatively concrete and explicit knowledge. Many benchmarking agreements fall into this category, as do non-collaborative buyer-supplier relationships.
- ***Knowledge absorption relationships:*** They rely on a one-way transfer of abstract know-how and represent an important learning challenge for the learning organization. We find these types of relationships in joint ventures and franchises.
- ***Merger and Acquisition relationships:*** If an organization believes that the knowledge held by another one has an important strategic value, it can obtain it by acquiring the organization that holds it. This learning is described by Huber (1990) as grafting. This logic of transfer is directly related to the transaction costs economic, which suggests using hierarchical interorganizational modes such as market relations or long-term contracts (Williamson 1991).
- ***Reciprocal learning relationships:*** Lubatkin et al. (2001) define reciprocal learning as "the blending of knowledge and skills by firms to jointly develop new knowledge, capabilities, or products" (Lubatkin et al. 2001, p.1354). According to the authors, the main objective of organizations that engage in a reciprocal learning relationship is not to acquire knowledge from one another but to exploit their capacities in order to jointly develop products or services which none of the partners could develop individually. These relationships aim to support a more targeted and intensive exploitation of the capacities of each organization that would have been difficult to imitate or acquire through a purely commercial transaction (Grant and Baden-Fuller 2004, McEvily and Marcus 2005). Partners learn to "learn" together and learn to exploit shared knowledge that makes them interdependent in the form of new products or services (Pavlovich and Corner 2006, Dyer and Nobeoka 2000).

2.4.2 Delimitation of the interorganizational learning by an SME embedded in a CIN

According to the previous definitions, ***reciprocal interorganizational learning seems to reflect the main objective of a CIN.*** The latter represents a form of access to external knowledge through the combination of knowledge of different organizations to jointly generate new mutually beneficial capacities, knowledge and products (Inkpen and Beamish 1997, Lubatkin et al. 2001). Grant and Baden-Fuller (2004) assimilate these relationships to an exploitation activity (March 1991) centered on "deploying existing knowledge to create value" (Grant and Baden-Fuller 2004, p.64). However, the authors emphasize that some actors in these collaborative relationships can also be motivated by their desire to acquire the knowledge held by their partners. Grand and Baden-Fuller (2004) consider this knowledge quest as an exploration activity (March 1991), which is mainly used to "increase an organization's stock of knowledge" (Grant and Baden-Fuller 2004, p.64). This activity refers to knowledge absorption (Lubatkin et al. 2001) or ***one-way learning*** (Lane and Lubatkin 1998) and ***represents the ability of an organization to acquire and exploit the knowledge developed by a partner to serve its own benefits*** (ibid).

The simultaneous presence of these two types of learning can generate a 'competition for learning' where each alliance member seeks to learn at a faster rate than its partner in order to achieve a positive balance of trade in knowledge (Hamel 1991). Such situation can lead to an opportunistic behavior which risks creating conflicts, inhibiting mutual trust and hindering the development of collective goals (Inkpen and Beamish 1997). ***In contrast, by conducting reciprocal and one-way learning actions simultaneously, an organization would adopt an ambidextrous innovation strategy*** (Raisch et al. 2009, Raisch and Birkinshaw 2008, O'Reilly and Tushman 2008, Jansen 2005). ***The latter allows it to generate a maximal profit by accessing the best of both worlds*** (Gibson and Birkinshaw 2004, He and Wong 2004).

Hence, we advocate that a one-way learning must take place in order to allow the SME to derive a maximal benefit from its collaborative experience (Grant and Baden-Fuller 2004, Argote and Ingram 2000). This is a compromise between the SME being a good partner and trying to win the learning race (Hamel 1991). Indeed, being only a good partner creates a risk of exploitation by others, especially when they have the capacity to absorb large volumes of information that maximize their individual benefits via the network (Larsson et al. 1998). This one-way learning is more a vicarious one (Bapuji and Crossan 2004), that is, it is not necessarily communicated and shared with the other actors of the network. In fact, Inkpen (1998, p. 72) observed that: "In some alliances, partners aggressively seek to acquire alliance knowledge while in others; the partners take a more ***passive*** approach to knowledge acquisition". ***The SME acquires knowledge through observation and interaction with its partners, without directly engaging them in the pursuit of its own interests*** (Iyer 2002).

Hence, this research aims at identifying the absorption practices that an SME can implement, together with its partners, to contribute to the achievement of a common innovation objective (reciprocal learning), but also the

practices enabling the SME to explore new knowledge that is potentially useful to improve the performance of its own organization (one-way learning).

2.4.3 Types of knowledge to be learnt in by an SME embedded in a CIN

Collaborative innovation networks constitute reciprocal learning relationships in which several types of knowledge are exchanged and mobilized by the partners to generate a mutually beneficial innovation (Lubatkin et al. 2001). Sammarra and Biggiero (2008) proposed a typology of these knowledge:

- First, most research on CINs argue that access to complementary technological knowledge is by far the main reason why organizations collaborate (Vanhaverbeke et al. 2002). Knowledge and skills are required for the product development process, and include both scientific knowledge and experimental one (Howells et al. 2003).
- Second, managerial knowledge includes the skills and know-how needed to effectively coordinate resources and processes. This type of knowledge also includes strategic networking capabilities (Hagedoorn et al. 2006), which can be a crucial source of competitive advantage and critical to the success of the innovation process (Inkpen and Tsang 2005).
- We finally distinguish marketing knowledge, defined as organized and structured information around the market (Li and Calantone 1998). They include knowledge of the characteristics, preferences and needs of the clients that organizations have to satisfy. This knowledge is exchanged between the partners (Choi and Lee 1997, Simonin 1999) and integrated into their common goal (Marinova 2004).

In a CIN, a partner can also conduct a one-way learning. According to Chen and Li (1999), an organization can learn through an interorganizational relationship two types of knowledge: Content knowledge and process knowledge:

- Content knowledge includes technologies, manufacturing capabilities, marketing skills and other functional knowledge. Chen and Li (1999) argue that in an increasingly dynamic environment, technological capabilities achieved through interorganizational relationships can help an organization to expand its own capabilities. In addition, the acquisition of marketing knowledge can help it identify new emerging market opportunities. Similarly, the acquisition of external supply chain knowledge can help the organization's new product development activity, which requires high quality and low cost manufacturing.
- An organization can learn two types of process knowledge: Collaboration management and innovation project management. Several studies have shown that organizations with prior experience in strategic alliances can successfully negotiate contracts, manage inter-partner relationships and resolve difficulties of cooperation (Doz 1996, Hamel 1991, Ring and Van de Ven 1994). Moreover, since these relationships involve a large number of functional domains, they generate valuable knowledge about the management of product development processes (Brown and Eisenhardt 1995, Dougherty 1992).

This literature review shows that previous studies agree on the areas of knowledge that are beneficial to the generation of innovation within a network, but also to serve the one-way learning intentions of an organization. These areas include technical and technological knowledge, manufacturing/supply chain, marketing, innovation project management and collaborative relationship management (Sammarra and Biggiero 2008, Chen and Li 1999).

2.4.4 Factors impacting the interorganizational learning by an SME embedded in a CIN

✓ **Characteristics of the necessary external knowledge**

The literature gives an important consideration to the effects of knowledge attributes on the ease of learning (Szulanski 1996, Simonin 1999, Kogut and Zander 1992, Minbaeva 2007). In this regard, Henderson and Clark (1990) differentiate between component knowledge that reflects knowledge of the content of a component, and architectural knowledge that represents how it can be integrated and aligned with other components. Sanchez and Mahoney (1996) suggest that the development of an innovation requires knowledge about components as well as architectural knowledge about their interactions. When this knowledge is transmitted, the component one would be relatively coherent and definable (McGaughey 2002). Also, Henderson and Clark (1990) argue that organizations may have more difficulty absorbing architectural knowledge than component one. This does not mean, however, that all component knowledge is easy to integrate (Tallman et al. 2004).

These properties of knowledge particularly affect the mechanisms necessary for learning (Mazloomi and Jolly 2013, Prévot 2005, Prévot and Spencer 2006). Grant and Baden-Fuller (2004) argue that in order to achieve a common goal, partners must coordinate their activities using guidance mechanisms, where each specialist sets rules and guidelines to guide the other actors. ***Therefore, the more the reciprocal learning by the SME within the CIN requires the integration of component and architectural knowledge from its partners, the more it will have to set up interactive communication mechanisms with them, for example by establishing common rules to facilitate the articulation of knowledge and agreeing on a sequencing to be respected (Grant 1996).***

✓ **Characteristics of the dyads regarding the reciprocal learning**

Other factors affecting the interorganizational learning are specific to the dyads involved in it. According to Nooteboom et al. (2007), this process requires that the partners share perceptions and consequently possess coherent cognitive schemes: "For organizations to achieve a common purpose, [...] they need to share certain basic perceptions and values to sufficiently align their competencies and motives. This requires a certain shared 'interpretation system' (Weick 1979 1995), 'system of shared meanings' (Smircich 1983) or organizational 'focus' (Nooteboom 2000), established by means of shared fundamental categories of perception, interpretation and evaluation inculcated by organizational culture (Schein 1985). Differences in such organizational focus yield cognitive distance between firms" (Nooteboom et al. 2007, p.1017). Moreover, these differences in social and cognitive structures at the beginning of an interorganizational relationship largely determine its evolution path (Sedaitis 1998). In this sense, Lubatkin et al. (2001) have highlighted the characteristics of this ***cognitive distance*** that promote the success of a reciprocal learning relationship:

- First, the authors assert that the ability to co-learn and discover together depends on ***the similarity of the general knowledge base of the partners.*** They suggest that the recognition and mutual appreciation of their specific knowledge requires from the partners to be familiar with the semantics, episodes and articulable rules that underpin the knowledge structures of each of them
- Then, Lubatkin et al. (2001) argue that the ability to co-learn and discover together depends on ***the similarity of values and institutional routines of the partners***. These values can often be deduced from observable organizational practices (Schein 1985), for example the compensation practices of an organization (Balkin and Gomez-Mejia 1990), and the distribution of tasks and responsibilities among its members, which can influence its way to innovate and solve problems (Walsh and Ungson 1991).

In addition to these two criteria specific to the cognitive distance between partners, Lubatkin et al. (2001) emphasize that reciprocal learning is favored by the ***heterogeneity of their activities***:

- On the one hand, effective reciprocal learning requires the ***abstract knowledge (i.e. expertise) of the partners to be different.*** The relationship is best served when the overlap between their skills is minimal. Too much similarity of their expertise would limit the potential benefits of the relationship (Saxton 1997).
- On the other hand, the success of the relationship is favored when the partners have similar strategic motivations (Saxton 1997) but ***different business objectives***. The partners must integrate the relationship with the willingness to cooperate, to co-learn and to discover together the way each of them can better meet its own commercial objectives without invading the markets of its partners (Lubatkin et al. 2001)

✓ **<u>Characteristics of the dyads regarding the one-way learning</u>**

As for the one-way learning, Lane and Lubatkin (1998) define an organization's ability to learn from a partner as its relative absorptive capacity regarding this partner, that is, its ability to identify, assimilate and apply new knowledge from the latter.

- Similarly to the reciprocal learning, Lane and Lubatkin (1998) assert that the absorption of knowledge depends on the ***similarity of the partners' general knowledge bases***. Indeed, understanding the basic knowledge allows the learning organization to understand the assumptions that shape the key competencies of its partner and thus have a critical judgment to evaluate the importance of its partners' knowledge for its own operations (Ahuja and Katila 2001).
- Also, this type of learning is favored by ***the similarity of their institutional values and their organizational routines***. If one student organization wishes to learn some of the valuable knowledge held by another, the student's propensity to internalize that knowledge is favored when their organizational structures are similar.
- In addition, Lane and Lubatkin (1998) emphasize that the ***specific expertise of the teaching organization must be sufficiently different*** to enable the learner to use effectively and creatively new knowledge.
- Finally, unlike reciprocal learning, the authors suggest that the one-way interorganizational learning is encouraged by the ***similarity of the partners' business objectives***. Indeed, this makes it easier for the learning organization to find commercial applications for knowledge newly acquired from its partner. This difference regarding the reciprocal learning may be a source of a dilemma for an SME embedded in a CIN. ***The latter should therefore be able to establish a balance in order to benefit from its exploitation and exploration initiatives in this coopetative situation (Fernandez et al. 2014, Stadler et al. 2016).***

Consequently, several factors facilitate the reciprocal and the one-way interorganizational learnings. Hence, their absence will incite the SME to provide more efforts in order to successfully conduct these two learning perspectives, in other words to intensify its reciprocal (Lubatkin et al. 2001) and one-way (Lane and Lubatkin 1998) absorptive capacity.

The implications of the literature review introduced so far to our research question are summarized in Figure 1.

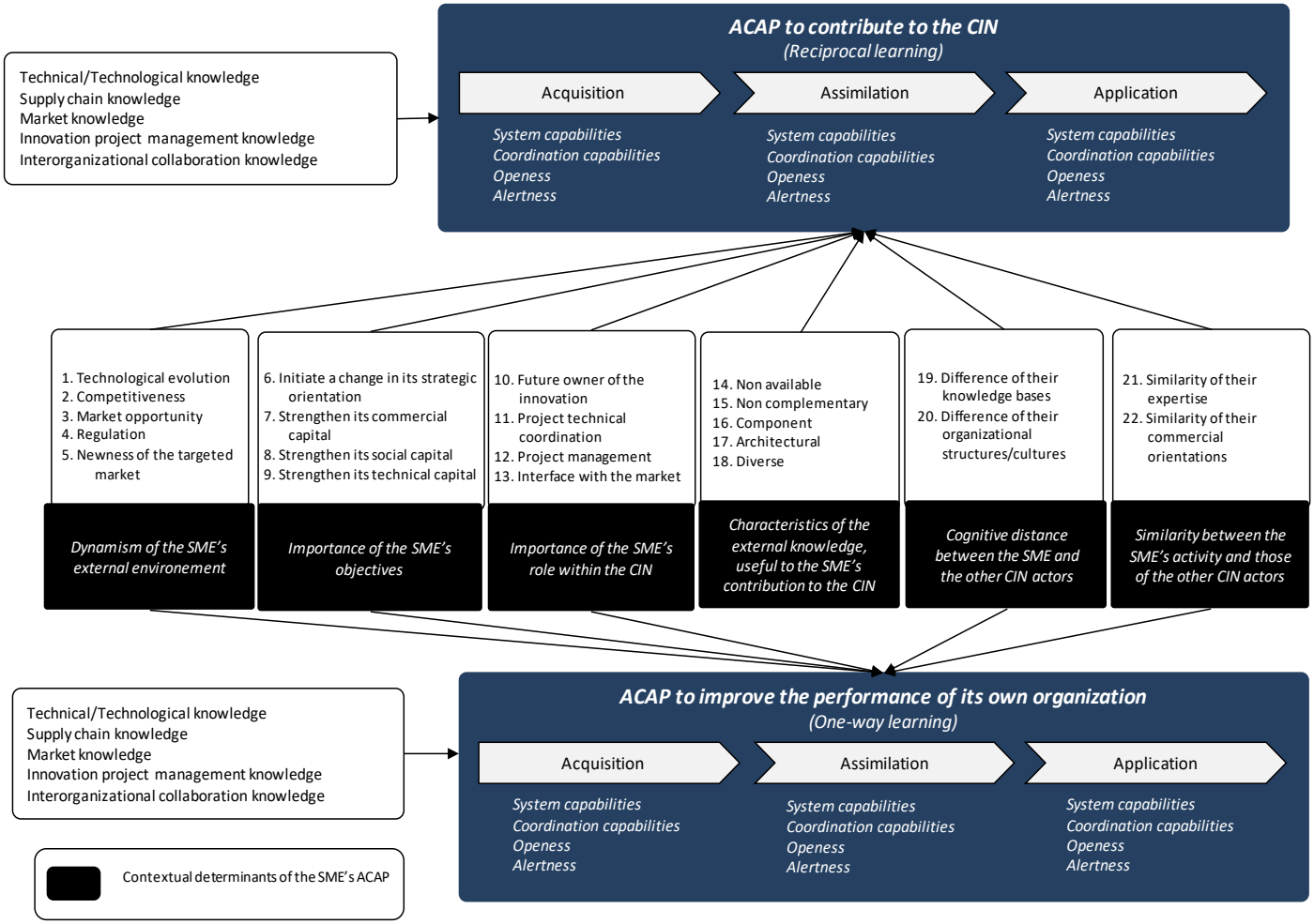

Figure 1 - Implications of the literature review to our research question

The next section presents a state of the art regarding maturity grids, which we aim to mobilize in order to operationalize the ACAP of an SME embedded in a CIN.

2.5 The choice of a maturity grid to operationalize the ACAP of an SME embedded in a CIN

2.5.1 The notion of maturity in the academic field

When discussing the concept of maturity, it is important to provide definitions as the language can be confusing. Broadly speaking, there is reference to two of its different aspects. First, maturity may refer to something or someone as having reached the state of completeness in natural development or growth. Second, there is reference to the process of bringing something to maturity, "to bring to maturity or full growth; to ripen" (Oxford English dictionary 2009). It is the latter definition, which stresses an evolutionary process leading to maturity that interests us in this research. This approach to maturity has been widespread in several academic fields that propose the development of maturity assessment models.

First, Paulk et al. (1993, p.21) define process maturity as "the extent to which a process is explicitly defined, managed, measured, and continuously improved". The notion of organizational maturity is also widely mobilized. This is particularly the focus of CMM softwares, which are based upon the idea that organizations advance through a series of five stages or levels of maturity from an initial level to an optimizing one (Dooley et al. 2001). As for project maturity, research in project management shows variations in how maturity is conceptualized. One way to determine a mature project is by looking at what organizations and people are doing operationally (Kwak & Ibbs 2002). Skulmoski (2001) goes further to include the organization's receptivity to project management.

Similarly to Skulmoski (2001), several authors have included multiple criteria in order to evaluate maturity. They conceive it as a composite notion, including the effective mastery of the processes, but also the attitude of the individuals within the organization regarding these processes. In this sense, Andersen and Jessen (2003) describe maturity as a subjective measure combining action (ability to implement activities), attitude (willingness to implement them) and knowledge (consciousness of the impact of the activities' implementation). The authors emphasize, however, that even if knowledge seems to be a decisive parameter, it must be supported by actions and attitudes. Also, Le Dain et al. (2008) in their maturity tool assessing collaborative design with suppliers, perceive maturity as the combination of the organization's effective ability to implement the practices, but also the organization's open-mindedness with respect to these practices.

Therefore, we agree with this conception of maturity to evaluate the ACAP of an SME embedded in a CIN. Following the proposal of Fraser et al. (2002), we consider maturity as the existence of the practices and the attitude of the SME towards them. This implies that the absorption practices are evaluated according to the capacity and the willingness of the SME to perform them (Andersen and Jessen 2003, Le Dain et al. 2008). This double assessment responds to Bach (1994)'s criticism of neglecting the human dimension in the evaluation of maturity.

2.5.2 Definition of maturity models

The fundamental underlying assumption of maturity models is that a higher level of maturity will result in better performance (Dooley et al. 2001). Maturity models reflect the degree to which key processes or activities are defined, managed and executed effectively to produce reliable results. ***They have in common the definition of a set of process areas that are mutually exclusive and collectively exhaustive to describe the object of the model*** (Maier et al. 2012). ***Each process area is defined through associated practices, implemented collectively, so as to satisfy a set of goals considered important for making improvements in this area. These process areas are described at a number of different levels of performance*** (Fraser et al. 2003, p.1500): "At the lowest level, the performance of an activity may be rather ad hoc or depend on the initiative of an individual, so that the outcome is unlikely to be predictable or reproducible. As the level increases, activities are performed more systematically and are well defined and managed. At the highest level, 'best practices' are adopted where appropriate and are subject to a continuous improvement process".

Even though they are based on self-reports, these models provide an instantaneous snapshot of a situation and a framework for defining and prioritizing improvement measures. Their key strengths include a simple use as they don't require complex quantitative analysis, a possible application to both functional and cross functional perspectives, and a possible implementation by external auditors or through self-assessment (Boughzala & de Vreede 2015). Two different types of maturity models can be distinguished, for instance models affiliated to CMMI (Capability Maturity Model Integration) and maturity grids.

2.5.3 CMM/CMMI

The first CMM (Capability Maturity Model) was developed for the field of software engineering in 1991 by the Software Engineering Institute (SEI) in response to the request of the US Defense department, in order to assess the ability of software suppliers to deliver a product that is compliant with department requirements in terms of cost, quality and time. Since then, other complementary or competing models have been developed, such as systems engineering, personnel management and product development and process integration. The multiplicity of these models engendered some confusion as it wasn't enabling the process rationalization that was initially targeted by the CMM tool. Therefore, in 2006, SEI developed the CMMI (Capability Maturity Model Integration) integrating these different models. The main objective of the CMMI model is to provide a framework of best practices to be implemented in order to improve the processes that are necessary for the development and the maintenance of a product or a service. It proposes to evaluate 22 process areas (Appendix 1, p.699). For each one, the main objectives to be reached and the practices to be applied by the organization to achieve these objectives are described. The model proposes to evaluate these process areas according to two different representations: Continuous or staged.

The continuous one uses capability levels to characterize an organizational improvement that is related to a process area. Indeed, in this representation, the 22 process areas are organized into four categories: process management, project management, engineering and support. This representation allows the organization to choose one or several areas that it wishes to improve in priority so as to fulfill its strategic objectives. In the staged representation, the 22 process areas are organized according to maturity levels. Indeed, this representation requires an implementation order of the process areas according to five maturity levels that determines the improvement path to be followed by the organization. In this approach, the transition from an initial level of maturity to the following one requires mastering all the practices that are associated to each process area in the initial level. Thus the completion of each stage ensures that the organization possesses a strong foundation to initiate the next one and hence allows incremental and sustainable improvement.

Since its creation, CMMI has been considered as an international standard to evaluate maturity so as to instigate an improvement cycle. Nevertheless, it has been subject to several criticisms. A first one concerns the delay that is necessary for its effective implementation. In fact, this model's complexity requires it to undergo several adaptations following the objectives and priorities of the organization before implementing it (Fraser et al. 2002). Such adjustments engenders investments that are substantial for a great majority of industrial companies and especially for SMEs (Moultrie et al. 2007). Another criticism is about its lack of consideration of the human dimension. Indeed, the maturity of a process in CMMI is evaluated only through its formalization, control and optimization. Therefore, this model is centered on processes' evaluation and neglects the actors of these processes, especially their propensity to adhere to their implementation (Bach 1994).

2.5.4 Maturity grids

Maturity grids are often seen as an alternative to the complexity of CMMI and its affiliated models. They differ from CMMI based models which apply to specific processes like software development and acquisition. Indeed, a maturity grid can be applied to companies in any industrial field to assess any sort of processes. They have been applied to different fields such as R&D management (Szakonyi 1994), technical innovation (Chiesa et al. 1996) communication in product design (Maier et al. 2006), collaboration in product development (Fraser et al. 2003), product information (Sander & Brombacher 2000), product design in SMEs (Moultrie et al. 2013) etc.

Hence, maturity grids are designed to communicate some good practices in a simple and efficient way. Their construction is more flexible and is adjusted according to the characteristics of the studied phenomenon (Crosby 1979). It requires determining a set of process areas and their associated practices that the organization must master regarding the studied phenomenon. The process areas and the maturity levels are defined in relation to the evaluated phenomenon and do not rely on a predefined architecture as for the models inspired from CMM (Maier et al. 2012). The highest level of maturity corresponds to the ideal situation where best practices are applied and are culturally anchored (Fraser et al. 2002). In a maturity grid, there is no prioritization of any activity against the other ones, nor is there an aggregation of the process areas' scores in an overall rating of the maturity (Moultrie et al. 2007). The process areas are therefore evaluated independently of one another similarly to the continuous representation of the CMMI. There are two approaches to formulating a maturity grid: prescriptive and descriptive.

In the prescriptive approach, specific and detailed actions are proposed for each level of maturity of a process area. Indeed, for each process area, each maturity level is described in the form of a text of a few lines, corresponding to the way its associated practices should be performed (Austin et al. 2001). The descriptive approach consists in providing a general description of the n levels without providing a detailed description of the actions that would compose each level of a process area. The maturation path is explained by means of the logical relation between the successive levels (Pöppelbuss and Röglinger 2011). In this type of approach, a hybrid formulation combining the definition of maturity levels and the description of their instances according to a set of questions is often used: "It is equivalent to a maturity grid where the characteristics are described only for the higher level "(Fraser et al. 2002, p.246). The process areas are evaluated through a set of questions formulated as an expression of the best practices to be considered (Fraser et al. 2002). Thus, the respondent evaluates his performance of these practices, using a Likert scale ranging from 1 to n, n being the highest maturity level where the best practices are applied and are culturally rooted.

2.5.5 The adopted approach in this research

Following this literature review, ***we are adopting a grid perspective to build our maturity model***. In fact, as opposed to CMM based models, maturity grids represent a user friendly solution that enables an organization to quickly measure the gap between its current practices and the ones to be targeted (Maier et al. 2012). This makes them adequate to SMEs at the initiation phase of a CIN, since they need to promptly address their abilities' gap and instigate the needed improvement.

Moreover, we propose to construct a maturity grid following ***a descriptive approach***. Indeed, Maier et al. (2012) argue that it is easier to provide detailed descriptions of what should be done at distinct levels when the evaluated subject is more technical than social. Moreover, De Bruin and Rosemann (2005) point out that a prescriptive approach is more difficult when the subject of the evaluation has not been sufficiently addressed in previous studies following a vision of maturity. In our case, although the ACAP has a technical dimension, it constitutes a construct with a strong social connotation because knowledge is closely linked to the individuals and the collective that hold it (Binmore 1999). Moreover, this concept has never been operationalized following a maturity model approach. Therefore, we do not have any initial conception of the intermediate states of knowledge absorption.

However, it is necessary to complete this approach in order to evaluate the ACAP of an SME embedded in a CIN. Indeed, the way the SME would proceed to absorb knowledge depends on the context in which it is embedded. This context results from the combination of the ACAP contextual determinants (Figure 1). By relying only on the generally accepted design of the maturity grids presented in this section, we assume that all the process areas and the practices have the same weight for an SME embedded in a CIN. However, for a given absorption practice, the ideal level of maturity would not be the same for all situations of absorption by the SME. Some practices may be critical for certain contexts and have an auxiliary role in other ones. ***It is therefore necessary to consider the criteria that will help users to determine the ideal level of maturity for their contexts, so that to implement the appropriate methodological progression (Alami et al. 2015, Cronemyr et al. Danielsson 2013).*** However, the literature concerning the construction of maturity models remains relatively silent regarding the possible approaches to take into account their contexts of application (Mettler 2011, Mettler and Rohner 2009). In fact, instead of taking into account the factors that influence and differentiate the evolution towards maturity, these models usually rely on a path leading to the same final state (Röglinger and Pöppelbuss and 2012, Albliwi et al. 2014).

In this research, we first propose to construct a generic maturity grid to evaluate the ACAP of an SME embedded in a CIN. On the one hand, the grid includes the process areas composing this absorptive capacity and the practices that are

associated with each process area. On the other hand, it comprises a maturity scale to evaluate these practices. Then, we will rely on a quantitative approach to contextualize this generic grid according the absorption situation of the SME embedded in the CIN. This situation derives from the combination of the different ACAP contextual factors that are summarized in Figure 1. These approaches will be explained in more details in Section 4.

This section provided the theoretical basis for our research. Subsequently, we will discuss the other essential components of a scientific study, namely the epistemological (Section 3) and methodological (Section 4) foundations of our research.

3 Research epistemology

In the management sciences, the researcher's posture regarding the reality he tries to understand is at the heart of his reflection. Explaining this posture, called epistemological, gives the researcher legitimacy to his work and to the methodological choices which underlie it (Avenier and Gavard-Perret 2008). However, the epistemological questioning is not limited to the methodological reflection. It aims to clarify the conception of the knowledge on which the research will be based and, at the same time, the expected value of the knowledge to be developed during the research process (Gavard-Perret et al. 2012). ***In this regard, we suggest that the foundations of this thesis are based on the hypotheses of the critical realism, since this paradigm corresponds "best to our intimate conception of knowledge" (Avenier and Thomas 2012, p.23).*** We hereafter explain the way this research adheres to the founding hypotheses of this paradigm.

3.1 Critical realism

From an ontological point of view, the critical realism postulates that laws exist independently of the individual's ability to perceive them. This reality is not easily reducible to our perceptions and experiences of it. In fact, a distinctive aspect of the critical realism is the idea of reality stratification into three interrelated domains (Bhaskar 1989): the *real* where the generating mechanisms reside, i.e. the rules that govern the occurrence of events; the *actual* which includes events occurring when the generating mechanisms are activated regardless of the fact that an individual observes them or not, and the *empirical* which represents the human perception of the *actual*.

As for as the epistemic dimension, this paradigm posits that what is knowable is the *empirical* reality. The objective of the knowledge creation process in the critical realism is to identify the generating mechanisms residing in the *real* and their activation modes engendering events in the *actual*. This paradigm recognizes that this profound reality cannot be easily apprehended as the research methods are fallible and the cognitive abilities of the researcher are limited (Gavard-Perret et al. 2012). He thus postulates an epistemic relativism admitting that the knowledge of the profound reality is always local and historical (Mingers et al. 2013). However, this epistemic relativity should not make the researcher lean towards an ethical relativity. The aim of science is to develop a real knowledge of this world; therefore the critical realism recognizes the necessity of objectivity in the sense of an ideal to be attained (Robert and Riddle 2013).

Also, the critical realism adopts a conception of the reality as an open system, i.e. a system that admits multiple explanations through several generating mechanisms (Bhaskar 1998). To identify the mechanisms generating this reality and explain their activation modes, it is necessary to take into account various internal and external conditions (Collier 1994), in particular social, organizational, environmental and technological contextual factors, which can play a causal role in the occurrence of the observed phenomenon (Wynn and Williams 2012).

To identify and explain the activation mode of the generating mechanisms, the critical realism adopts a recursive abductive reasoning based on an induction / abduction / deduction loop (Van de Ven 2007). Indeed, unlike induction, abduction is not intended to establish generic laws explaining the similarity of empirical observations, but rather to identify the plausible causes of the observed phenomena, by mobilizing all the available information, even if they are heterogeneous. In this abductive process, as new conjectures are developed, unobservable mechanisms can be observed by the development of new instruments or measures in later phases of research.

3.2 Our research with regard to the founding hypotheses of the critical realism

In the critical realism, "the fundamental purpose of the knowledge process is to identify the generating mechanisms, as well as to understand their activation mode according to different possible intrinsic and extrinsic circumstances" (Gavard-Perret et al. 2012, p.33). Accordingly, our research responds to the hypotheses of the critical realism as explained below:

- ***We consider that the ACAP represents the generating mechanisms that explain how the SME achieves the objectives of its participation to the CIN (Financial gain, learning, competitive advantage etc.). This capacity prevails regardless of the fact that the researcher studying the SME's participation to the CIN is aware of it, and of the fact that there are any apparent manifestations of it.***
- ***The intrinsic circumstances are linked to the internal operating rules of the generating mechanisms. They represent, in our case, the structuring of the absorption practices in successive distinct dimensions, which take place in an iterative way. The SME acquires external knowledge, then assimilates and applies it. In addition, it will implement this process as long as it needs to mobilize external knowledge.***

- ***On the other hand, extrinsic circumstances depend on the specific contexts in which the mechanisms operate. In our case, they refer to the different situations of an SME's participation to a CIN, induced by the ACAP contextual factors.***

These points explain the adequacy of our research to the founding hypotheses of the critical realistic paradigm. This epistemological positioning enabled us to progressively establish an adequate methodological approach to identify the generating mechanisms and their modes of activation. Indeed, the coherence between the choice of an epistemological posture and the transition to instrumentation is essential to produce valid and reusable scientific knowledge (Charreire Petit and Durieux 2007). We explain in the following paragraph this transition by highlighting the integration of our methodological choices in our reasoning.

4 Research methodology

The objective of this research is to construct a maturity grid enabling an SME embedded in a CIN to assess its absorptive capacity. ***In order to achieve this purpose, we mobilize a mixed methodology, i.e. an approach using qualitative and quantitative methods to understand a particular phenomenon (Johnson and Onwuegbuzie 2004).*** According to Venkatesh et al. (2013), mobilizing a mixed method in a research enables to grasp the richness of a phenomenon, to offer a complete picture of it. Therefore, the use of such an approach is consistent with the objectives of this research. Indeed, by building an evaluation tool for the ACAP of an SME embedded in a CIN, our aim is to provide the most complete view of this concept and its peculiarities according to the contexts of the SME's participation to the CIN.

First, we used a qualitative approach to characterize the ACAP of an SME embedded in a CIN. Qualitative data are distinguished by "their richness and their encompassing character, with a strong potential to decipher the complexity; such data produce dense and penetrating descriptions nested in a real context" (Miles and Huberman 2003, p.27). Accordingly, ***employing a qualitative approach enabled us to generate a holistic view of the SME's ACAP through a set of practices. Moreover, it provided us with an initial understanding of the ACAP instances in some contexts where SMEs are embedded.***

However, Strauss and Corbin (1990) report that qualitative studies provide an understanding of the particular circumstances of a concept, but do not aim to understand all the situations. Our objective being to establish a refined conception of the ACAP of an SME embedded in a CIN in all its possible absorption situations, no qualitative approach would have allowed us to cover all these contexts induced by the combinations of the ACAP contextual factors. ***A quantitative study was therefore necessary in order to widen the results of our qualitative phase and provide the refined conception of the ACAP we seek to achieve in this research. This approach allowed us to predict the relevant ACAP practices according to the context in which an SME is embedded. The latter will then assess its maturity regarding these appropriate practices.***

Figure 2 summarizes our mixed methodological approach based on a qualitative phase followed by a quantitative one.

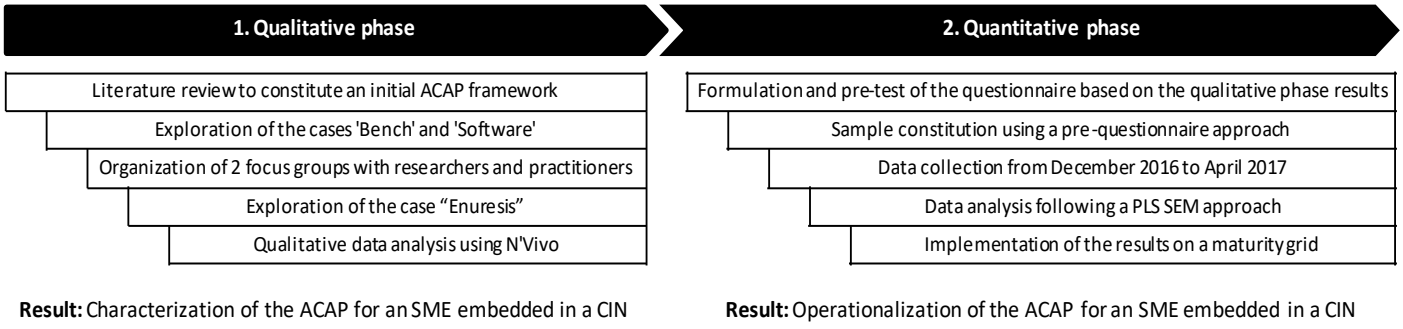

Figure 2 – Summary of the research methodology

4.1 The qualitative phase of the research

In order to initiate our field exploration, and as explained in paragraph 2.3.4, we closely examined the 420 ACAP practices that were identified in prior studies. Through this deductive qualitative approach (Patton 1990), we categorized the practices and concluded an initial framework of the ACAP (Figure 1). Then, we explored cases of CINs including SMEs to complete the literature outcomes. After conducting interviews and analyzing secondary data within two CINs, we generated an improved framework of the ACAP and organized two focus groups with researchers and practitioners to discuss and eventually enrich our propositions. Then, we explored a third CIN and the analysis of the whole data corpus helped us settle our ACAP framework. This methodological approach based on a case studies and discussions with experts is appropriate to perform exploratory research (Yin 2013) and to emphasize the validity of our findings (Eisenhardt & Graebner 2007). Hence, combining literature findings and empirical data enabled us to generate an ACAP generic maturity grid for an SME embedded in a CIN. In this section we will first describe the explored case studies and their selection

process. Next, we will present the followed analysis method of the data collected from these case studies. Finally, we will emphasize on the focus groups process and explain how they were conducted.

4.1.1 A data collection based on multiple embedded case studies

In this phase of the research, we rely on the study of ***three embedded cases*** (Bench, Software and Enuresis).

On the one hand, ***the multiplication of cases*** in our research is related to the nature of its object. The latter (the ACAP of an SME embedded in a CIN) is closely linked to the SME's context of absorption. The use of a multiple case study is necessary to take into account the effect of the context and to allow an analytical generalization of our results (Yin 2003). We do not intend to investigate a representative sample of the population of SMEs embedded in CINs, but rather cases that allow us to "highlight typical aspects of the object of study" (Ayerbe and Missonier 2007, p. 44). The multiplication of cases contributes to the enrichment of the ACAP theory and makes it possible to identify a certain number of keys favoring the transposition of our results (David 2004).

On the other hand, what characterizes an ***embedded case study*** is that investigations are conducted both at the level of the case and the unit of analysis (Hlady-Rispal 2009). This aspect is consistent with the nature of a CIN, which is a composite reality made up of actors of different natures and whose levels of interaction are pluralistic. Indeed, our research object (ACAP of an SME embedded in a CIN) depends on contextual factors that link the SME to the rest of the network actors (cognitive distance, similarity of activities, important roles occupied by the SME within the CIN). Such multilevel analysis reinforces the internal and the construct validities (Yin 2003, Musca 2006). In this sense, in addition to analyzing the ACAP of SMEs (Units of analysis) according to the contextual factors, we will investigate knowledge absorption at the level of each case (CIN) as a whole.

Table 1 gathers the characteristics of our three case studies which are described hereafter.

- ***Bench*** is the case that initiated our exploratory study. It was identified with the help of a researcher from the ACIC project team. Bench is a project which was initiated by a large industrial group in the military sector. This group wanted to build a test bench in order to simulate the braking capabilities of moving projectiles. Hence he contacted MB, an SME he knew from a previous collaboration on a past project. MB is an SME located in France, specialized in the production of mechanical pieces. The project was very profitable but represented a huge challenge for MB because the SME did not have the necessary expertise to realize it alone. The latter addressed, in her turn, a neighboring SME (MC) who is specialized in mechanical engineering. MC then coordinated the implementation phase and used its strong involvement in a regional mechanical cluster to recruit new partners who are experts in all the areas that are related to the targeted innovation, while MB assured all business interactions with the client. The network brought together 5 SMEs who have complementary competencies in several mechanical domains, namely special machinery, boiling, design and engine automation. None of the participants had an IP right over the resulting innovation as it was intended to a specific client for non-commercial use.
- ***Software*** is the second case of our exploratory study that was identified thanks to Thésame, an industrial partner of the ACIC project. Indeed, we were looking for a case that is complementary to the first one regarding the ACAP contextual factors. This project was born from an innovative idea, initially elaborated by a group of software development SMEs who knew each other through an industrial club in France. These SMEs possess complementary skills, each one being specialized in the development of industrial softwares in different areas such as quality management or security. During their usual interactions within the club, they figured out that, by putting together their different expertise, they could address a new market, namely the manufacturing execution systems (MES) market. Their idea was to produce the most possibly complete MES, containing functional blocks that will be developed by these SMEs according to the expertise of each one of them. To set up the project, the group first integrated ASSO; an SME specialized in innovation projects' coordination. Later, two university laboratories joined this network, and ensured the compliance of the solution to specific standards. The network thus gathered five SMEs in software edition, one SME in innovation project management and two research laboratories. The resulting innovation was initially meant to enable the creation of a new legal entity gathering its future owners. However, due to business model issues, it was independently appropriated by each one.
- One week after the second focus group, a third case ***(Enuresis)*** agreed to take part to our exploratory study. This case was identified following a social network monitoring process. Indeed, we were looking for a case that has analogies and differences with respect to each of the first two explored CINs, in order to carry out comparative analyzes of the practices that are mobilized in them. Enuresis is a project that was set up in response to a competition launched by the British Ministry of Research, through the SBRI (Small Business Research Initiative). It is a government process that connects public sector challenges with innovative ideas arising from SMEs. The SBRI was proposing one million pounds for the entity who is able to design an innovative idea preventing the problem of children bedwetting. After several competitive rounds, a network of actors led by FC, an SME who is specialized in computer programming won the challenge. This network gathers 5 SMEs who are experts in product design, programming, video games, regulatory issues, project management, but also academic researchers whose role is to design the hardware part of the innovation, a children's hospital that provides guidance towards the medical concepts and the preventive

measures, and is supported by a medical cluster. A legal entity gathering the different innovation owners is being created. At this moment, the first clinical trials are being carried out and the group of partners is discussing the commercialization strategy of the innovation.

Table 1 – Description of the case studies

	Bench	**Software**	**Enuresis**
Project starting date	2012	2007	2015
Project duration	1 year	5 years	Ongoing
Project location	Saint-Etienne, France	Haute-Savoie, France	Liverpool & Manchester, UK
Origin of the need of this innovation	Requested by an external client	At the initiative of a group of partners	Governmental challenge to come up with an innovative solution
Project budget	N/A	1 million and 46 thousand Euros	1 million pounds
Project financing source	The client	1 million gathered from regional incentives, and the rest provided by the future owners of the innovation	SBRI (The governmental entity responsible of the challenge)
Nature of the resulting innovation	Product	Product	Product
Sector of the resulting innovation	Mechanical applied to nuclear	Software applied to manufacturing industry	Digital applied to the medical sector
Number and natures of the project actors	5 SMEs, 1 Large group	6 SMEs and 2 research laboratories	5 SMEs, 1 university, 1 children hospital
Nature of the contractual relationships between them	Buyer-supplier contracts	Consortium agreement	Consortium agreement
Number of the innovation owners	1 (The large group)	5 (The software editors)	2 (The university and one SME)
Appropriation mode of the innovation	Appropriated by the client	Appropriated by the network actors intended to own it	Appropriated by the network actors intended to own it
Commercialization of the innovation	For internal use	Independently by each of the owners, according to commonly agreed competitive arrangements	Jointly through the creation of a common juridical entity gathering the owners

To explore these case studies, ***20 semi-directive interviews*** were conducted with the actors involved in them (Table 4.6, p.340). An interview guide (Appendix 2, p.702) was built-up in order to structure the interviews according to a series of themes (Gavard-Perret et al. 2012). This instrument is based on the theoretical elements presented in Section 2. It was tested with two researchers from the ACIC team before of its effective implementation during the cases' exploration. The data collected through these interviews was triangulated with secondary sources (websites, business documents, activity reports). This collection strategy was applied until data saturation was reached (Hlady-Rispal 2015).

4.1.2 Analysis of the data collected within the case studies

To analyze the collected data, 4 of the 7 interviews conducted in the UK and 11 of the 13 interviews conducted with the French cases were ***transcribed***. The other interviews did not represent rich empirical corpuses for our research purpose. Theses interviews were then grammatically sub-divided to enable their categorical analysis (Miles & Huberman 1994) and generate the targeted ACAP operationalization***. This generation was based on an inductive coding approach using N'Vivo*** (Appendix 7, p.716). Such approach promotes high levels of content and face validity. The sub-divided verbatims were tagged with codes that described the practices the SMEs within the CINs undertook to absorb external knowledge. Subsequently, we categorized the codes into higher-order categories and lower-order sub-categories and labeled them (Appendix 6, p.712). This approach resulted into the identification of the distinct absorption practices, but also the most consistent practices through their occurrence. In addition, the recordings were played and listened several times to circumvent any possible missing points. This methodological approach ensures the internal validity of our results.

By using the N'Vivo 10 software, we were also able to conduct ***a transversal analysis of the entire corpus*** resulting from our three embedded case studies. This analysis highlights the recurrences and regularities from one document to another within the total corpus (Gavard-Perret et al. 2012). Huberman and Miles (1991, p.271) argue that "in a multiple case analysis, the problem is to identify processes and outcomes found in each case and to understand how such processes are modified by specific variations in the local context". Our multiple embedded case studies aim precisely at identifying the patterns of absorption practices according to the contexts of the SME. Hence, we performed ***a comparison of the practices within the cases using matrix encoding requests under N'Vivo.*** When the entire data corpus is encoded, the software can compare pairs of elements and display the results in a matrix. At the intersection of columns and rows, the matrix indicates the number of coded nodes that can be opened to explore their contents. This analysis is used to

generate the results introduced in section 5.1.2. The software has been configured to display the absorption practices in the rows and the contextual factors in the columns.

Finally, we carried out a frequency analysis of the words in the whole corpus to ensure that we did not miss any regularity, in particular a highly mobilized absorption practice that we wouldn't have identified. The software has been set to display the 9999 most frequent words with a minimum length of 4 letters. This lexical analysis did not lead to a significant result for our research object.

4.1.3 Description of the focus groups' process

To discuss our propositions regarding the structure of the tool and its use, two restitution sessions were organized with the industrial partners, representatives of the four clusters that label the ACIC project and the SMEs that took part in the two first cases. These discussions enabled us to confirm the structure of the tool, i.e. the process areas and the maturity evaluation scale. In addition, we profited from these sessions to compensate for the difficulty of accessing additional field. In this sense, we organized ***two focus groups' exercises*** (Appendix 3, p.705) with the participants to eventually enrich the identified practices.

A focus group is a discussion of a particular topic under the direction of a moderator who promotes group participation and communication and manages the discussion through a series of interactions (McDonald 1994). It seeks to maximize time efficiencies, and to take advantage of possible synergies that the combined effort of a group will provide (Parent et al. 2000). In this respect, these focus groups enabled us to benefit from the diverse experiences of their participants in contexts that are similar to the one addressed in our study. We profited from the simultaneous presence of these experts to enhance our initial ACAP framework that was generated following the first case studies' exploration. The course of the different interaction times is explained in the following:

- The group was first introduced to some of the basic concepts of the ACAP and to examples of its practices that were identified following the exploratory phase.
- Subsequent to this unidirectional presentation, a brainstorming exercise was processed requesting the participants to come up with examples of absorption practices by attaching them to their previous experiences in CINs.
- Once the brainstorming exercise was achieved, each participant was requested to place the practices he came up with on a white board, according to the appropriate ACAP dimension and explain how these practices are connected to his prior experience. This exercise helped us confirm and enrich our framework of ACAP practices.
- At the end of the session, the maturity evaluation scale was discussed with the participants, to have their opinion concerning the most appropriate criteria to assess the ACAP.

Each focus group discussion was recorded and synthesized into a document that was sent to the participants for any further comments and feedback. These exercises did not bring us any new practices. On the other hand, they allowed us to confirm some previously identified practices in the literature and in the case studies, as will be explained in section 5.

4.2 The quantitative phase of the research

The qualitative approach allowed us to describe what Miles and Huberman (2003) call local causalities, i.e. causalities strongly marked by the context and the intrinsic characteristics of the studied cases. This is one of the limitations of the results obtained by a qualitative approach which, despite the use of the analysis of several contexts possibly increasing its external validity, are always linked to "a context that can be designated but not exhausted by a finite analysis of its constituting variables" (Passeron 1991, p.25). The quantitative approach we wish to develop is more in line with the logic of variance (Mohr 1982), which tends to explain a phenomenon as the product of independent variables and allows us to examine their relative effects and influences (Poole et al. 2000). Indeed, this approach enables the researcher to free himself from the particularities of the studied cases, and from individual representations, beginning with his own one, in an essential process of objectification (Martin 2012). Therefore, the quantitative methodology provides a greater objectivity due to the rigor and the accuracy of the statistical techniques that it uses (Baumard and Ibert 2007).

These statistical techniques allow us to obtain precise and reliable estimates from our data while considering that- in line with our critical realistic posture- error remains possible (Archer et al. 2013). We have sought to minimize this error by implementing robustness tests. In this section, we present the sample of respondents and then explain the statistical approach adopted to analyze the data collected from them.

4.2.1 A data collection based on an online survey

In order to complete our study, we had to interview respondents who belong or have belonged to SMEs and have experienced a CIN. Since we were unable to estimate and address our entire population, we adopted a survey approach. This method involves questioning a fraction of the population, i.e. the sample (Creswell 2009). To constitute our sample, we relied ***on an empirical sampling technique*** (Evrard et al. 2009). This convenience sample (Royer and Zarlowski 2007) is suitable when practical limits are encountered. In our case, since we didn't have any statistics regarding the number of

SMEs involved in CINs, it wasn't possible to elaborate a sample using a probabilistic technique. Hence, ***an initial questionnaire*** (Appendix 8, p.717) was sent out in July 2016 to the contacts of CGPME-Isère, four clusters (Imaginove, Minalogic, Viaméca, and Techtera) and Thésame, a specialist in supporting innovative SMEs. This diversity of the respondents' sources enables us to address various sectors with different levels of technological intensity and hence fosters the generalizability of our results. Following this approach, a sample of 50 potential respondents was constituted.

Based on the results of the qualitative phase, ***a survey*** was formulated with the help of 3 researchers from the ACIC team (Appendix 9, p.720). In order to maximize the responses' variance (Ulaga and Eggert 2006), the respondent was asked to ***choose an experience in a CIN considered to be successful in terms of benefit and learning, and a second one that was less successful. Therefore, a response refers to an experience of the SME in a CIN.*** This survey was then ***tested*** with 2 practitioners (Thésame and the CEO of an SME) and 2 academic experts other than the 3 who contributed to its elaboration (Forza 2002). Accordingly, minor changes regarding the formulation of the questions (clarity, vocabulary, etc.) were implemented.

The survey was then launched using the Computer Assisted Self-Administered Interview (CASI) method (Baumard et al. 2007). In this approach, the respondent discovers the questions by himself and answers directly online. We chose ***the Sphinx solution***, specifically Sphinx iQ2 for the survey design and Sphinx Online for its diffusion, as this tool offers advanced features and ergonomic interfaces. The questionnaire was sent by e-mail to the constituted sample (Appendix 10, p.727). In addition, it was shared with some interviewees from the case studies and relayed to our partners' contacts. Three reminders were required over a four-month period (December 2016 to April 2017) to get a sufficient number of responses.

Out of the 86 obtained answers, we selected ***72 which were exploitable***. These responses were provided by 61 participants. Some of them responded only for the positive or the negative CIN experience. A description of the sample composition is presented in Table 2.

Table 2 – Characteristics of the sample

SME's sector		**Respondent function**	
Electronics / Electricity	34%	General management	63%
Consulting	8%	Logistics	13%
IT / Telecommunications	20%	Production	19%
Mechanics / Precision mechanics	33%	Purchasing	4%
Textile / Clothing / Shoes	3%	Other	2%
Other	2%		
SME's size		**Respondent seniority**	
Less than 20 employees	20%	Less than 5 years	17%
Between 21 and 50	34%	Between 6 and 10 years	40%
More than 51	46%	Between 11 and 20 years	43%

4.2.2 Data analysis: A PLS SEM based approach

To analyze the collected data, we rely on ***Structural Equation Modeling (SEM)*** which is increasingly used in research in organizational theories (Hair et al. 2011, Sosik et al. 2009). These models allow introducing latent or unobservable variables, to specify the nature of the relationships between these variables and their measurements and to identify the type of links between these latent variables (Croutsche 2002). ***In our case, our ACAP dimensions and the 6 constellations of the contextual factors that impact them represent latent variables. These impacts embody the structural links between the variables.***

A latent variable can be represented based on a formative or a reflexive mode. In the first one, the items define the construct while they represent manifestations of it in the reflexive mode (Petter et al. 2007). To define the practices and the contextual factors, we mobilized the literature outcomes and our observations stemming from the cases' exploration. These items are non-exclusive symptoms of their associated latent variables. Consequently, ***the reflexive modeling mode seems more convenient to our study.*** Moreover, according to Bollen and Lennox (1991), formative measures are not substitutable, whereas reflexive ones are interchangeable. In our case, changes in items (addition, deletion, non-observation) do not change the meaning of the construct.

Two approaches can be used in multivariate data analysis based on SEM: the Covariance-Based method (CB-SEM) and the Partial Least Squares one (PLS-SEM) (Hair et al. 2011). The covariance (CB) method aims to minimize the distance between the theoretical matrix of covariance resulting from the research model and the covariance matrix estimated from the data. The PLS method is based on the prediction of the explanatory variables. It aims to maximize the explained variance and to minimize the residual one (Chin and Dibbern 2010). ***In this research, we mobilize a PLS approach for several reasons:***

- First, CB SEM is appropriate when the objective of the research is to test or confirm theories, while the PLS method is used in predictive studies (Esposito Vinzi et al 2010, Hair et al. 2011, Sosik et al. 2009). ***Our objective is not to test a***

theory, but rather to detect semi-regularities of knowledge absorption practices by SMEs embedded in CINs and to predict those that would be relevant for future cases of SMEs (Rönkkö et al 2016). The PLS method is therefore more appropriate.

- Second, this approach is particularly appropriate when information on the mobilized theories is scarce (Chin 2010). ***In our case, the practices were mostly identified following exploratory interviews. Also, the theoretical support explaining the links between the latent variables is present but slightly assured.***
- Finally, the survey collected a modest number of responses (72). The use of a CB approach would be problematic as the latter is effective for samples that are larger than 200 (Roussel et al. 2002). Moreover, despite the small size of our sample, it allows us to respond to a constraint of using the PLS approach. Indeed, the largest number of structural links between a dependent variable (an ACAP dimension) and independent variables (Constellations of the ACAP contextual factors) is 6. ***Since our model is entirely reflexive, the analysis implies a minimum sample size of 10*6 observations (Chin 1998). Hence, our number of observations (72) makes it possible to fulfill this requirement.***

5 Results

5.1 Contributions of the qualitative phase

5.1.1 Characterization of ACAP for an SME embedded in a CIN

As explained in paragraph 2.3.4, the deductive analysis of the multidimensional ACAP measures that were proposed in previous studies enabled us to build an initial framework of the ACAP of an SME embedded in a CIN composed of four categories of practices (Figure 1). Then, our field study enabled us to confirm some of the practices identified in the literature and to identify new ones (Table 3) through the case studies and/or the focus groups. This process enabled us to generate a framework of the ACAP of an SME embedded in a CIN (Figure 3).

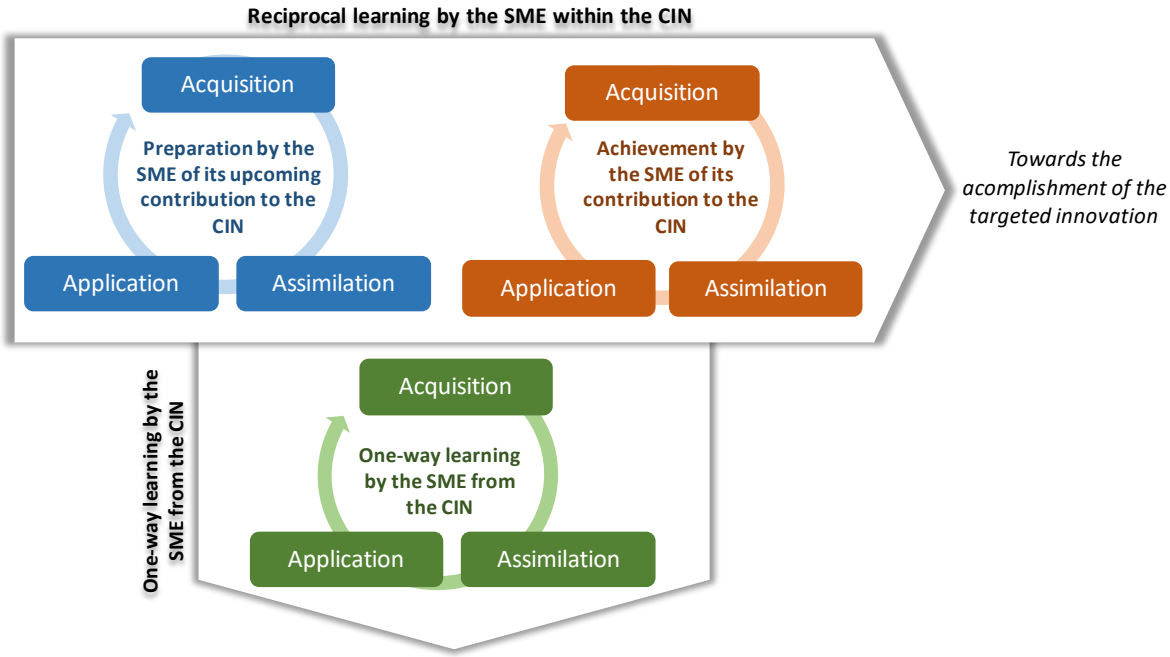

Figure 3-Framework of the ACAP of an SME embedded in a CIN

The generated characterization has the following properties:

- In line with our literature review which suggests that there are two learning perspectives within a CIN, ***some identified practices are devoted to the one-way learning by the SME while others serve the reciprocal one.***
- ***The two learning perspectives take place alongside the contribution of the SME to the CIN***. In addition, the ***one-way learning can persist beyond the lifecycle of the CIN***, as long as the SME capitalizes on its experience on the network.
- The practices identified for reciprocal learning reveal that some of them take place in the upstream phases of the SME's contribution to the CIN. They represent ***the preparation by the SME of its contribution*** to the latter, through the exploration of the innovation environment, a review of the risks and benefits of working with specific types of partners and the establishment of a common vision with all actors concerning the development of the innovation.
- On the other hand, some practices take place later, when the actors are ***achieving their contributions to the network***. At this stage, each SME acquires knowledge mainly from the other actors, evaluates the usefulness of these elements

regarding its tasks and then applies them individually or jointly to contribute to the common objectives that have been defined earlier.

- Each of the two stages of the reciprocal learning as well as the one-way learning is composed of ***the acquisition, the assimilation and the application*** dimensions. These dimensions are ***implemented in an iterative process*** as long as the SME needs to mobilize new knowledge.
- Finally, as illustrated in Table 3, our results adhere to the conception of this construct as the combination of antecedents representing ***coordination capabilities, systems capabilities, alertness and openness***.

Table 3- Characterization of the ACAP for an SME embedded in a CIN

ACAP Dimension	Category of antecedent		Practice	Literature	Focus groups	Verbatims from the case studies
Acquisition by the SME to prepare its contribution to the CIN	**Coordination capabilities**	P1.1	Get informed through the project actors identified at this stage	Szulanski (1996), Chauvet (2014)		Max found me through the design agency that works in the project (Enuresis)
		P1.2	Get informed through the client if applicable	Jansen et al. (2005)		
		P1.3	Get informed through experts (Clusters, consultants, researchers, suppliers, etc.) apart of the project actors	Tu et al. (2006), Flatten et al. (2011), Jansen et al. (2005), Wang et al. (2010), Delmas et al. (2011), Nieto et Quevedo (2005), Lichtenthaler (2009), Camison et Faurès (2010), Gold et al. (2001), Valentim et al. (2015)	x	I was introduced to Max by a colleague who runs a center for innovation and development in Manchester. Max asked him for help on regulatory issues (Enuresis)
		P1.4	Get informed through the participation in scientific or industrial events	Camison et Faurès (2010)	x	We talked to people who were present in the software show and said that the SOA lab had an expertise on it (Software)
	System capabilities	P1.5	Use of data sources (Scientific databases, Press, Internet, Social networks ...)	Ter Wal et al. (2011), Wang et al. (2010)	x	We've put a lot of ads in newspapers, on LinkedIn, to find someone with medical business skills (Enuresis)
	Alertness	P1.6	Make sure to collect technical and technological knowledge relevant to the targeted innovation	Lichtenthaler (2009), Gold et al. (2001), Valentim et al. (2015), Chauvet (2014), Thuc Anh et al. (2006), Ter Wal et al. (2011)		The mechanical subjects were investigated by MB and MC and we took care of everything related to electronics (Bench)
		P1.7	Make sure to collect supply chain knowledge relevant to the targeted innovation	Chauvet (2014)		It was also necessary to find specialists in heavy boiler work, machinery, heat treatment with steels and stainless steel. It was fairly easy, given that in Saint-Etienne we are on an important industrial basin, and we find everything here (Bench)
		P1.8	Make sure to collect market knowledge relevant to the targeted innovation	Camison et Faurès (2010), Gold et al. (2001), Valentim et al. (2015), Jansen et al. (2005), Delmas et al. (2011), Nieto et Quevedo (2005), Flatten et al. (2011), Thuc Anh et al. (2006), Lichtenthaler (2009), Tu et al. (2006), Ter Wal et al. (2011)		I've never put any medical equipment on the market, I had no ability to do so, so I looked around to find someone who had these skills and was already commercializing a medical device (Enuresis)
		P1.9	Make sure to collect knowledge regarding innovation project management	Thuc Anh et al. (2006), Chauvet (2014)		We've met Asso during the exchanges in the Rhône Alley club, and we knew that they had skills to manage and animate such projects (Software)
		P1.10	Make sure to collect knowledge regarding interorganizational collaboration management			The object of collaboration is a project which has an end in itself, and which in my opinion requires specific responses regarding its collective management (Software)
	Openess	P1.11	Be open to explore any knowledge domains that may be useful to prepare the project	Flatten et al. (2011), Camison et Faurès (2010), Wang et al. (2010)	x	To get through the first stage of the competition, it was necessary to present a technically completed concept and an overview of a business model. I had to work on the technical aspects of the game so I asked Adrien to take care of the business model. He went to see some people in the cluster to get help on this matter (Enuresis)

Assimilation by the SME to prepare its contribution to the CIN	Coordination capabilities	P2.1	Actively involve the client if applicable	Jansen et al. (2005), Wang et al. (2010)		In this type of projects, we try to involve the customer from the beginning to avoid any surprise (Bench)
		P2.2	Organize exchanges with the project actors to ensure the coherence of the overall vision	Jimenez-Barrionuevo et al. (2011), Ter Wal et al. (2011), Flatten et al. (2011), Wang et al. (2010)	x	Once we discuss these issues through common reflections, we can start working on our contributions (Bench)
	System capabilities	P2.3	Use boundary objects (presentations, supporting documents, simulators ...) to exchange with the other actors and/or the client if applicable	Delmas et al. (2011), Flatten et al. (2011)	x	First, we had to settle the machine requirements, through preliminary drafts and descriptive documents (Bench)
	Alertness	P2.4	Make sure to analyze the risks and benefits of integrating a project with competing entities			And to be quite honest, we thought that if we went further, some actors could even merge, and there were people in our company who saw our position at risk (Software)
		P2.5	Make sure to analyze the risks and benefits of integrating a project with researchers (academics, laboratories ...)			For the laboratories, it is mainly an academic interest, while for the SMEs; it's more about having something profitable in the end. It can create lags. As a result, some editors were not really open to the idea of integrating a research lab (Software)
		P2.6	Make sure to analyze the risks and benefits of integrating a project with large groups			We knew it would be difficult again with this customer. Large groups do not approach you the same way when you are an SME of 25 people. It is always complicated to work with them. It happened to me a long time ago, two or three times, to come to a meeting where you have ten people in front of you, it was a kind of tribunal! It was unbearable! (Bench)
		P2.7	Make sure to analyze the risks and benefits of integrating a project with entities that the SME did not know before	Kotabe et al. (2011)		Naturally we go to the people we know, who are the most endearing, that is to say those who have the most sympathetic sense of relational. I strongly take into account the human aspect because, in the end, everything becomes possible if we collaborate with people we trust (Bench)
	Openess	P2.8	Be open to integrate a project including unusual types of actors (Competitors, Researchers, Large groups, Entities that the SME did not know before)		x	It's a kind of agility, when you're targeting markets where you're not competent because you do not have sufficient functional coverage, you have to work with partners who are sometimes competitors (Software)
Application by the SME to prepare its contribution to the CIN	Coordination capabilities	P3.1	Identify the project actors that are at the interface of the SME's contribution	Szulanski (1996), Garcia Morales et al. (2008)		So there were many meetings around this table, on the distribution of roles and identification of inputs and outputs (Bench)
		P3.2	Identify within the SME the human resources to be involved or solely dedicated to the project	Jansen et al. (2005)		Those who had the biggest turnover were able to dedicate human resources, it was really planned (Software)
		P3.3	Designate the boundary actors (Project Manager, Technical Coordinator, Commercial Interface) that are necessary for the project	Jimenez-Barrionuevo et al. (2011), Delmas et al. (2011)		It was necessary to place people in the middle to articulate and coordinate all the exchanges, otherwise I don't think that the project would have progressed at a similar pace (Software)
	System capabilities	P3.4	Set up the collaborative tools that are necessary to control the interfaces between the different project actors (Shared databases, Collaborative platform ...)		x	I had to put in place the various collaborative tools that enable the actors to work on the project and that make it easier for them to access the needed information (Software)
	Alertness	P3.5	Make sure to define the performance management modalities of the targeted innovation (expected performance objectives and its steering mode based on these objectives)			The best thing to do is to put these decisions on paper, to define how the machine will work, what performance it will achieve (Bench)
		P3.6	Make sure to define the project management modalities (Deliverables, preliminary planning ...)		x	In this project planning everything was clear; We even specified what should be done per week, per day! (Bench)

		P3.7	Make sure that the designated boundary actors are legitimate and non-conflicting			When there is a neutral actor who animates and manages the project, it is very comforting for the partners (Software)
		P3.8	Make sure to define a business model of the targeted innovation that is approved by all the concerned actors			So clearly if we had to redo this project, we would not start it without defining a business model at the very beginning (Software)
		P3.9	Make sure to evaluate the coherence of the project's common objectives with the strategic orientation of the SME (Risks and possible impact on its own business)			They were very excited and quickly embarked in this project. But they did not know how much it was likely to change their business. And when it happened, they stepped back! (Software)
		P3.10	Make sure to formalize the relationships with the project actors that are risky		x	The key to the collaboration success is that everyone could benefit from the project without feeling threatened by a competitor. It took us one year to sign the consortium agreement. After that, it was clear that some partners were feeling much more secure (Software)
		P3.11	Make sure to define and communicate to the other project actors the SME's contribution to the budget			We said 'here is the budget, here is the part of each one' and hop! Cut it in 7! (Software)
		P3.12	Make sure to define and communicate to the other project actors the SME's terms to be taken into consideration (own objectives, usual rules of collaboration, cultural particularities ...)			The industrialists do not understand the rhythms of the theses, the first six months of literature review. I mean, it's a cultural shock, and it works the other way too (Software)
		P3.13	Make sure to define and communicate to the other project actors the SME's proposal of operational contributions			Each of us provided an encryption of its study and design part (Bench)
	Openess	P3.14	Be open to eventually adjust the SME's own objectives according to the common orientation of the project		x	Our objectives and universes (The SMEs and the research labs) are very divergent. So to make the two cohabitate, all the partners needed to make adjustments, to make concessions (Software)
Acquisition by the SME to achieve its contribution to the CIN	**Coordination capabilities**	P4.1	Get informed through the project actors identified at this stage	Szulanski (1996), Chauvet (2014)		What is good about Dave is that I can also ask him about things other than the regulatory issues he is supposed to be managing. As a scientist, he understands compliance, he developed products (Enuresis)
		P4.2	Get informed through the client if applicable	Jansen et al. (2005)		
		P4.3	Get informed through experts (Clusters, consultants, researchers, suppliers, etc.) apart of the project actors	Tu et al. (2006), Flatten et al. (2011), Jansen et al. (2005), Wang et al. (2010), Delmas et al. (2011), Nieto et Quevedo (2005), Lichtenthaler (2009), Camison et Faurès (2010), Gold et al. (2001), Valentim et al. (2015)	x	When I took knowledge of MC's specifications, I went to see a bearing manufacturer to get informed about the diameters of certain mechanical pieces (Bench)
		P4.4	Get informed through the participation in scientific or industrial events	Camison et Faurès (2010)	x	It happened that all publishers and doctoral students participate in training courses. For example, the interoperability language is based on a standard that they have discovered together (Software)
	System capabilities	P4.5	Use of data sources (Scientific databases, Press, Internet, Social networks ...)	Ter Wal et al. (2011), Wang et al. (2010)	x	The cluster helped us with their CRM tool. They need to know who is doing what, in what business. So when Adrian left the project, we used it to look for someone with similar skills on Liverpool (Enuresis)
	Alertness	P4.6	Make sure to get informed about the constraints and requirements of the other project actors (and the client if applicable) that the SME impacts			In order to calculate the axial forces, MB needed some clarification about the masses that I was using (Bench)
		P4.7	Make sure to get informed about the constraints and requirements of the other project actors (and the client if applicable) that impact the SME			The editors had to improve their bricks and they had to be informed about the specificities of each other to anticipate the interoperability problems (Software)

	Openess	P4.8	Be open to explore any knowledge domains that may be useful to accomplish the project	Flatten et al. (2011), Camison et Faurès (2010), Wang et al. (2010)	x	We went to that trade show in order to get informed concerning scanners. We were lacking information about this component since none of the partners knew anything about it. So someone had to stick to it. We learned about the faro arms, the various scanners screens, the measuring arms etc. (Bench)
Assimilation by the SME to achieve its contribution to the CIN	**Coordination capabilities**	P5.1	Actively involve the client if applicable	Jansen et al. (2005), Wang et al. (2010)		The guy from the funding entity was very comprehensive, very involved in the problems of the project. We always solicited him about the most insignificant problems we could have (Enuresis)
		P5.2	Organize exchanges with the project actors at the interface of the SME's contribution so as to decide on knowledge application according to their constraints and requirements		x	There were different types of meetings: R&D meetings gathering some of the software editors, project steering meetings, and finally commercially oriented and marketing meetings (Software)
		P5.3	Organize exchanges with all the project actors to ensure the coherence of the overall vision	Jimenez-Barrionuevo et al. (2011), Ter Wal et al. (2011), Flatten et al. (2011), Wang et al. (2010)	x	We have regular partners' meetings and also mandatory meetings with the organization that funds us. Everyone is making presentations on how we are progressing. We do not drag people into big meetings where everyone is present just for the sake of it (Enuresis)
	System capabilities	P5.4	Use boundary objects (presentations, supporting documents, simulators ...) to exchange with the other project actors and/or the client/end user	Delmas et al. (2011), Flatten et al. (2011)	x	During this meeting, they showed how all the devices would interact. Academics handed out copies of the sensor, the company responsible for developing the application showed simulations. It was interesting to see all these things together; it brought life to the project (Enuresis)
		P5.5	Use information technology means (Databases, SharePoint ...) dedicated to knowledge and information sharing with the other project actors and/or the client if applicable	Flatten et al. (2011), Camison et Faurès (2010), Lichtenthaler (2009), Wang et al. (2010)	x	We established a set of common services that enabled us to progress and share any new information on the issue of standardization (Software)
	Alertness	P5.6	Make sure that the SME is vigilant during its interactions with the other project actors that involve its organization's key knowledge			The code that was used to develop the application was not shared. But even if we had shared it with the other actors, most people would not know what to do with it. Now that I think about it, someone from the university might actually know how to use it ... The code includes some parts that we use in other games and applications or with other customers, so we try as much as possible to avoid problems of intellectual property and license by not sharing it (Enuresis)
		P5.7	Make sure to question the propositions of the other project actors and/or the client that may alter the quality of the SME's contribution			He said to me 'you have to simplify because it will be costly for me to buy these components', Well if it was possible yes, but if the quality of the machine was questioned, well no sorry I am not changing my design (Bench)
	Openess	P5.8	Be open to eventually integrate knowledge and usages other than the SME's own knowledge or ways of doing	Tu et al. (2006), Kotabe et al. (2011), Jimenez-Barrionuevo et al. (2011), Tu et al. (2006)	x	The problem is that in our jobs the ego persists, we are convinced that we propose the best solutions (Bench)
Application by the SME to achieve its contribution to the CIN	**Coordination capabilities**	P6.1	Closely work with the actors impacting the SME's contribution	Gold et al. (2001), Valentim et al. (2015), Nieto et Quevedo (2005)		Some of them worked together, for example to develop the bricks. The editors who worked on the same technology closely collaborated (Software)
		P6.2	Test the generated innovation with its respective user (the client) or a potential one before its commercialization		x	We took the game to the hospital and gave it to children, everyone around the age of 5, 6 loved the game, but the rest hated it (Enuresis)

		P6.3	Promote the generated innovation in events (Trade fairs, conferences ...)		x	I had a role on the promotion of the project, there was quite a lot of communication in software fairs to make our idea known upstream (Software)
	System capabilities	P6.4	Use technical and/or technological means (technological platform, website to communicate, models ...) adapted to the nature of the SME's contribution to the project		x	He produced the brake components and proceeded to the removal of additional substances with high precision machines (Bench)
		P6.5	Provide a document describing the SME's accomplished contribution	Jimenez-Barrionuevo et al. (2011), Wang et al. (2010)	x	One of the crucial things for medical devices is that you have the duty and need to clearly inform what you are doing. So when we have a user group or when there is exposure to potential clients and families, we document it (Enuresis)
	Alertness	P6.6	Make sure to question the SME's contribution in order to reach the highest possible performance levels	Nieto et Quevedo (2005)	x	We worked a lot with what we call the factory acceptance tests, and we carried out our tests and controls very far to fully master the implementation process (Bench)
		P6.7	Make sure to raise all the SME's doubts in order to avoid misunderstandings that would prevent achieving the common project objectives			We had a lot of disagreements and that's fine. Usually it is so easy to walk around in a product that nobody believes in simply because everybody appreciate each other and they are afraid to express what they actually think. The more disagreements we had, the happier I was. At least we did not come to a point where something was not working and someone said 'well, I knew it would not work' (Enuresis)
	Openess	P6.8	Be open to provide help to all the project actors	Jimenez-Barrionuevo et al. (2011), Tu et al. (2006), Flatten et al. (2011)	x	So you have to create a climate where even if you have a partner who has difficulties, you have to intervene on your side, try to bring out support. It is important not to leave someone blocked. (Bench)
		P6.9	Be open to eventually adjust the SME's contribution following the request of the client or another project actor		x	When we changed the connector, he had to adjust his software because the communication between the different bricks was no longer optimal. At first he did not want to, because he would have had to put a full-time engineer on it (Software)
		P6.10	Be open to eventually allocate to the project additional internal resources (human and/or financial)			If we have to put 50,000 Euros more, is everybody willing to do that? And yet we did! The SAP connector was not planned at the beginning, but after two years, we thought 'it would be so good', we all handed over money, 10,000 Euros each, on the SAP connector (Software)
Acquisition by the SME of potential learnings from its experience within the CIN	Coordination capabilities	P7.1	Organize an assessment meeting at the end of the project in order to collect feedbacks that might be useful to the SME's own organization		x	In the final project assessment meeting, there was a lot of tension, not open conflicts, but it was even worse. We felt that there were brakes, for example when some people were asked a question, they answered superficially, fearing to let the others benefit! Once, twice, three times! (Software)
		P7.2	Organize intermediate assessment meetings to collect knowledge that is potentially useful to the SME's own organization			At an intermediate assessment meeting, we concluded that the salesmen were reluctant in all our companies. That was something that had really happened everywhere. Some editors even claimed that this is a recurring problem in collaborative projects (Software)
		P7.3	Get informed formally or informally through the project actors who can provide potentially useful knowledge to the SME's own organization	Tu et al. (2006), Wang et al. (2010), Delmas et al. (2011), Lichtenthaler (2009), Camison et Faurès (2010), Flatten et al. (2011), Delmas et al. (2011), Jansen et al. (2005)		After an informal exchange that I had with one of the editors, their technical team had become more mature and was able to take advantage of technology for their own products (Software)

		P7.4	Benefit from the SME's participation to external events related to the project (Trade Shows, Conferences, Round Tables ...) in order to identify knowledge that is useful to its own organization	Camison et Faurès (2010)		
	System capabilities	P7.5	Implement continuous learning material (Astonishment reports, databases ...) during the SME's participation to the project in order to preserve any potentially useful knowledge	Chauvet (2014), Jansen et al. (2005), Lichtenthaler (2009), Wang et al. (2010)		We can very well have feedback on a project. After that, it can be difficult to write it because there are transpositions to be done. We tried to do it on this project as there were parts of the mechanisms that we wanted to recover. We went into big writings saying "here, we have a keyword; at this step we did this etc." (Bench)
	Alertness	P7.6	Make sure to collect technical and technological knowledge	Lichtenthaler (2009), Gold et al. (2001), Valentim et al. (2015), Chauvet (2014), Thuc Anh et al. (2006), Ter Wal et al. (2011)		So in the objectives that were a bit secondary and directly relevant to us, it was also to enable our technical team to become more competent regarding the technologies that were used in the project (Software)
		P7.7	Make sure to collect supply chain knowledge	Thuc Anh et al. (2006), Chauvet (2014)		
		P7.8	Make sure to collect market knowledge	Camison et Faurès (2010), Gold et al. (2001), Valentim et al. (2015), Jansen et al. (2005), Delmas et al. (2011), Nieto et Quevedo (2005), Flatten et al. (2011), Thuc Anh et al. (2006), Lichtenthaler (2009), Tu et al. (2006), Ter Wal et al. (2011)		With Dave, it is just exciting to see the development of an application and I wanted to learn more about how to introduce an application to the market (Enuresis)
		P7.9	Make sure to collect knowledge regarding innovation project management	Thuc Anh et al. (2006), Chauvet (2014)		
		P7.10	Make sure to collect knowledge regarding interorganizational collaboration management			Animating this type of project allowed us to broaden our skills in collaborative team management, to learn how to manage a heterogeneous group of companies (Software)
	Openess	P7.11	Be open to collect knowledge in any domain even beyond the SME's discipline	Flatten et al. (2011), Camison et Faurès (2010), Wang et al. (2010)		Our involvement in the technical and scientific aspects of the MES universe has enriched us, now we can show that we have skills on it (Software)
Assimilation by the SME of the learnings acquired from its experience within the CIN	**Coordination capabilities**	P8.1	Organize exchanges with the SME's internal collaborators, about the knowledge acquired from the project	Jimenez-Barrionuevo et al. (2011), Ter Wal et al. (2011), Wang et al. (2010), Gold et al. (2001), Valentim et al. (2015), Flatten et al. (2011)	x	Well, we organized group reflexions to see how this project can be useful to our firm (Bench)
	System capabilities	P8.2	Use boundary objects (Support documents, Simulation ...) to exchange with the SME's internal collaborators about the knowledge acquired from the project	Delmas et al. (2011), Flatten et al. (2011)		
		P8.3	Use information technology means (Shared databases, SharePoint, Intranet ...) to store and/or share knowledge that might be useful for the SME or for some of its collaborators	Flatten et al. (2011), Camison et Faurès (2010)		We did not push very far the plug in referencing what we learned. We did it a bit with Excel filters. It works quite well. It is accessible to everyone (Bench)
	Alertness	P8.4	Make sure to communicate to the SME's internal collaborators the knowledge acquired from the project that can be useful to them	Jimenez-Barrionuevo et al. (2011), Jansen et al. (2005), Camison et Faurès (2010), Ter Wal et al. (2011), Flatten et al. (2011), Szulanski (1996), Gold et al. (2001, Valentim et al. (2015), Tu et al. (2006), Thuc Anh et al. (2006), Lichtenthaler (2009)	x	
	Openess	P8.5	Be open to discuss with anyone within the SME, about the knowledge acquired from the project	Tu et al. (2006), Flatten et al. (2011), Chauvet (2014), Lichtenthaler (2009)	x	

Application by the SME of the learnings acquired from its experience within the CIN	Coordination capabilities	P9.1	Encourage the creativity of the SME's internal collaborators so as to retrieve all the possible benefits from the project learnings	Flatten et al. (2011), Chauvet (2014), Thuc Anh et al. (2006)	x	
	System capabilities	P9.2	Adapt the knowledge acquired from the project to the internal context of the SME (Translation, codification ...) in order to anticipate its possible use	Camison et Faurès (2010), Ter Wal et al. (2011), Flatten et al. (2011), Kotabe et al. (2011)		
	Alertness	P9.3	Make sure to use the SME's experience in this project so as to improve the competitiveness of its organization	Camison et Faurès (2010), Nieto et Quevedo (2005), Gold et al. (2001), Valentim et al. (2015), Flatten et al. (2011)		
		P9.4	Make sure to use the SME's experience in this project so as to improve the efficiency of its other projects	Cadiz et al. (2009), Gold et al. (2001), Valentim et al. (2015), Flatten et al. (2011)	x	Besides, in other projects, I brought back a lot of things we did with this client, for example in projects aiming to build high-speed special machines (Bench)
		P9.5	Make sure to use the SME's experience in this project so as to create new uses	Camison et Faurès (2010), Nieto et Quevedo (2005), Gold et al. (2001), Valentim et al. (2015), Flatten et al. (2011), Lichtenthaler (2009), Kotabe et al. (2011), Tu et al. (2006)	x	Clearly, some of the editors took the technology, then they used it in their own products (Software)
		P9.6	Make sure to use the SME's experience in this project so as to improve collective practices in its organization	Cadiz et al. (2009), Flatten et al. (2011), Kotabe et al. (2011), Tu et al. (2006), Chauvet (2014)		
		P9.7	Make sure to use the SME's experience in this project so as to improve the practices of some functions within its organization	Cadiz et al. (2009), Kotabe et al. (2011), Chauvet (2014)		
		P9.8	Make sure to use the SME's experience in this project so as to renew its working tools	Gold et al. (2001), Valentim et al. (2015), Chauvet (2014)		
		P9.9	Make sure to use the SME's experience in this project so as to strengthen its professional network	Nieto et Quevedo (2005)		Following this project, we established partnerships to accomplish other projects, to respond to other clients' requests (Bench)
	Openess	P9.10	Be open to put in place all the necessary means (change management, training, investments ...) in order to foster the application of learnings acquired from the project	Thuc Anh et al. (2006), Flatten et al. (2011), Nieto et Quevedo (2005), Tu et al. (2006)		To move forward you have to heavily invest, you have to accompany the change. The doors of change do not open from the inside (Software)

5.1.2 Comparative analysis of the absorption practices

The exploration of the case studies as well as the focus groups enabled us to complete the literature outcomes so as to propose a generic characterization of the ACAP of an SME embedded in a CIN through a set of practices. In order to ***qualitatively highlight the impact of the ACAP contextual factors on the relevance of the absorption practices, we carried out a comparative analysis supported by the N'Vivo software.*** This analysis allows us to identify the particularities of ACAP in the contexts of studied SMEs and thus facilitates the transferability of our results to similar contexts (Ayerbe and Missonier 2007).

In a multiple embedded case study, the analyses are performed at the levels of the cases and the units of analysis (Yin 2013). To fulfill such analysis, Miles and Huberman (2003) state that two approaches can be adopted. The authors distinguish between "case-oriented" approaches where the researcher carries out within cases' analyzes and cross-case comparisons. On the other hand, Miles and Huberman (2003) specify the "variable-oriented" approaches where the analysis is based on factors that can introduce a variance. In this method, the researcher conducts within-variables and cross-variable analysis to distinguish the sources of causality. In the analysis of the corpus resulting from the case studies, we followed the recommendations of Miles and Huberman (2003) to evaluate the relevance of the absorption practices at the macro (CIN) and the micro (SME embedded in a CIN) levels.

- Following our literature review, we did not identify characteristics that are specific to the ***macro level*** with regard to the ACAP. Therefore, we investigated this level by adopting a "***case-oriented approach".*** Accordingly, we holistically analyzed and compared the practices in the three studied cases. To carry out this analysis process, we used the 'case' nodes proposed in the N'Vivo software. Since the one-way learning is carried out by an SME independently of the CIN, we will only rely on reciprocal learning practices to analyze the macro level.
- To analyze the ***micro level***, we used a "***variable-oriented***" approach. Indeed, our literature review (Figure 1) highlights contextual factors that are specific to this level of analysis and which are likely to induce an intense ACAP. To perform

this analysis at the micro level, we used a matrix crossing request provided by the N'Vivo software to explore the presence of the practices according to the contextual factors.

We first present the results of our comparative analysis at the macro level (CIN), and then introduce those related to the micro level (SME embedded in a CIN).

✓ **Within-case analysis**

The studied CIN cases represent a variety of situations which would be interesting to analyze and compare regarding the absorption practices that are employed in them. In order to carry out this analysis, we calculated the frequencies of the practices' occurrence. We estimate that a practice is frequent if its occurrence is strictly greater than 50%. In the remainder of this section, we quote the practices through their indexes (Pi.j) previously introduced in Table 3.

Table 5.25 (p.489) summarizes the results of the practices' occurrence in 'Bench' case. It seems that the application dimensions in this CIN are relatively important (c, f), and their associated practices intensely mobilized (P3.1, P3.5, P3.7, P3.8, P3.10, P3.11, P3.13 / P6.1, P6.4, P6.5, P6.7, P6.9). Moreover, the acquisition dimension regarding the actors' preparation of their contributions (a) does not appear to be essential. As for the acquisition practices, the actors mainly mobilized practices between each other within the CIN (P1.1, P4.1, P4.6, P4.7).

Similarly, the within case analyses of the CINs 'Software' and 'Enuresis' are depicted in Tables 5.26 (p.490) and 5.27 respectively. ***In sum, our results suggest that the implementation intensity of the absorption dimensions and practices depends on the characteristics of the actors embedded in each CIN. 'Bench' merely relies on the acquisition in the early phases of the project because the innovation was driven by a client. Consequently, none of the actors needed to deeply explore the environment so as to formalize his innovative idea. In 'Software', the assimilation dimensions are weakly mobilized, due to the cognitive proximity between the SMEs that compose it.***

✓ **Cross-case analysis**

The results of the cross-case analysis are introduced in Table 5.28 (p.492). According to this table, all the SMEs embedded in the 3 CINs have strongly solicited the other actors of the networks in order to acquire useful knowledge to prepare (P1.1) and achieve (P4.1) their contributions. They also made sure to get informed regarding the constraints and the requirements of each other (P4.6, P4.7) that might impact them. Similarly, Table 5.28 highlights the high occurrence of other practices in all 3 cases (Practices in green). ***All these practices seem to be relevant regardless of the case.***

Our results also suggest that some practices (in red) are weakly mobilized in the 3 studied cases. For example, the actors merely explored knowledge related to supply chain (P1.7), project management (P1.9) and collaborative relationship management (P1.10). This is due to the fact that these tasks were carried out only by the few SMEs (4 out of the 13 interviewed), who investigated these knowledge in order to identify new partners. ***Overall, the analysis of the practices in red shows that their weak mobilization in the CINs mainly stems from the fact that they are specific to actors who have a boundary-spanning role. Thus, the variance of the macro level results from the characteristics of the micro level.***

Finally, our cross-case analysis results suggest that some practices have been strongly mobilized in a particular CIN (in orange). For example, the SMEs of the CIN 'Software' intensely attended external events to acquire useful knowledge (P1.4, P4.4). This is due to the fact that the actors had similar expertise; therefore an alternative source should have been used to fill the knowledge gap for each of these SMEs. ***By analyzing the rest of the practices in orange, we conclude that their mobilization differences across the CINs are due to the characteristics of the actors and not of the CIN as a whole.***

Our results justify the relevance of this thesis objective, i.e. measure the ACAP at the micro level (SME in the CIN) and not the macro one (CIN).

✓ **Within-variable analysis**

In order to analyze the relevance of the ACAP practices at the micro level we rely, as explained earlier, on a variable-oriented approach (Miles and Huberman 2003). In our study, these variables correspond to the 22 ACAP contextual factors that are summarized in Figure 1. To analyze their impacts on the practices' relevance, we first characterized each of our 13 units of analysis according to these factors (Tables (5.3, p.408), (5.5, p.418), (5.7, p.430)). Then, we calculated the frequencies of the practices' occurrence according to the presence of each factor. The results of these analyzes are presented in Tables 5.29 (p.497) to 5.40 (p.514). ***These tables suggest that the occurrences of some practices are logical as they can stem from the presence of certain factors. Nevertheless, other results seem to be surprising. For example, in Table 5.31 (p.501), practices (P2.4, P2.5, P3.2, P3.3, P5.6, P6.2, P6.3, P6.10) appear to be important in the presence of factor 6 (initiating a change in the strategic orientation). However, this factor cannot explain the consistent presence of these practices. A cross-variable analysis might provide further clarifications to these results.***

✓ **Cross-variable analysis**

We performed a cross-variable analysis to identify the similarities and differences of the absorption practices' occurrence among the 22 contextual factors. The results of this analysis are presented in Table 5.41 (p.515). ***This table suggests that some practices are consistent (in green) or non-consistent (in red) regardless of the context in which the SME is embedded. Other practices are mobilized exclusively when certain factors are present (in yellow). Nevertheless, some***

causal effects cannot be qualitatively explained (e.g. (P2.6, Factor 8) or (P7.8, Factor 9)), thereby matching the conclusion of the within-factor analysis.

Such results would come from a possible limitation of our data corpus, from the fallibility of our subjective interpretation of this data, or from potential interaction effects between the contextual factors. We explore this possibility in the next paragraph.

✓ **Multi-factor analysis**

The results of our comparative analysis prompted us to qualitatively explore the existence of interaction effects between the ACAP contextual factors. Hence, we considered as an example the factors 10 (Future owner of the innovation) and 13 (Interface with the market). We compare the absorption profiles of the studied SMEs belonging to this strategic position where the two factors are present, with those of the SMEs where only factor 13 is. The results of this comparison are introduced in Table 5.42 (p.520).

This table shows that several practices (all those that are colored) are more recurrent when the two factors are simultaneously present than when only factor 13 takes place. The joint presence of these two factors seems to increase the relevance of these practices! Furthermore, some practices (in blue) are relevant only when the two factors coexist!

In fact, the uncommon nature of some of these practices can stem from this strategic position where both factors 10 and 13 are present. For example, an SME that belongs to this position has to be open enough to explore any area of knowledge that could be useful for its targeted innovation (P1.11, P4.8). Indeed, this SME must maintain a close link with the external environment of the CIN and make sure to explore all the potentially useful knowledge to push its own innovative idea. Nevertheless, the simultaneous presence of these two factors does not provide any rationale for the observed relevance of the other practices. This would require considering the joint effect of all the 22 ACAP contextual factors, not only these 2 variables.

To qualitatively identify all the interaction effects between the 22 factors, it would be necessary to explore all the absorption situations which may result from their combinations, i.e. 2^{22} = 4 194 304 possible situations! Given the difficulty to proceed to such analysis in a qualitative manner, we opted for a quantitative approach (Section 5.2). This process enables us to propose a contextualized characterization of the ACAP for an SME embedded in a CIN and thus takes into account any eventual interaction between the factors.

5.2 Contributions of the quantitative phase

5.2.1 Initial data processing

First, the collected data was extracted in an Excel file format that was scanned to check for any visible abnormality. Thus, we eliminated the observations containing a high level of non-response and those where the respondents repeatedly checked the same modality. Then, in the remaining exploitable observations, we replaced the missing values for each indicator by the mean of the extant answers (Hair et al. 2016).

Second, we used Harman's single factor test to check for the absence of common method bias resulting from the collection mode (Conway and Lance 2010, Podsakoff et al. 2003). This test consists in performing a factor analysis based on the set of variables (Rönkkö and Ylitalo 2011). The presence of errors is suspected when a component brings together the majority of the variables. When we perform this test under XLSTAT (Appendix 11, p.728), the variance explained by the single factor is 37.065%, therefore suggesting the absence of a common method bias.

Finally, we carried out a principal component analysis with a varimax rotation (Appendix 12, p.730) to ensure that the factorial structure corresponds to the empirical data and to remove indicators that do not contribute significantly to their associated constructs. Such analysis increases the explanatory power of the model (Andreev et al. 2009, Petter et al. 2007). Among the 104 indicators that are used to measure the 15 constructs, 11 were eliminated as their communalities were lower than 0.5 (Carricano and Poujol 2008).

After refining our collected data, we can now carry out their statistical analysis using the PLS SEM method. The structural model summarizing our variables is presented in Figure 4. We mobilize the PLS SEM approach in order to guide an SME embedded in a CIN towards the knowledge absorption practices that are relevant to its context. In other words, our aim is to contextualize the practices describing our 9 ACAP dimensions according to the contextual factors that impact them. However, considering the large number of structural links to be estimated simultaneously (51 structural links in Figure 4) and the small size of our sample (72 responses), we chose to contextualize each ACAP dimension in an independent structural model. Each of the resulting 9 models includes on the one hand an ACAP dimension, and on the other hand the constructs expressing the contextual factors that impact it.

To assess these structural equation models, a two-step analysis is necessary (Hulland 1999, Tenenhaus et al. 2005). The first step is to examine the measurement model, also called the outer model. This model evaluates the reliability and validity of latent variables in terms of the contribution of their respective indicators (Hair et al. 2011). The inner model analyzes the structural paths between the different latent variables. All the tests were performed under XLSTAT.

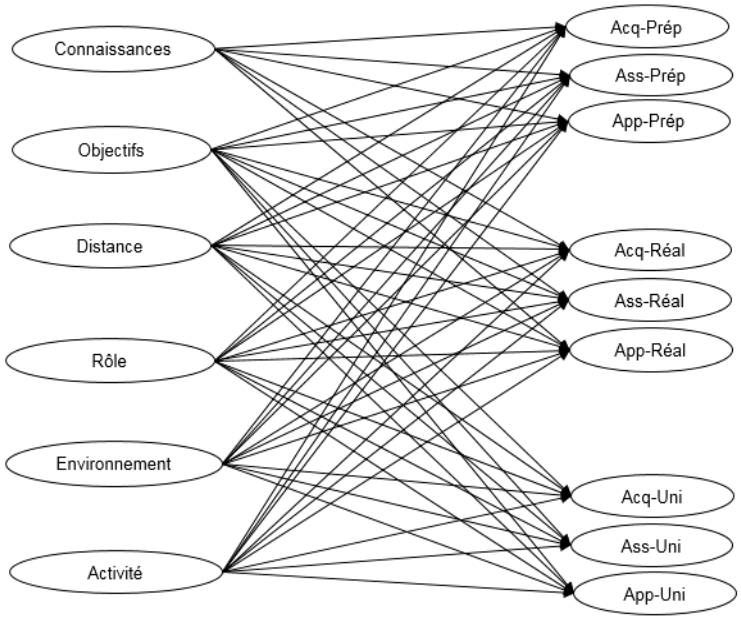

Figure 4 – Global structural model

5.2.2 Assessment of the outer models

- For each of the 9 models, we first verified the ***unidimensionality*** of its constructs. A construct is unidimensional when the first eigenvalue of the correlation matrix between its manifest variables is greater than 1 and the second one is less than 1 or at least much smaller than the first one (Fernandes 2012).
- Then, we tested the ***convergent validity of the indicators*** to eliminate those with loadings below 0.4 and / or that are not statistically significant. We checked for their significance using a 500 sub-samples bootstrapping approach (Marcoulides and Saunders 2006). Significance is confirmed by a Student test, which must be greater than 1.96 to be valid, with p <0.05 for a bilateral test (Wetzels et al. 2009).
- After removing the non-significant indicators, we evaluated ***the composite reliability of the constructs***. This criterion is verified by calculating their Dillon-Goldstein Rhô and, incidentally, their Cronbach Alpha (Tenenhaus et al. 2005). The value of these indices is considered good above 0.7 but is accepted beyond 0.6 (Esposito Vinzi et al. 2010). We introduce the Cronbach Alpha values for informational purposes.
- To confirm the ***convergent validity of constructs***, we examined the values of their Average Variances Extracted (AVEs), which are considered satisfactory above 0.5 (Bagozzi and Yi 2012).
- Finally, ***the discriminant validity*** must on the one hand satisfy the Fornell-Larcker criterion. The latter stipulates that the correlations between a construct and the other latent variables must be lower than the square root of its AVE (Chin 2010). On the other hand, this validity is evaluated by examining the cross-links between the model's indicators. The loading of an indicator must be higher than its cross loadings with the other constructs of the model.

The Student test results of the loadings significance are introduced in Appendix 13 (p.732). The results of the cross-loading discriminant validity test are presented in Appendix 14 (p.737). Finally, the results regarding the remaining tests to assess our outer models are provided in Tables 6.3 (p.548) to 6.20 (p.563).

5.2.3 Assessment of the inner models and formulation of the practices' prediction equations

We evaluate the inner models by examining the structural paths between their different constructs:

- The ***paths' values are calculated*** using the linear regressions obtained from the standardized scores of the explanatory variables (Sosik et al. 2009). Then, a 500 sub-samples bootstrapping approach allows us to estimate the ***statistical significance of these structural coefficients*** (Marcoulides and Saunders 2006) with respect to the thresholds ***p<0.001, **p<0.01 and *p<0.05.
- To extend the interpretation of the structural links' importance, we evaluate their ***size effects f^2*** (Fritz et al. 2012). An important effect indicates that the studied phenomenon is very likely to be observed among the population. Chin (2010) notes that a size effect with a value between 0.02 and 0.15 corresponds to a small effect, between 0.15 and 0.35 to an average one, and beyond 0.35 to a consequent effect.

- Then, it is necessary to evaluate the predictive power of the model. The latter is expressed by the proportion of the ***extracted variance (R^2)*** for the endogenous constructs. According to Croutsche (2002), three thresholds of R^2 can be considered. If R^2 is greater than 0.1, the model is significant. If it is between 0.05 and 0.1, then the model is tangent. Finally, the model is not significant when R^2 is below 0.05.
- The overall quality of the model is evaluated using the ***Goodness of Fit (GoF) index*** (Tenenhaus et al. 2005). For small samples, this value should exceed 0.1 (Wetzels et al 2009). The authors indicate that the following GoF values respectively correspond to a small, a medium and a high predictive validity: 0.1, 0.25 and 0.36.

Table 4 summarizes the results of the inner model assessment for the dimension "acquisition by the SME of knowledge to prepare its contribution to the CIN (Acq-Prép)".

Table 4 – Results of inner model assessment for the dimension Acq-Prép

Structural link			Value of the link		t-statistics	f^2
Environnement	→	Acq-Prép	0,115		1,259	0,036
Objectifs	→	Acq-Prép	0,489	***	3,779	0,204
Rôle	→	Acq-Prép	0,532	***	4,904	0,63
Connaissances	→	Acq-Prép	-0,127		-1,465	0,062
Distance	→	Acq-Prép	-0,019		-0,307	0,002
Activité	→	Acq-Prép	-0,031		-0,342	0,002
R^2					0,854	
GoF					0,728	

***p<0,001, **p<0,01, *p<0,05

Therefore, we are able to ***formulate the score prediction equation for each practice of the Acq-Prép dimension***, according to the standardized weights of the manifest variables and the significant structural paths of the model. This prediction relies on ***the equality between two equations resulting from the inner and the outer models***:

- On the one hand, the estimation of the ***inner model*** enables us to formulate the prediction equation for the latent variable Acq-Prép on a scale of 1 to 6 (similar to the Likert scale of the questionnaire). In this regard, after removing the non-significant structural paths (Table 4), we run the PLS algorithm again using the original manifest variables scores (i.e. on a scale of 1 to 6). The equation resulting from the inner model is as follows:

  *Acq-Prép= 0,916 +0,344*Rôle +0,44*Objectifs*

  The constructs 'Rôle' and 'Objectifs' are calculated using the scalar product of their vectors {Scores of the construct indicators} and {Weights associated with the construct indicators}. The weights of all the variables resulting from the inner model are presented in Table 5.

Table 5 – Normalized weights of the indicators used in the model Acq-Prép

Latent variable	Indicator	Normalized external weight
Acq-Prép	Acq-Prép1	0,132
	Acq-Prép2	0,1
	Acq-Prép3	0,177
	Acq-Prép4	0,06
	Acq-Prép5	0,06
	Acq-Prép6	0,134
	Acq-Prép7	0,074
	Acq-Prép8	0,085
	Acq-Prép10	0,107
	Acq-Prép11	0,071

Latent variable	Indicator	Normalized external weight
Rôle	Rôle1	0,272
	Rôle2	0,19
	Rôle3	0,214
	Rôle4	0,324
Objectifs	Objectifs1	0,273
	Objectifs3	0,253
	Objectifs4	0,474

- On the other hand, the ***outer model*** estimation suggests that the construct Acq-Prép can be calculated using the scalar product of its vectors {Scores of Acq-Prép indicators} and {Weights associated with Acq-Prép indicators} :

  *Acq-Prép = {*Scores of Acq-Prép indicators*}. {*Weights associated with Acq-Prép indicators*}^{T}*

By establishing the equality between the two equations, we formulate:

{*Scores of Acq-Prép indicators*}. {*Weights associated with Acq-Prép indicators*}^{T} = 0,916 +0,344*Rôle +0,44*Objectifs

In this research, our aim is to predict the scores of each of the indicators of the Acq-Prép construct, i.e. predict the values of the vector ***{Scores of Acq-Prép indicators}***. Solving this equation comes down to inverting the vector {Weights associated with Acq-Prép indicators}^{T} which represents a column matrix. Being a non-square matrix, this vector does not

admit an inverse but rather a unique pseudo-inverse of Moore-Penrose (Penrose 1955). The latter is expressed as the product of its transpose and the inverse of the square of its norm.

Thus, the solution of this equation is as follows:

$$\textbf{\{Scores of Acq-Prép indicators\}} = \frac{(\text{Acq-Prép} * \{\text{Weights associated with Acq-Prép indicators}\})}{//\{\text{Weights associated with Acq-Prép indicators}\}^T//^2}$$

With:

- {Weights associated with Acq-Prép indicators} being the transpose of {Weights associated with Acq-Prép indicators}^{T}
- // {Weights associated with Acq-Prép indicators}^{T} // representing the norm of this vector.
- Acq-Prép resulting from 0,916 +0,344*Rôle +0,44*Objectifs
- Rôle = {Scores of Rôle indicators}. {Weights associated with Rôle indicators}^{T}
- Objectifs = {Scores of Objectifs indicators}. {Weights associated with Objectifs indicators}^{T}

This formula enables us to predict the scores of the practices describing the Acq-Prép dimension according to the indicators of the contextual factors 'Rôle' and 'Objectifs' that impact it. The higher the predicted score is, the more relevant the practice is to the SME's context. We will explain in Section 5.3 how we mobilize this formula to guide the SME towards the practices that are appropriate to the context of its participation in the CIN.

Similarly to the Acq-Prép dimension, we evaluated the remaining 8 structural models and formulated the prediction equations for each dimension. The results are shown in Tables 6.23 (p.568) to 6.38 (p.581).

5.3 Implementation of the results in a maturity grid

The aim of this research is to propose an operationalization of the ACAP of an SME embedded in a CIN, in order to guide it towards the knowledge absorption practices which would foster the success of its experience within the network. Hence, as explained in Section 2.5, this operationalization will be structured according to a maturity grid. This tool is an a priori self-assessment support that would enable the SME to identify its strengths and weaknesses regarding the practices it needs to master. The grid integrates the practices identified following the qualitative phase of the research (Section 5.1) and the prediction equations resulting from the quantitative study (Section 5.2). First, we describe the structure of the maturity tool. Then, we introduce its various possible usages and the steps of its implementation.

5.3.1 Structure of the grid

Following our literature review introduced in Section 2, we identified six different dimensions composing the ACAP of an SME embedded in a CIN (Figure 1). They reflect the acquisition, assimilation and application of knowledge by the SME for its reciprocal and one-way learnings. These dimensions seem to be mutually exclusive and collectively exhaustive to describe the concept of ACAP. Hence, they could have constituted the process areas to be considered in our maturity grid (Maier et al. 2012).

Nevertheless, following our qualitative phase of research, we have established that the reciprocal learning by the SME within the CIN occurs in two stages. First, the SME acquires, assimilates and applies knowledge to prepare its future contribution to the CIN. Then, it differently mobilizes these three dimensions in order to achieve its effective contribution. Therefore, ***the introduction of this temporality suggests conceiving the ACAP of an SME embedded in a CIN as the combination of 9 process areas,*** instead of the 6 ones that were identified following our literature review. The associated practices to each process area derive from the multidimensional measures of the ACAP existing in the literature that have been transposed to the context of an SME embedded in a CIN, and were completed by the practices that have emerged from our case studies (Table 3). All these practices were then refined following the quantitative phase of this research. ***Thus, the final grid gathers 76 practices structured in 9 process areas as explained in Appendix 15 (p.742).***

Drawing on Le Dain et al. (2008), the maturity of an SME regarding these practices and process areas is assessed through its ***capacity*** and ***willingness*** to perform the absorption practices. These two dimensions are defined as follows:

- ***Capable to do***: The purpose of this criterion is to check if the knowledge absorption is performed methodically. The SME will be expert if it perfectly performs all the practices, applies the methods and uses the tools that are needed for this knowledge absorption.
- ***Willing to do:*** The purpose of this evaluation criterion is to assess if the SME perceives the interest of performing the practice. Thus, this SME will be a firm believer if it is convinced with the relevance of the practice and is willing to perform it whenever it is necessary.

To evaluate the maturity of the SME regarding each of these two dimensions, ***we use a questionnaire based on a Likert scale ranging from 1 to 4.*** For each practice associated with a process area, the participants answer the following two questions (Figure 5):

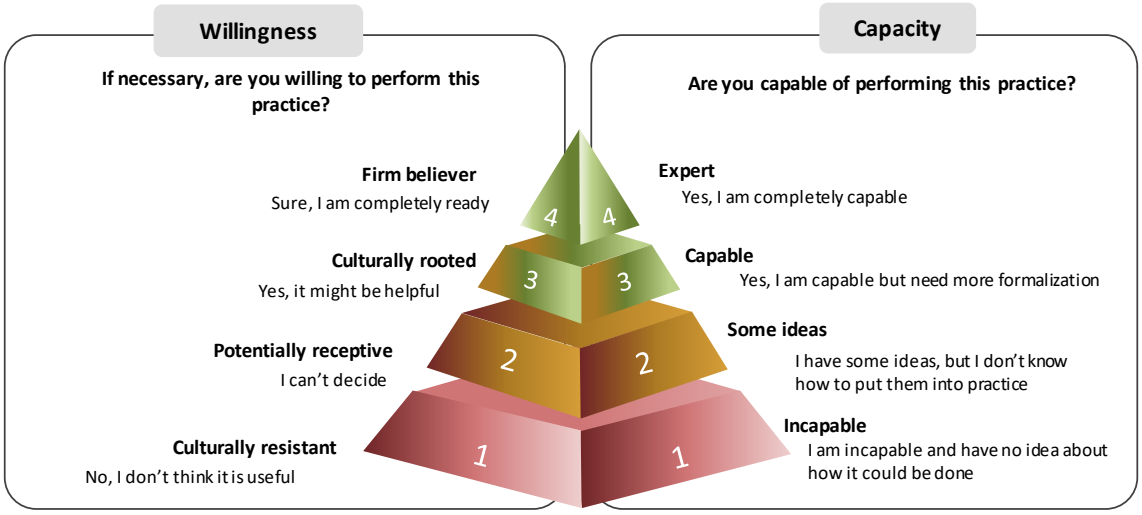

Figure 5 – Maturity evaluation scale

According to its answer to these two questions, a level of maturity is attributed to the SME for each assessed practice (Figure 5). We defined 4 levels to qualify the capacity of the SME to perform the absorption practice and 4 other levels to evaluate its willingness regarding this practice. Thus, achieving an ideal absorption requires from the SME to be mature both in terms of capacity and willingness to deploy the necessary practices. By combining these two dimensions***, four global ACAP maturity levels have been defined (Figure 6): Critical, untapped, uncontrolled and champion*** (Cheriti 2011, Le Dain et al. 2008).

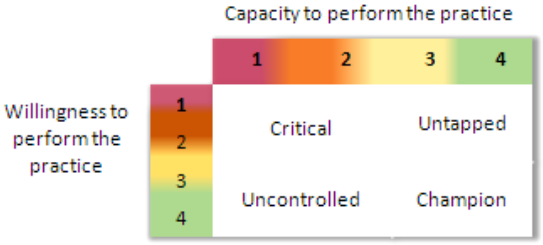

Figure 6 – Global maturity scale

This scale was discussed and approved during the two restitution sessions with researchers and practitioners. Thus, based on the process areas and their associated practices on the one hand and on the two dimensions of maturity on the other hand, a generic self-assessment grid for the ACAP of an SME embedded in a CIN is proposed in appendix 15 (p.742). The use of this grid is explained in the following paragraph.

5.3.2 Expected usages of the grid

A maturity grid is an a priori performance evaluation tool (Le Dain et al. 2008). It allows an organization to capture the current state of its practices in order to define the improvement actions to be implemented so as to reach a desired objective (Boughzala and De Vreede 2015). We thus distinguish four possible uses of the grid:

- ✓ This grid can be used ***ex ante by a single SME***, i.e. ahead of its contribution to a CIN. Such an evaluation will enable it to put in place the necessary improvement measures according to the context of its future participation to the network.
- ✓ The grid can also be used ***ex ante by a set of initial partners***, thus enabling them to better configure their network. Indeed, an evaluation involving all the identified partners at an early stage would allow them to dispatch the tasks and responsibilities according to the skills of each of them (e.g. partners who are best suited to occupy boundary spanning roles). It will also enable them to identify the weaknesses of their network and search for new complementary partners (e.g. if none of the current actors is proficient in terms of market related knowledge).
- ✓ The grid can also be mobilized ***by an SME in situ***, i.e. during its participation to the CIN, especially if an ex-ante self-assessment has not been carried out. Such use will allow the SME to catch up its deficit by implementing the necessary corrective actions. An in situ assessment is particularly interesting regarding the one-way learning practices, as it would guide the SME towards the mechanisms to be put in place in order to capitalize on its ongoing experience in the CIN.

- ✓ Finally, the grid can be used ***in situ as a mediation tool between a set of partners***. A self-assessment will allow them to review, if necessary, the disposition of the roles assigned to each of them in order to foster the accomplishment of their common objective.

In all these four usages, the self-assessment will be mainly carried out by the SMEs' managers. In fact, these actors are involved not only in the strategic but also in the operational aspects of innovation projects (Garcia and Calantone 2002). Moreover, they initiate and carry most of the conduct change projects within their organizations (Dettmer 1997). However, if the manager feels that other collaborators can provide a more consistent or a complementary insight of the SME's ACAP, a collective assessment is possible. Besides, Fraser et al. (2002) and Chiesa et al. (1996) emphasize that the involvement of people from different functional groups gives the evaluation a more transversal approach and thus provides an opportunity for consensus and team building.

5.3.3 Implementation steps of the grid

The objective of this tool is to raise an SME's awareness regarding the practices that are relevant to the context of its participation to a CIN. In this regard, an interactive administration mode conducted by a moderator and based on individual interviews or multi-participant workshops is recommended (Fraser et al. 2003). In such a process, respondents can ask for clarification to better understand the content of the grid, which would contribute to the accuracy of the evaluation results. We explain in this paragraph the self-assessment process by an SME ahead of its implication in a CIN (Usage 1). This procedure can be adjusted according to the other possible usages of the grid:

- ✓ ***Step 0: Introduction:*** First, an introductory page (Appendix 16, p.747) recalls the objectives of the grid and its structure, and provides generic instructions to better guide its implementation according to the desired usage by the participants. It enables the users to get familiar with the key used concepts and to understand the meanings of the process areas and the maturity criteria.
- ✓ ***Step 1: Contextualization of the generic maturity grid:*** The ACAP of an SME embedded in a CIN refers to a set of practices that this entity must implement in order to promote the success of its experience within the network. However, the importance of each of these practices depends on the context of the SME's participation to the CIN. It is therefore necessary to take this context into account in order to guide the SME towards the appropriate practices. In this regard, the quantitative study introduced in Section 5.2 enabled us to formulate the equations that predict the scores of each practice according to the context of the SME's participation to the CIN. These predicted scores therefore determine the most important practices regarding which the SME will assess its maturity. Practically, to take account of the SME's context, the second step in the usage of the grid requires from this entity to position itself regarding the ACAP contextual factors. The grid user is asked to answer, on a Likert scale ranging from 1 to 6, a set of questions concerning each of the factors that were retained following our quantitative study (Appendix 17, p.749).
- ✓ **Step 2: Self-assessment by the SME:** After identifying the practices that are relevant to the SME's context, the latter carries out a self-assessment regarding each of them. The evaluation consists of providing, for each retained absorption practice, an answer to the two questions concerning the previously introduced maturity criteria (Figure 5), namely capacity and willingness.
- ✓ ***Step 3: Restitution of the results:*** Following the self-assessment exercise, a maturity profile of the SME is drawn up (Appendix 18, p.750). On the one hand, this draft enables the identification of the most important process areas for the SME's context. The importance of a process area is evaluated through a rate (displayed at the bottom of the latter) which represents the ratio between the number of this process area's practices evaluated by the SME, and the total number of its practices in the generic maturity grid. On the other hand, the matrix Capacity/Willingness for each process area provides a repartition of the evaluated practices, according to the four global maturity levels introduced in Figure 6. Following these results, the moderator and the participants define the order by which they will analyze the deficient practices for each process area.
- ✓ ***Step 4: Formulation of the improvement actions:*** Based on the generated results, the participants discuss with the moderator the reasons of their deficiency regarding the process areas and the practices they are supposed to master. Recommendations for improvement are then formulated and recorded on the 'Action Plan' sheet (Appendix 19, p.751). The types of recommendations will differ according to the nature of the deficient maturity criterion (Le Dain et al. 2008, Cheriti 2011).
- ✓ **Step 5: Evaluation of the relevance of the grid:** With the successive implementations of the grid and the adjustments it may undergo, the author must make sure that this intervention method is up-to-date with regard to the uses for which it is intended (Chanal et al . 1997). For this matter, we draw on the work of Fraser et al. (2003), Moultrie et al. (2007), Le Dain et al. (2008), Cheriti (2011) and Personnier (2013) to formulate a questionnaire enabling the grid users to assess its usefulness, ease of use and completeness (Appendix 20, p.752). Collected continuously, their feedbacks will help maintaining the maturity grid.

6 Discussion

6.1 Contributions of the research

6.1.1 Theoretical contributions

This thesis proposes an operationalization of the ACAP in a collaborative interorganizational context. Hence, it covers a gap in the research stream that focuses on developing operational measures of this construct. The developed operationalization generalizes to a CIN context some practices that were proposed in other configurations of innovation. In addition, it identifies new practices that are specific to this context. Among them, we emphasize the need for the SME to agree with the concerned actors on a business model of the targeted innovation, and to analyze the risks and benefits of integrating a network with unusual actors.

Furthermore, our research contributes to the characterization of the ACAP antecedents. On the one hand, it confirms the critical role of coordination and system capabilities (Van den Bosch et al. 1999) to absorb knowledge in a CIN context. These capabilities represent actions to be performed by the organization. On the other hand, it highlights the critical role of socialization (Volberda et al. 2010) and collaboration (Blomqvist and Levy 2006) capabilities that reflect an attitude of openness. In addition, a fourth category of antecedents, namely 'alertness', emerged from our qualitative study. Combining these actions and attitudes makes the ACAP of an SME embedded in a CIN a reasoned action (Ajzen and Fishbein 1975). This characteristic assumes that the SME's absorption results from an anticipated evaluation, a hypothesis that it makes about the consequences of its action (Davis et al. 1989). This evaluation is intimately linked to its beliefs of what is admissible and/or rewarding, but also to its motivations that could eventually alter its beliefs and norms (ibid).

In addition, our quantitative study provides empirical evidence of the impact of the ACAP contextual factors on its dimensions. These constructs constitute the extrinsic circumstances which activate the absorption mechanisms enabling an SME to achieve the objectives of its participation to a CIN. The SME's absorption efforts are highly correlated with the architectural and component natures of the external knowledge (Sanchez and Mahoney 1996), the dynamism of its external environment (Zahra and George 2002), the importance of its own objectives (Ahuja 2000) and its dominant role within the network (Todorova and Durisin 2007).

Also, this research proposes a vision of the interorganizational learning that takes place in a collaborative interorganizational context. Our conception goes beyond the mere accessibility to a partners' knowledge in order to achieve a mutually beneficial objective (Grant and Baden-Fuller 2004, Lubatkin et al. 2001). Indeed, our results propose that effective learning in a collaborative context combines both reciprocal and one-way perspectives that are carried out in parallel. Accordingly, an organization implements an ambidextrous innovation strategy (Raisch and Birkinshaw 2008, O'Reilly and Tushman 2008), can achieve sustainable benefits and thus accesses the best of both worlds (Gibson and Birkinshaw 2004). Moreover, the one-way learning that takes place in this context is rather discreet, meaning that it is not necessarily shared and communicated with the other actors of the CIN. Such learning allows the organization to capitalize on its collaborative experience without harming the joint creation of value that is targeted by the collaborative network (Hamel 1991, Iyer 2002).

Finally, this study contributes to the design sciences research stream (Blessing and Chakrabarti 2002) by proposing a tool to improve the design practices of an innovative product.

6.1.2 Managerial contributions

From a practical point of view, this study proposes an operationalization of the ACAP for an SME embedded in a CIN, using a maturity grid. This tool constitutes an a priori self-assessment support, which would enable an SME before or during its contribution to a CIN, to identify its strengths and weaknesses regarding the practices it should master. Hence, the SME will be able to define and implement actions to improve the skills of its project team in order to promote the success of its experience within the network.

In addition, the grid could be used as a mediation tool between the actors of a constituted CIN. Assuming that the maturity of a chain corresponds to the maturity of its weakest link (Garrett and Rendon 2005), performing an evaluation at the level of each actor would allow the network to analyze the risks related to its current configuration in order to accomplish a mutual objective of innovation. The CIN will thus be able to reconfigure itself according to the aptitudes of each actor in order to foster the innovation success.

Finally, this grid can be mobilized by SMEs in a perspective of continuous learning. Indeed, by using it in each of their CINs experiences, SMEs would identify the maturity requirements for different types of contributions to a CIN. Then, they would be able to implement improvement actions to meet the level of certain types of contributions that can be more demanding in terms of maturity. Consequently, the SMEs would continuously improve their practices in favor of collaborative innovation, which is an important lever for their competitiveness and a major focus of European policies.

6.1.3 Methodological contributions

First, this research is one of the few studies that use a mixed methodological approach to operationalize the concept of absorptive capacity (Saad et al. 2017, Sedoglavich et al. 2014, Flatten et al. 2011, Murovec and Prodan 2009, Bröring and

Leker 2007). Among them, only Flatten et al. (2011) developed a multidimensional measure of this concept. Although we also propose a multidimensional conception of the ACAP, our research is distinguished by the development of a measure in a CIN context which, moreover, is contextualized according to the factors impacting the ACAP. Indeed, the qualitative study helped identifying absorption practices that are specific to a collaborative context and has demonstrated that the relevance of these practices depends on the simultaneous effect of a set of contextual factors. The quantitative study made it possible to refine the identified practices and to explain more precisely their relevance according to the contextual determinants of the ACAP. The implementation of this mixed methodology thus enabled us to take advantage of the complementarity between qualitative and quantitative approaches (Venkatesh et al. 2013).

This research also contributes to the stream of maturity models' development, by proposing a quantitative approach to contextualize them. Hence, it offers an element of response to the studies that criticize these tools for neglecting the factors influencing and differentiating the states of maturity (Mettler 2011, Mettler and Rohner 2009). In addition, it provides support to the few authors of maturity tools that have reorganized the maturity levels of their practices and process areas according to the context in which their tools are implemented (Hribar Rajteric 2010, Lee and Wang 2011). These researchers relied on qualitative interpretations of experts to generate estimates of maturity and implemented them using a supervised automatic learning process. Similarly to these studies, we also rely on the views of experts (SMEs who have experienced CINs) in order to adapt the practices' maturity levels to the context the SME's absorption. However, instead of implementing qualitative interpretations of experts, this research uses a quantitative method to formulate the prediction equations of the practices that are relevant to an SME's context.

Finally, this study mobilizes the PLS method in order to predict the scores of the absorption practices for future cases of SMEs, according to their contexts of participation to a CIN. Hence, it represents one of the first examples that uses the PLS approach to establish statistical prediction at the indicators' level (Rönkkö et al. 2016). Indeed, in the very few operations management studies that focus on prediction (Helm et al. 2016, Juran and Schruben 2004, Mazhar et al. 2007), none of them utilize the PLS approach. Thus, this study provides a proof of the consistency of this method to predict observations.

6.2 Limits of the research

In order to operationalize the ACAP of an SME embedded in a CIN, we first used a qualitative approach to generate a characterization of this concept through a set of practices. These practices are derived from the analysis of the existing ACAP measures in the literature and were supplemented by the case studies' outcomes. In order to explore these cases, we mainly interviewed the SMEs' managers, since they are often involved on the strategic and the operational aspects of innovation projects (Garcia and Calantone 2002, Thom 1990). Moreover, they carry most of the continuous improvement and the change conduct projects within their organizations (Dettmer 1997). Although we observed a semantic saturation of the practices following the interviews, which was confirmed during the two focus groups, we assume that the mobilization of other members of the projects' teams (engineers, salesmen, etc.) would have generated other practices.

In an interorganizational context, the ACAP is a relative concept (Lane and Lubatkin 1998). This property suggests that this construct depends on the characteristics of the knowledge transmitters and receptors. Thus, in order to propose the operationalization of the ACAP of an SME embedded in a CIN, we made sure to take account of these characteristics. They refer to the cognitive distance separating the SME from its partners (Distance) and the similarity between their activities (Activity). In the qualitative and quantitative phases, we evaluated these constructs for each unit of analysis (the SME) through an overall estimation regarding its partners in the CIN. However, these two constructs act rather at a bilateral level. Hence, our weighing scheme prevents us from providing consistent theoretical insights of these factors' contributions to the concept of ACAP. This limit can be perceived through our statistical results. In fact, these two contextual constructs (Activity & Distance) only present isolated significant links (Table 6.39, p.584). Therefore, they do not allow identifying semi-regularities of their impacts on the 3 ACAP dimensions and the 2 perspectives of learning.

A final limitation relates to the modest size (72 responses) of our sample. Indeed, although our results suggest statistical models with good predictive power, we believe that a data collection at a larger scale would have allowed us to firmly assess the loadings of some removed practices and the significance of some structural links.

6.3 Perspectives of the research

First, in order to firmly assess the significance of some of our statistical results, an extension of the scale of our quantitative study can be considered. In this regard, French clusters other than the four that contributed to this research (Imaginove, Minalogic, Techtera, Viameca), but also English ones (Potentially accessible via the Bradford and Liverpool universities that are partners of the ACIC project) can be solicited in order to access a larger sample of respondents. These clusters constitute a favorable ground to identify cases of SMEs embedded in CINs, as they are accustomed to accompanying or even initiating collaborative projects (De Benedittis 2016).

Thus the mobilization of several bases of respondents would allow us to constitute a larger sample. Such a sample is an ideal opportunity to conduct a two-stage data collection so as to develop an ACAP measurement scale according to the Churchill paradigm (1979).

In addition to quantitatively reinforcing the consistency of our results, it would also be relevant to qualitatively extend some of them. This research has highlighted the unanimous impact of the contextual factor 'Importance of the role occupied by the SME in the CIN' on the 9 dimensions composing our conception of the ACAP (Table 6.39, p.584). Therefore, we propose to look closer at the various power positions that can be induced by this construct, in order to generate theoretical conceptions of the ACAP that are specific to these types of actors.

Also, to overcome our results' limit regarding the impact of the contextual factors 'Activity' and 'Distance' on the ACAP dimensions, new case studies could be conducted. In fact, they would enable us to highlight the impact of these factors on a bilateral level, i.e. between the SME and each of its partners (Lane and Lubatkin 1998). It would also be possible to investigate the intensity of this relative ACAP at different moments of the CIN lifecycle.

Finally, following three years of research in this thesis, the content of the maturity grid evaluating the ACAP of an SME embedded in a CIN and its implementation process have been defined. In order to reinforce the validity of our research, the grid should be used with real cases of SMEs embedded in CINs. In this regard, 3 SMEs from the case 'Software' agreed to test it regarding their experiences on this CIN. These applications of the grid with organizations that took part in its development will thus support the internal validity of our mixed methodological approach. On the other hand, 3 new SMEs in the new technologies, agro-alimentary and mechanical sectors, have expressed their interest to use the tool on their upcoming collaborative projects. Such tests with SMEs that have not been involved in this research will contribute to the progressive establishment of the mixed method's external validity.

7 Conclusion

Nowadays, collaborative networks are perceived as a powerful lever for the innovation and the performance improvement of SMEs (Lee et al. 2010). However, in order to generate substantial benefits from their experiences in these networks, SMEs must develop an absorptive capacity adapted to their contexts of participation to the CINs. Therefore, this research proposed an operational tool allowing an SME to evaluate its ACAP in such an innovation context. To fulfill this objective, a research protocol using a mixed method was deployed.

The first phase, a qualitative one, enabled us to characterize the absorptive capacity of an SME embedded in a CIN. It is a dynamic capability that evolves according to two parallel perspectives. On the one hand, it includes reciprocal learning by the SME to prepare and then achieve its contribution to the objectives of the network. On the other hand, it implies one-way learning to capitalize on its experience in the latter and improve the performance of its own organization.

The second phase, a quantitative one, enabled us to refine the characterization of the ACAP resulting from the qualitative approach. Using PLS structural equation modeling, we formulated the prediction equations for the relevance of the absorption practices, according to the contextual ACAP factors. These results were then implemented in a maturity grid. This tool would allow an SME embedded in a CIN assess its capacity and willingness regarding the practices that are relevant to its context of participation to the network. Following this evaluation, the SME would identify its weaknesses and formulate the necessary improvement actions to overcome them.

This thesis proposes an operationalization of the ACAP of an SME embedded in a CIN. Future studies guided by the perspectives suggested in the discussion section would extend its results.

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