SANDOR LÖWIK

MICRO-FOUNDATIONS OF ABSORPTIVE CAPACITY

A study on knowledge processes for innovation in SMEs

MICRO-FOUNDATIONS OF ABSORPTIVE CAPACITY

A STUDY ON KNOWLEDGE PROCESSES FOR INNOVATION IN SMES

DISSERTATION

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Doe en ich in eine camper

Allebei aad en gries

Veur tuffe de wijde wereld in

En zinge nog altied os eige wies

Sandor Löwik

april 2013

¹ Gé Reinders, ‘Aad waere mit dich’

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Absorptive capacity (ACAP) is considered a key concept in innovation and strategic management literature to explain why firms differ in firm performance (Lane, Koka & Pathak, 2006; Volberda, Foss & Lyles, 2010). ACAP is the ability of a firm to recognize the value of external knowledge, to assimilate it, to transform it, and to exploit it, to produce an organizational capability (Cohen & Levinthal, 1990; Zahra & George, 2002). Firms often need external knowledge as input for innovation in the form of new ideas, unexpected insights and creativity, or as resource to enable the development and commercialization of new products and services (Cohen & Levinthal, 1990; Zahra & George, 2002).

Although ACAP is important for both large and small firms, it is of particular interest for small and medium-sized enterprises (SMEs). These SMEs suffer from liabilities of smallness and newness, which hamper their innovation activities. These liabilities relate to limitations in resources (Cohen & Klepper, 1996; Ortega-Argiles, Vivarelli & Voigt, 2009), capabilities (Rothwell & Dodgson, 1994) and management attention (Jones, Macpherson & Thorpe, 2010), which limit SMEs to engage in risky or long-term innovation activities. To overcome these liabilities SMEs often engage in collaborations and alliances to spread risk and to acquire knowledge and resources from external partners (Baum, Calabrese & Silverman, 2000; Groen, Wakkee & De Weerd-Nederhof, 2008; Street & Cameron, 2007). However, to benefit optimally from these collaborations and alliances, SMEs require *high* ACAP to integrate the externally acquired resources within their organizations in order to produce new products or services.

Yet, extant ACAP literature assumes that SMEs have *low* ACAP, due to their liabilities of smallness and newness (Cohen & Levinthal, 1990). For instance, young SMEs do not have had time to build a broad knowledge base which is required to recognize new knowledge (Cohen & Levinthal, 1990). Further, SMEs often have limited capacity to engage in own R&D (Spithoven, Clarysse & Knockaert, 2010), which is required to adjust newly acquired knowledge to firm-specific requirements. Furthermore, SMEs employ only a small number of people, which restricts knowledge heterogeneity and opportunities to create a broad external network to recognize and acquire new knowledge (Raymond, Julien & Ramangalahy, 2001). Finally, SMEs often lack extensive and formal communication systems (Lang, Calantone & Gudmundson, 1997), which according to extant ACAP literature are required to diffuse the new knowledge among organization members (Cohen & Levinthal, 1990; Zahra & George, 2002).

In sum, on the one hand, literature shows that SMEs acquire new knowledge through collaborations and alliances to improve their innovation performance, which implies that SMEs have *high* ACAP to benefit from this external knowledge. Yet,

applying key assumptions of extant ACAP literature to SMEs implies that these firms have *low* ACAP. So, using extant ACAP theory on SMEs leads to paradoxical reasoning.

The appearance of these paradoxes could originate from insufficient understanding of the assumptions that underlie the ACAP construct. Mostly paradoxes are resolved by considering assumptions at different levels of analysis, regarding assumptions' temporal differences, or including assumptions from new theoretical perspectives (Poole & Van de Ven, 1989). Accordingly, to resolve the paradoxes that arise when ACAP theory is applied to SMEs, better understanding of the assumptions of the ACAP construct is needed.

In this respect, the emerging research stream on micro-foundations is of particular interest. Micro-foundations are the individual and organizational factors that determine the creation of organization-level routines and capabilities (Abell, Felin & Foss, 2008; Felin et al., 2012). As ACAP is considered an organization-level capability which consists of processes and routines (Zahra & George, 2002), the micro-foundations lens could open the black-box of the ACAP construct (Volberda et al., 2010), thereby enhancing our understanding on how individuals' actions, their interactions and organizational mechanisms shape SMEs' ACAP. Therefore, the aim of this research is to examine the micro-foundations of ACAP in order to offer practitioners and scholars insights into how SMEs can develop their ACAP and improve their innovation performance.

This research consists of one theoretical and three empirical studies. First, a literature review is conducted on four paradoxes that arise from the application of ACAP theory on SMEs. This review takes stock of the literature on ACAP in SMEs, which in turn is used to resolve the four paradoxes and to derive propositions for future research. Second, three empirical studies examine ACAP routines and their underlying micro-foundations. More specifically, the first empirical study examines the routines that are applied by SMEs to recognize new knowledge. The second empirical study investigates what antecedents affect individuals' ACAP, and the third study examines how individuals' ACAP in combination with organizational mechanisms determine organization-level ACAP in SMEs.

The results from these four studies offer insights into how SMEs can develop ACAP despite their liabilities of smallness and newness, thereby resolving the paradoxes that appear when extant ACAP literature is applied to SMEs. Further, the investigation of micro-foundations informs practitioners in SMEs about the factors that can be influenced to change ACAP in their organizations, and challenges scholars to further examine the micro-foundations of ACAP in both SMEs and large firms.

This chapter is organized as follows. Next, the theoretical background of this research is described, which leads to the overall research question. Then, the research

approach is discussed. This chapter concludes with a brief summary of the chapters in this thesis.

1.2 THEORETICAL BACKGROUND AND RESEARCH QUESTION

1.2.1 Defining absorptive capacity

The concept of absorptive capacity (ACAP) was introduced by Cohen and Levinthal (1989, 1990) who defined it as ‘the ability of a firm to recognize the value of new, external information, assimilate it and apply it to commercial ends’ (1990:128). ACAP enables firms to quickly and timely identify new and promising developments, to efficiently assimilate new knowledge among its employees, and to apply new knowledge to create new products and services. Cohen and Levinthal’s (1990) definition implies that ACAP is a multi-dimensional construct, consisting of three processes of recognition, assimilation and application which together comprise ACAP. They also conceptualized ACAP as a multi-level construct which consists of individuals’ absorptive capabilities (individual-level) and organizational mechanisms to integrate these individuals’ capabilities (organization-level). Yet, Cohen and Levinthal (1990) empirically used the mono-dimensional and firm-level factor of R&D intensity as a proxy for ACAP, which was adopted by many other scholars, thereby largely neglecting its multi-dimensional and multi-level character (Lane et al., 2006).

To stimulate new research that could further explore the richness of the ACAP construct, Zahra and George (2002) reconceptualized ACAP as a dynamic capability. A dynamic capability is defined as ‘the capacity of an organization to purposefully create, extend or modify its resource base’ (Helfat et al., 2007:4). This reconceptualization drew attention to the underlying dimensions of ACAP, which were considered to be distinctive, yet interrelated (Zahra & George, 2002). These four dimensions of acquisition, assimilation, transformation and exploitation - Zahra and George (2002) distinguished four dimensions instead of the three of Cohen and Levinthal (1990) – are assumed to be processes and routines, each with different antecedents and outcomes.

Zahra and George (2002) suggested that this dynamic capability perspective could contribute to theoretical and empirical development of ACAP in three ways. First, the notion of ACAP as a multi-dimensional construct consisting of four capabilities could provide new insights into their processes and relationships, thereby guiding practitioners to develop, maintain and renew their firms’ ACAP. Second, ACAP could be better related to broader strategic outcomes and competitive advantage, instead of merely to innovation and learning. This view also implies that ACAP is subject to purposeful managerial actions as strategic decisions on resource allocations, such as knowledge distribution, determine a firm’s competitive position. Third, a dynamic capability view could encourage studies on the conditions and

influencing factors under which ACAP would create value. This informs scholars and practitioners on why firms show different performance in the same industry, and how firms can sustain performance over time.

For this PhD research the dynamic capabilities perspective on ACAP is appropriate as it assumes that the ACAP construct is composed of routines and processes, which in turn consist of micro-foundations. These micro-foundations are the main units of analysis in this research, which are further explained in section 1.2.4. Further, the dynamic capabilities perspective assumes that managers can influence these routines to increase an organization's performance. This relates well to the aim of this research to offer practitioners insights into how they can develop their firm's ACAP to improve innovation performance.

Taking a dynamic capabilities perspective on ACAP logically implies the use of Zahra and George's (2002:186) definition of ACAP as 'a set of organizational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organizational capability'. For this PhD research two adjustments to Zahra and George's (2002) definition are made. First, Zahra and George's (2002) dimension of 'acquisition' is redefined as 'recognition', following the suggestion of Todorova and Durisin (2007). In their conception recognition includes the 'technical processes' of knowledge acquisition, but also denotes the more entrepreneurial ability to sense and identify new opportunities, which is a crucial ability to absorb novel knowledge. Second, Zahra and George (2002) define the outcome of ACAP as the production of a dynamic capability, while this research views the outcome more generally as the production of an organizational capability, which includes both 'operational' and 'dynamic' capabilities². Accordingly, throughout this thesis ACAP is defined as:

ACAP is the ability of a firm to recognize the value of new external knowledge, to assimilate it, to transform it, and to exploit it, to produce an organizational capability.

This definition comprises the 'absorptive capabilities' of recognition, assimilation, transformation and exploitation. Recognition is the ability to identify new knowledge that is critical to the firm's operations and to access, transfer and acquire externally generated knowledge. Assimilation is the ability to analyze, process, interpret and understand the information from external sources. This capability is related to sense-making, as external knowledge is often context-specific, hindering outsiders to understand or replicate this knowledge (Szulanski, 1996). Transformation is the ability to develop and refine routines that facilitate the combining of existing and

² More on differences between dynamic and operational capabilities is found in Helfat et al., (2007), Newey and Zahra (2009), Winter (2003) and Zahra et al. (2006).

new knowledge (Zahra & George, 2002: 190). This capability involves the creation of new schemas and cognitive frames to establish a fit between two distinctive knowledge components. Exploitation, the last capability, is the ability to refine, extend and leverage existing competences to create new ones by incorporating acquired and transformed knowledge into its operations (Zahra & George, 2002: 190). It encompasses Cohen and Levinthal's (1990) application, but also stresses its routine character of systematic creation of goods, systems, processes, knowledge, or organizational forms.

1.2.2. Innovation performance and absorptive capacity in SMEs

Innovation in SMEs can be problematic due to liabilities of smallness and newness. For instance, due to their size and age SMEs have limited access to resources, such as qualified personnel and external financing (OECD, 2010). Further, SMEs encounter difficulties to engage in R&D activities for new process and product development. They often have limited resources to engage in risky projects (Ortega-Argiles et al., 2009) or have a small market share which limits the opportunities to recover the costs once the new product is developed and commercialized (Cohen & Klepper, 1996). Furthermore, SME managers, and especially entrepreneurs, often lack formal management skills that are necessary to manage complex R&D projects and have difficulties to cope with complex regulations and patenting systems (Rothwell & Dodgson, 1994). Moreover, SME managers might be too occupied with day-to-day operations, so they cannot pay sufficient attention to long-term activities like new product development and technology and market scouting (Jones et al., 2010).

To circumvent these liabilities of smallness and newness, SMEs engage in collaborations and strategic alliances to get access to resources, which enable them to develop new products and services, and to enter new markets (Street & Cameron, 2007). For instance, SMEs that establish a large network of alliances have higher innovation performance (Baum et al., 2000). Further, a case study of a high-tech start-up showed how alliances with a university gave access to research facilities, and how collaboration with a multi-national provided resources to exploit current knowledge (Groen et al., 2008). Furthermore, a study on SMEs in the Dutch medical devices industry shows that collaboration with external partners help to overcome limitations in innovation processes in a complex and highly regulated industry (Pullen et al., 2012). Moreover, Van de Vrande et al. (2009) studied open innovation practices of SMEs and found that the majority of SMEs engaged in inter-organizational networks and collaborations with customers to improve product development, to integrate new technologies and to keep up with current market developments.

Yet, managing these collaborations and alliances are not without problems. Van de Vrande et al. (2009) also studied the barriers for open innovation practices. They found that organization and culture-related issues regarding the alignment of

collaboration partners were most hindering innovation processes in SMEs. This confirms Cohen and Levinthal's (1990) and Grant's (1996) arguments that for effective knowledge exchange and learning some level of common knowledge or language is required in order to relate the new knowledge to what is already known. Further, Lane and Lubatkin (1998) empirically showed that inter-firm learning is more effective when these firms show similarities regarding basic technological knowledge, organizational structures and problem solving logic. These issues about common knowledge as a prerequisite for effective learning relate to what Nooteboom et al. (2007) called 'cognitive distance'. Cognitive distance denotes differences in knowledge, competences, motives, values and beliefs, which determine the alignment of activities between alliance partners. Nooteboom et al. (2007) argued that a focal firm's innovation performance as a function of cognitive distance between alliance partners takes the form of an inverted U-shape, as graphically represented in Figure 1.1.

Figure 1.1. A firm's innovation performance, novelty value and absorptive capacity as function of cognitive distance between alliance partners (Nooteboom et al., 2007)

This inverted U-shape is the result of two counteracting factors, which are depicted by two straight lines that represent the novelty value of knowledge from the alliance and the ACAP of the focal firm. The novelty value of knowledge increases with increasing cognitive distance. The argument made in literature is that novel knowledge typically comes from distant partners that operate in other markets, industries or technological domains than the focal firm (Burt, 2000). Through these so-called 'weak ties' firms can get access to novel knowledge which is regarded a key resource for breakthrough innovations (Granovetter, 1973; Katila & Ahuja, 2002). However, the benefits that can be achieved from this novel knowledge from a partner at larger cognitive distance depend on the focal firm's ACAP (Mowery, Oxley & Silverman, 1996; Nooteboom et al., 2007). The effect of ACAP decreases with

increasing cognitive distance between alliance partners due to communication problems that result from lack of commonalities across the alliance partners.

In sum, the two counteracting factors of increasing knowledge novelty and decreasing effects of ACAP lead to an optimum in innovation performance at moderate cognitive distance. At the left-hand side of Figure 1.1., increasing cognitive distance leads to more novelty value of knowledge as it is still easily absorbed by the firm. At the right-hand side of Figure 1.1, innovation performance drops as it becomes harder for the firm to absorb the potentially valuable knowledge with increasing cognitive distance.

When the aforementioned reasoning is applied to SMEs, the advice to SME managers to enhance the probability for innovations would be to increase the firm's ACAP. This would enable these SMEs to absorb novel knowledge from partners at larger cognitive distance in other industries and markets, which could result into more innovative processes, products and services. This strategy is also suggested by the OECD (2010: 154), which states that ACAP of SMEs needs to be strengthened as lack of motivation and capacities proves to be the main barrier for university-industry knowledge exchange.

However, young and small firms are assumed to have low ACAP and difficulties to develop it, due to the relative small prior knowledge base that is developed over a short time period or by only a few people. This was emphasized by Cohen and Levinthal (1990:138) who stated that 'firms may not realize that they should be developing their absorptive capacity due to the irony associated with its valuation: the firm needs to have some absorptive capacity already to value it appropriately'. So, on the one hand SMEs are suggested to increase their ACAP to enable effective collaborations with external partners to circumvent liabilities of smallness and newness. On the other hand, ACAP literature assumes that particularly SMEs have difficulties to develop ACAP, due to these liabilities of smallness and newness. These seemingly contradictions are further described in the next section.

1.2.3 Paradoxes of ACAP in SMEs

When theoretical assumptions in extant ACAP literature are applied to SMEs four paradoxes emerge that need to be resolved to develop suggestions on how SMEs can enhance their ACAP. The first paradox concerns the path-dependent nature of ACAP, which means that ACAP develops cumulatively over time. Extant ACAP literature assumes that the more diverse a firm's knowledge base, the easier it is to recognize new knowledge and to absorb it, as the new knowledge is easier associated with what is already known (Cohen & Levinthal, 1990). Yet, small and young firms do not have had time to build experience or an extensive knowledge base. Still, these firms are able to acquire knowledge and some even create breakthrough innovations (Baum et al., 2000; OECD, 2010).

The second paradox relates to the role of in-house knowledge creation capabilities, such as R&D. Extant ACAP literature assumes that firms need these capabilities to absorb new knowledge and to apply it to create new products and services (Cohen & Levinthal, 1990). However, as mentioned earlier, SMEs often have limited R&D capabilities (Spithoven et al., 2010) or do not have R&D employees at all (Hervas-Oliver, Garrigos & Gil-Pechuan, 2011). Despite this lack of in-house knowledge creating capabilities, SMEs seem capable to assimilate knowledge from external partners.

The third paradox relates to the assumption in ACAP literature that ACAP depends on the heterogeneity of the sum of individuals' prior knowledge (Cohen & Levinthal, 1990). However, SMEs have relatively few employees which reduce knowledge heterogeneity and limit the exchange opportunities with the firm's environment (Raymond et al., 2001; Vossen, 1989). Still, SMEs collaborate with other firms.

The fourth paradox concerns the assumption in extant literature that organizational ACAP not only depends on the sum of the individuals' ACAP, but also on social integration mechanisms to integrate these individuals' knowledge (Cohen & Levinthal, 1990; Zahra & George, 2002). However, SMEs are considered flexible and innovative due to the absence of these (formal) integration mechanisms (Nooteboom, 1994).

These four paradoxes show that the application of extant ACAP literature on SMEs is not straightforward. Specific characteristics of SMEs due to limitations of smallness and newness call for a better understanding of the assumptions underlying ACAP theory, in order to resolve these paradoxes. Therefore, examination of the micro-foundations of ACAP could provide new insights into how SMEs develop ACAP to benefit from collaborations and alliances.

1.2.4 Micro-foundations of ACAP

Micro-foundations are individual and organizational factors that determine the creation of organization-level routines and capabilities (Abell et al., 2008; Felin & Foss, 2005; Felin et al., 2012). The micro-foundations stream in strategic management originated recently from critiques on the assumptions that underlie knowledge-based and dynamic capability theories. In these theories, capabilities and routines are regarded as key organization-level units of analysis that can explain differences between firm performances (Teece, Pisano & Shuen, 1997; Helfat et al., 2007; Kogut & Zander, 1992; Winter, 2003). In turn, most research study antecedents and outcomes at organization-level, thereby assuming homogeneity at lower-levels of analysis (Felin & Hesterly, 2007). This homogeneity-assumption views individuals as being malleable with a random distribution of individual characteristics within organizations (e.g. Spender, 1996). However, some scholars questioned this assumption on individual

homogeneity and argued that individuals are the locus of knowledge creation and that heterogeneity of individual-level factors better explains firm performance than organization-level factors (Felin & Hesterly, 2007; Grant, 1996; Simon, 1991). This has resulted in a focus on micro-foundations in knowledge-based and dynamic capability literature, which has been defined as individuals' actions and interactions that determine the creation of organization-level routines and capabilities (Abell et al., 2008; Felin & Foss, 2005).

More recently the micro-foundations concept has been expanded to include not only individuals' actions and interactions, but also organizational processes and structures (Felin et al., 2012; Hodgson, 2012). The reasoning is that capabilities and routines are created by the mutual interaction between individuals and organizational mechanisms. Where Felin and Foss (2005: 441), in favor of individual-level micro-foundations, argued that 'organizations are made up of individuals, and there is no organization without individuals', Hodgson (2012: 1391), as a critique on Felin and Foss (2005), argued that 'there is no organization without social relations'. The current micro-foundations stream assumes that organizations differ in performance due to differences in individuals, their social processes and organizational structures (Felin et al., 2012). The aim of this emerging stream is to take a multi-level perspective on routines and capabilities to explain how these are built, maintained and changed by individuals' behavior and their interaction with organizational mechanisms (Felin et al., 2012; Foss, 2011).

This micro-foundations perspective is appropriate to study ACAP for two reasons. First, ACAP is assumed to be grounded in individuals' prior knowledge and cognitions as Cohen and Levinthal (1990:131) stated: 'An organization's absorptive capacity will depend on the absorptive capacities of its individual members'. These individual members at the interface of the organization and its environment determine which knowledge is identified as valuable and is acquired subsequently (Cohen & Levinthal, 1990). Further, individuals' creativity determine the extent and ways in which the newly acquired knowledge is used to create new products, processes and services (Lane et al., 2006; Zahra & George, 2002). Second, ACAP is considered to be the product of individuals' ACAP and organizational mechanisms. These organizational mechanisms relate to communication structures of knowledge transfer from the external environment into the organization, and to dissemination of this knowledge within the organization. To quote Cohen and Levinthal (1990:131): 'A firm's absorptive capacity is not, however, simply the sum of the absorptive capacities of its employees, and it is therefore useful to consider what aspects of absorptive capacity are distinctly organizational'.

Although ACAP literature has called for more research on these micro-foundations, empirical studies are still scarce (Lane et al., 2006; Volberda et al., 2010). Some studies examined effects of organizational mechanisms on the four dimensions of ACAP (e.g. Jansen, Van den Bosch & Volberda, 2005) or investigated the effects of organization-level factors on individual behavior (e.g. Lenox & King, 2004; Minbaeva et al., 2003; Zhao & Anand, 2009). Others examined the effects of factors at the individual level on outcomes at organization-levels (e.g. Hayton & Zahra, 2005; Zhao & Anand, 2009). However, these studies have not examined the *joint* effects of individual and organizational factors on ACAP, while this combined effect was implicitly suggested by Cohen and Levinthal (1990) when they stated that ACAP of an organization is not the mere sum of its individuals' ACAP.

To summarize, extant ACAP literature hardly has studied the micro-foundations of ACAP, and therefore scarcely provide suggestions to SME managers on how to improve their firm's ACAP. More insight into these micro-foundations of ACAP could inform SME managers how to increase organizational ACAP. This could enable them to collaborate with partners at larger cognitive distance to acquire more novel knowledge, thereby increasing their innovation performance. Therefore, this study aims to contribute to ACAP literature by answering the following research question:

How can small and medium sized enterprises develop their absorptive capacities to improve their innovation performance?

1.3 RESEARCH APPROACH

This PhD research consists of one conceptual study and three empirical studies. This paragraph describes the research approach taken for these studies. A more detailed description of the applied research methods is found in the corresponding chapters.

1.3.1 Theoretical research approach

The study in Chapter 2 is a systematic literature review to explore the four paradoxes that arise when extant ACAP literature is applied to SMEs. As discussed in section 1.2.3 the four paradoxes relate to 1) the path-dependent nature of ACAP, 2) the role of in-house knowledge creation such as R&D, 3) the characteristics of individual organization members and 4) the effects of social integration mechanisms. The literature review aims to resolve the paradoxes to understand how SMEs are able to manage ACAP, in order to benefit from new external knowledge despite their limitations. To do so, for each paradox relevant literature is reviewed that addresses ACAP in the context of SMEs. The systematic literature review is based on 44 articles which comprise several research fields, such as small business management, entrepreneurship, innovation management, alliance management, information systems and internationalization. Based on this review, each paradox is resolved and

propositions are developed that challenge and extend key assumptions of extant ACAP theory. The study concludes with a research agenda regarding the temporal characteristics of ACAP, its idiosyncratic characteristics as a dynamic capability, individuals' characteristics regarding decision making, and the role of social integration mechanisms in different organizational configurations.

1.3.2 Empirical research approach

The empirical research setting is the manufacturing industry in the Eastern part of The Netherlands. The regions of Twente and Achterhoek have the second-highest population of manufacturing firms after the region of Noord-Brabant (Boomkamp et al., 2011). Due to the presence of the University of Twente and the Saxion university of applied sciences, industrial firms have access to new technologies and to highly educated employees. Yet, the overall innovation performance of industrial firms in the Twente/Achterhoek region is around average in comparison to other regions in The Netherlands (Van Wijk, 2010). Further, in 2008-2010 around 60% of the innovations was created in-house, while only 34% of industrial firms developed innovations with third parties (Boomkamp et al., 2011). Based on these figures, it is assumed that the potential to benefit from collaborations and alliances is not fully exploited yet, which makes this an appropriate research setting to study how ACAP could be improved.

An empirical study on how SMEs recognize new knowledge

The empirical study in Chapter 3 aims to answer the question of how SMEs recognize new knowledge. Recognition is the first step of ACAP and it includes the processes of searching, identifying and acquiring new valuable knowledge (Cohen & Levinthal, 1990). The study addresses the effects of cognitive distance on novelty of knowledge, as explained in paragraph 1.2 and Figure 1.1. It is assumed that with higher cognitive distance, the novelty value of the acquired knowledge increases. In this empirical study, cognitive distance is operationalized as 'strong' and 'weak' ties. Strong ties are established, high-frequent and long-lasting relationships which are associated with low cognitive distance, whereas weak ties are new and low-frequent relationships, which are associated with high cognitive distance. This study examines how SMEs recognize knowledge in weak and strong ties.

For this study a case study approach was chosen as it was explanatory in nature (Yin, 2009). The sample consisted of four Dutch technology oriented SMEs in the Eastern part of The Netherlands where in total 20 interviews were taken from multiple respondents. This sample consisted of two firms which participated in the research project 'Competences for Innovation' in which this PhD research was embedded. The project was a collaboration between the University of Twente and 18 industrial firms in the Eastern part of The Netherlands, which main goal was to strengthen the innovation competences of industrial SMEs in order to improve their competitive

market position. Initially two of the industrial SMEs showed interest in participation in the study on knowledge recognition. As the study focused on acquiring new knowledge from external partners, the two SMEs were asked to mention the source from which they had received the most innovative knowledge during the last year. These two sources also appeared to be technology oriented SMEs and were asked to participate in the study. Doing so, the number of cases was increased, which offers more accurate, more generalizable and better grounded theory, compared to a single case study (Eisenhardt & Graebner, 2007).

In contrast to literature, this study found that SMEs not only find new knowledge in weak ties, but also in strong ties. While extant literature assumes an inverted U-shaped relationship between tie-strength and new knowledge acquisition, this study suggests a positive, curvilinear relationship. The multiple case study shows that firms use specific relational capabilities - which are defined “bridging capabilities” - to acquire new knowledge. These bridging capabilities mitigate the risk of overembeddedness in strong ties through increasing multiplexity, that is, through establishing and leveraging multiple relations within a single tie. The findings suggest that small firms should invest more in the exploration of strong ties instead of increasing their weak tie network. This empirical study contributes to ACAP literature on SMEs by showing how bridging capabilities act as micro-foundations to recognize new knowledge.

An empirical study on individual ACAP

The empirical study in Chapter 4 specifically looks into the antecedents, dimensions and outcomes of individual ACAP. As discussed in section 1.2.4 individuals are a key factor in determining the micro-foundations of ACAP. This study aims to determine the effects of three antecedents - prior knowledge, network diversity and cognitive style - on individuals’ ACAP. Yet, in ACAP literature no proper measurement scale for individuals’ ACAP is available. Therefore this study also conceptually defined individuals’ ACAP and developed a measurement scale for it. Data was collected through a survey which was administered among 147 employees of a Dutch kitchen manufacturer, and analyzed with the structural equation method of Partial Least Squares (PLS).

This study shows that an individual’s bisociative cognitive style is more important than an individual’s prior knowledge, and that external network diversity is another relevant antecedent for individual ACAP. Furthermore, it shows that individual ACAP predicts employees’ idea generation and implementation activities, and that managers have higher levels of individual ACAP than non-managers. As such, this paper contributes to a better understanding of the micro-foundations that underlie ACAP and dynamic managerial capabilities.

An empirical study on individual and organizational micro-foundations of ACAP

The third empirical study, which is described in Chapter 5, is a multi-level study to explain how micro-foundations of ACAP at individual and organization-level jointly determine organizational ACAP. A multi-level approach is warranted as Cohen and Levinthal (1990) explicitly stated that ACAP is built from individuals' capabilities and organizational mechanisms, implying that there are at least two levels of analysis: the individual and the organizational level (Lane et al., 2006; Volberda et al., 2010).

The research approach involved a quantitative survey method within a multiple case- study setting. Four case-study firms were selected for this study, which were different from the empirical study in Chapter 3, but included the kitchen manufacturer of Chapter 4. These cases were chosen mainly on research access. To be able to acquire comprehensive information about individual characteristics and organizational factors, a survey was administered among all employees. Due to the large number of variables and to warrant a high response rate the survey was administered during working hours. This required quite an investment in time and internal organization of the case study firms. One of these case study firms was a participant in the project 'Competences for Innovation'. The other three firms were approached by the researcher. In total 297 questionnaires of employees within the four case study firms were used for analysis.

To determine the micro-foundations of organizational ACAP, the interaction between individual and organizational factors in relation to departmental ACAP were examined. The choice for departmental ACAP as organizational level of analysis is related to the applied research method. First, to study interactions between micro- and macro-level variables, the number of macro-level variables determines the availability of appropriate methods of (statistical) analysis and generalizability of the results. With four case study firms the number of cases at organizational level would be relatively small, while at departmental level the number of cases could be increased to 48. Second, to determine organizational mechanisms it was assumed that employees would be better able to assess organizational mechanisms of their own department than those of the organization.

To assess the relative importance of individual and organizational factors in terms of necessary and sufficient conditions, this study applied a fuzzy set qualitative comparative analysis (fs/QCA) approach to derive multiple configurations which lead to high or low organizational ACAP. This study contributes to ACAP literature by finding empirical support for Cohen and Levinthal's (1990) assumption that organizational ACAP is more than just the sum of the individuals' ACAP that comprise the organization. The results show that individuals' ACAP is a necessary, yet insufficient condition for high organizational ACAP. In addition, organizational mechanisms are needed that facilitate knowledge exchange (through establishing formal and informal communication channels) and that motivates employees to

exchange their knowledge (through culture and management style). The study also shows that there are several combinations of individuals' ACAP and organizational mechanisms that lead to high or low organizational ACAP, which implies that there is no 'one best solution'. This provides SME managers alternative ways to improve their firm's ACAP, and offers scholars new insights into the micro-foundations of ACAP.

1.4 OUTLINE OF THIS THESIS

The remainder of this thesis is organized as follows. **Chapter 2** describes the systematic literature review on the four paradoxes that arise when ACAP theory is applied to SMEs. This chapter examines the four paradoxes and offers suggestions on how these paradoxes can be resolved, and provides a research agenda.

Chapter 3 presents the empirical case study on how SMEs use strong ties as sources of new knowledge. This chapter examines the routines and processes of the first dimension of ACAP: recognition. It shows the 'bridging capabilities' that SME managers develop to acquire new knowledge from long-lasting relationships with customers and suppliers. In contrast to extant literature, the study suggests that in order to get access to novel knowledge, SMEs might better invest in bridging capabilities with existing partners, instead of searching for new partners.

Chapter 4 describes the empirical study on the effects of prior knowledge, networks and cognitive style on individuals' ACAP. This chapter conceptually describes individual ACAP and presents a measure for it. Further, the antecedents and outcomes of individual ACAP are examined. The study shows which antecedents are most important to explain individuals' ACAP, thereby enhancing the understanding of individual-level micro-foundations of ACAP.

Chapter 5 examines the joint effects of individuals' ACAP and organizational mechanisms on organization-level ACAP. It uses a configurational approach to show that individuals' ACAP is a necessary, yet insufficient condition for organizational ACAP, and that organizational mechanisms are complementary. The study further shows that there is equifinality in the configurations, indicating that there are multiple ways to achieve high ACAP. These results contribute to a better understanding of the causal complexity of the micro-foundations of ACAP and have implications for managerial dynamic capabilities.

Chapter 6 integrates the results of the theoretical and empirical studies in order to answer the research question of how small and medium sized enterprises can develop their ACAP to improve their innovation performance. From this research, two strategies for SMEs are derived to improve their innovation performance. Further, a model is presented to show the relationships between the studies of this PhD research. Then theoretical and practical implications and contributions are described. Finally, research limitations and avenues for future research are discussed.

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CHAPTER 2

PARADOXES OF ABSORPTIVE CAPACITY IN SMES: A REVIEW AND RESEARCH AGENDA

Four paradoxes arise when absorptive capacity (ACAP) theory is applied to small and medium sized enterprises (SMEs). These paradoxes concern 1) the path-dependent nature of ACAP, 2) the role of in-house knowledge creation such as R&D, 3) the characteristics of individual organizational members, and 4) the effects of social integration mechanisms. To resolve these paradoxes, we conducted a systematic literature review on ACAP in SMEs. In this review we examine how SMEs develop and maintain ACAP despite the paradoxes. Based on this review we develop propositions that challenge and extend key assumptions of extant ACAP theory. We conclude with a research agenda with research opportunities regarding the temporal characteristics of ACAP, its dynamic capabilities characteristics, managerial decision-making and different organizational configurations.

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2.1 INTRODUCTION

Although absorptive capacity (ACAP) is becoming a central theoretical concept in management literature, little attention has been paid to explain how this construct applies to small and medium-sized enterprises (SMEs). This is remarkable as ACAP is associated with benefits of new knowledge from collaborations and alliances with external partners, which is of particular interest for SMEs, whose own knowledge and resources generally are limited. Research on SMEs shows that these firms are able to collaborate and to benefit from these collaborations (e.g. Almeida, Dokko & Rosenkopf, 2003; Baum, Calabrese & Silverman, 2000; Groen, Wakkee & De Weerd-Nederhof, 2008; Tether, 2002; Van de Vrande et al., 2009), which suggests that these SMEs have *high* ACAP. However, according to ACAP theory, SMEs are considered to have *low* ACAP (Cohen & Levinthal, 1990). This apparent inconsistency manifests itself in four paradoxes that arise from the application of key assumptions of extant ACAP theory to the context of SMEs.

The first paradox results from the assumption in extant ACAP literature that ACAP depends on prior knowledge and experience (Cohen & Levinthal, 1990), while small and young firms have not had the time to develop knowledge and experience yet. The second paradox relates to the assumption that ACAP is mainly dependent on the level of R&D activities (Cohen & Levinthal, 1990), while most SMEs have low levels of R&D (Spithoven, Clarysse & Knockaert, 2010), or do not have R&D departments or R&D employees at all (Hervas-Oliver, Garrigos & Gil-Pechuan, 2011). Third, extant literature assumes that ACAP of an organization depends on the diversity of specialist knowledge of its organization members (Cohen & Levinthal, 1990), while SMEs are characterized by a small number of employees who are more generalist than specialist. The fourth paradox results from the assumption in ACAP literature that social integration mechanisms are needed to facilitate internal knowledge dissemination (Cohen & Levinthal, 1990; Zahra & George, 2002), while informal communication structures and lack of bureaucratic structures are generally regarded as the main reasons for SMEs' innovativeness and flexibility (Nooteboom, 1994).

To advance understanding of ACAP in SMEs, these paradoxes first need to be resolved. In turn, these paradoxes could stimulate further theory building by presenting opportunities to discover different assumptions, shifting perspectives, posing problems in fundamentally different ways, and focusing on different research questions (Poole & Van de Ven, 1989:564). So, the aim of our study is to resolve these paradoxical findings on ACAP in SMEs, thereby contributing to new insights on the assumptions underlying the ACAP construct and offering new research opportunities.

This study applies a systematic literature review, which is warranted when research on the topic under study is dispersed over multiple research fields (Torraco, 2005; Webster & Watson, 2002). The studies that address ACAP in SMEs are found

among several research streams like small business management, entrepreneurship, innovation management, alliance management, information systems and internationalization, and are only marginally addressed in the main management journals.

This review contributes to ACAP literature and dynamic capability literature in four ways. First, it shows that the cumulative and path dependent nature of ACAP does not need to be considered a threat for SMEs, but can be used as a strength to develop ACAP quickly, thereby outperforming their larger counterparts. It highlights that ACAP is a dynamic construct in stead of a static prior knowledge base. As such this study contributes to research on the dynamization of capabilities (Schreyögg & Kliesch-Eberl, 2007) by explaining how firms can radically change their capabilities to overcome the risk of path dependency and rigidity (Leonard-Barton, 1992) and to engage in ‘creative destruction’ (Malerba & Orsenigo, 1997).

Second, in contrast to extant literature, our review shows that external knowledge acquisition can act as a *substitute*, in stead of a complement, for internal knowledge creation. The review shows that SMEs do not need in-house knowledge creation capabilities, such as R&D, when the external knowledge source is able to provide knowledge that is tailored towards firm-specific requirements. This finding poses questions on what aspects of ACAP are idiosyncratic and how these affect a firm’s competitive advantage.

Third, the review shows that organizational ACAP not only depends on the diversity of individual prior knowledge, but also on other individual capabilities, such as relational capabilities and organizing capabilities. Also, the individual ACAP of (middle) managers seems to be more important than ACAP of other organization members, such as R&D employees. This calls for more research on the importance of personal characteristics of managers in relation to their individual ACAP.

Fourth, our study suggests that social integration mechanisms can offer structure and control to increase efficiency in knowledge processes up to a threshold value, after which too much social integration mechanisms can hinder creativity and flexibility, indicating an inverted U-shaped relationship with ACAP development. Our review challenges the implicit assumption in extant literature that organizations are functionally structured and offers research opportunities to understand how ACAP can be developed in other organizational structures, such as teams and ‘ambidextrous’ organizations (Lavie, Stettner & Tushman, 2010; O’Reilly & Tushman, 2008).

This chapter is organized as follows. The next section explains the method of the systematic literature review and data analysis. Then, we discuss each of the four paradoxes subsequently, leading to propositions that revise or extend current assumptions underlying ACAP theory. The chapter ends with discussion and a research agenda.

2.2 METHOD

We conducted a systematic literature review, following the protocols as outlined by Tranfield, Denyer and Smart (2003) and Macpherson and Holt (2007). In general, we used a two-stage approach. First, we defined review protocols to map the field on ACAP in SMEs. Second, we analyzed the results to identify the main paradoxes and to examine how the reviewed literature contributes to resolving these paradoxes.

2.2.1 Review protocol

The first step to start our review was to identify the key words and search strings. We used five search strings of “absorptive capacity” in combination with “small”, “medium”, “sme” “venture”, and “start-up” in title, abstract, keywords or topic in the databases of Scopus (Social Sciences and Humanities) and Web of Science (Social Sciences Citation Index). An overview of the review protocol is provided in Table 2.1. We restricted the search to peer reviewed articles. This initial search resulted in 663 articles, which were exported to referencing database software EndNote. After removing 207 duplicates we kept 456 articles for further study.

Search string	Scope	Date of search	Date range	Nr. of entries
Search protocol for Scopus				
“absorptive capacity”				
AND “small”	Title, keywords and abstract	2 March 2012	1980-present	60
AND “sme”	Title, keywords and abstract	2 March 2012	1980-present	12
AND “venture”	Title, keywords and abstract	2 March 2012	1980-present	39
AND “start-up”	Title, keywords and abstract	2 March 2012	1980-present	9
AND “medium”	Title, keywords and abstract	2 March 2012	1980-present	51
Search protocol for Web of Science				
“absorptive capacity”				
AND “small”	Topic or title	2 March 2012	1980-2012	101
AND “sme”	Topic or title	2 March 2012	1980-2012	18
AND “venture”	Topic or title	2 March 2012	1980-2012	291
AND “start-up”	Topic or title	2 March 2012	1980-2012	13
AND “medium”	Topic or title	2 March 2012	1980-2012	69
Total in Endnote				663
Removing duplicates				- 207
Selecting "absorpt*" in abstract				- 297
Selecting based on exclusion criteria				- 107
Removed after complete reading				- 11
Included after complete reading				+ 3
Total selected for review				44

Table 2.1: Overview of review process

As shown by the review of Lane, Koka and Pathak (2006), many articles try to benefit from the popularity of the ACAP construct, while only using it as a minor citation. Due to the available search options in Scopus and Web of Science, the first selection included studies with search strings used in general indices as ‘key words’ and ‘topics’ while we were interested only in articles that used ACAP as a main construct in their theory. Therefore we refined the scope by using the search and select functions of the database referencing software to select only those papers that used “absorpt*” in their abstract or title. This way we ensured that the selected articles at least had the intention to use ACAP as a main construct in their study. From this step 297 articles were dropped, leaving 159 of which the abstract was studied in detail. Based on the abstracts, we decided whether the article should be selected for complete reading, based on the inclusion and exclusion criteria, which are mentioned in Table 2.2.

Nr.	Criteria	Reason for exclusion
1	Pre 1980-articles	The concept absorptive capacity was first coined by Cohen & Levinthal (1989). It is expected that papers before 1980 do not address this topic specifically
2	“Absorpt*” not mentioned in abstract	Lane et al. (2006) showed that almost 80% of papers in their review used ACAP as minor citation. If it is not mentioned in the abstract or title, it assumed not to be treated as a relevant factor
3	Firms larger than 500 employees	This does not include SMEs
4	Sample selection not based on firm size	Empirical papers that do not sample on firm size, do not explicitly focus on SMEs
5	ACAP of clusters, regions or countries	The focus of this paper is on firms as the main level of analysis
6	ACAP in education	This does not refer to firms
7	Medical topics	This does not refer to firms
8	SMEs acquired by large firms	These SMEs get internalized, hence get access to more resources from the parent firm
Nr.	Criteria	Reason for inclusion
1	Empirical papers with samples with small and large firms	This allows for determining specific characteristics of SMEs compared to large firms
2	Small and medium sized (international) joint ventures	These are often ‘stand-alone’ firms

Table 2.2: Exclusion and inclusion criteria

When a decision could not be made based on the abstract, the full paper was checked for additional information, for instance to check whether the empirical part focused on SMEs. Finally 52 papers were kept for analysis. After complete reading, 11 papers were evaluated to be of low academic quality or not fulfilling the aim of the review

and were excluded from the analysis. Further, during complete reading 3 papers were added to the selection, which were deemed to fulfill the inclusion criteria, but had been missed in the review selection process (Huang & Rice, 2009; Liao, Welsch & Stoica, 2003; Muscio, 2007). Finally, 44 articles were used for comprehensive data analysis.

2.2.2 Data analysis

The data analysis was designed as a three-stage process. During the first stage of data-analysis the selected articles were fully read and assessed on the main challenge(s) that the article's author(s) regarded the main reasons for their study. These challenges then were categorized, and confronted with key assumptions of extant ACAP literature which ultimately resulted in four paradoxes.

In the second stage, the articles were fully read again to identify the main hypotheses and key findings that related to ACAP in SMEs to determine the contribution of the studies to each of the paradoxes. Further, the applied research methodology and the definition and operationalization of the ACAP-construct were examined to assess the theoretical embedding of ACAP of each study.

Then, the third stage of data analysis concerned resolving the four paradoxes. For this we relied mainly on the suggestions of Poole and Van de Ven (1989) on how to use paradoxes for theory building. They offer three solutions to resolve paradoxes. The first solution is 'spatial separation' of the two seemingly conflicting propositions or statements. This assumes that the paradox is caused by arguments that are made at different levels of analysis, for instance the individual-organizational level or organizational-cluster level. The paradox is caused by treating a multi-level phenomenon as a single-level construct, which applies assumptions at one level to the other. When the conditions differ per level, these assumptions fall short.

The second solution that is suggested by Poole and Van de Ven (1989) is 'temporal separation'. This approach takes account of the effects of time. The assumption here is that the two seemingly conflicting propositions are both true, but at different time periods. It could be that one proposition precedes the other, or that they swing back and forth in time.

The third way to resolve paradoxes is 'synthesis', which implies the introduction of new terms. The assumption here is that the paradox stems from conceptual limitations and flaws in theoretical assumptions. Poole and Van de Ven (1989:562) state that every organizational theory has its limitations, as it tries 'to capture a multifaceted reality with a finite internally consistent statement (..)', which makes it '(..) essentially incomplete'. They suggest that the introduction of new concepts and new perspectives can address these conceptual limitations. The application of these three approaches of Poole and Van de Ven (1989) to resolve the paradoxes leads to propositions that extend ACAP theory and offer new research directions.

2.2.3 Sample characteristics

The 44 selected articles cover several research fields which is indicated by the ten journals that cover more than half of the selected articles: technology management (*Research Policy*: 5 articles; *Technovation*: 4 articles; *International Journal of Technology Management*: 2 articles; *Industry and Innovation*: 2 articles), entrepreneurship (*Entrepreneurship and Regional Development*: 3 articles; *Entrepreneurship Theory and Practice*: 2 articles; *Journal of Business Venturing*: 2 articles), small business management (*Journal of Small Business and Enterprise Development*: 2 articles) and strategic management (*Strategic Management Journal*: 2 articles). Further, only two articles (4.5%) come from general and strategic management journals³, which seems to confirm that extant literature mainly focuses on large firms and only marginally address the challenges of ACAP in SMEs. Also, we expect an increasing trend in popularity in the topic of ACAP in SMEs. Since 2001 there is a more or less stable number of 3 to 4 yearly papers⁴, which increases in 2009 and 2011 to 7 yearly papers.

The sample consists of 4 conceptual papers, one literature review and 39 empirical papers. From these empirical papers 5 applied qualitative research with case studies, while the others used quantitative research methods, mostly based on surveys. Only one study used longitudinal data (Rothaermel & Thursby, 2005).

The definition of SMEs varies across studies, from less than 100 employees (Branzei & Vertinsky, 2006) to less than 650 employees (Malik & Wei, 2011). Not all studies report the selection criteria of SMEs (e.g. Lane, Salk & Lyles, 2001; Lin et al., 2009; Wang & Han, 2011), and some studies use age to define young firms (e.g. Larrañeta, Zahra & González, 2012).

The definition and operationalization of ACAP also varied across studies. Almost half of the studies used a mono-dimensional operationalization of ACAP like R&D expenditures or R&D intensity (5 studies), or another measure that mostly represented some form of prior knowledge (21 studies) like prior internationalization knowledge (Fernhaber, McDougall-Covin & Shepherd, 2009), training expenditures (Huang & Rice, 2009) or technological workforce (Lal, 2007). This is despite the call for more multi-dimensional measures by Lane et al. (2006). In contrast, the other half of the studies did use multi-dimensional operationalizations of ACAP. Most of these studies (11) followed the conceptualization of Zahra and George (2002) and used four dimensions. Other studies (4) used three dimensions in line with Cohen and Levinthal (1990) and Lane et al. (2006). In total 8 studies developed another multi-dimensional

³ The main general and strategic management journals considered here are: *Academy of Management Review*, *Academy of Management Journal*, *Administrative Science Quarterly*, *Journal of Management*, *Journal of Management Studies*, *Management Science*, *Organization Science*, *Strategic Management Journal*.

⁴ Before 2001 there is only one article in our sample which is Mowery et al. (1996)

measure which often contained R&D-related and non R&D-related items (e.g. Hervas-Oliver et al., 2011; Julien, Andriambeloson & Ramangalahy, 2004).

In sum, the sample of articles is quite diverse, with different theoretical perspectives and conceptualizations and measurements of the key variables SME and ACAP. To ensure validity and reliability of our analysis we provide an overview of the articles in our sample in Appendix 2.1.

2.3 PARADOXES OF ACAP IN SMES

In the following section we first describe each paradox, which is related to a basic assumption in ACAP literature. Then we use the results from our literature review to discuss how SMEs manage these paradoxes. Based on the three approaches to resolve paradoxes (Poole & Van de Ven, 1989) we derive propositions for each paradox, which challenges or refines a key assumption that underlies the paradox.

2.3.1 Paradox 1: ACAP is path dependent, yet young firms do not have history

Key assumption. One of the most accepted and most important assumption of ACAP is that it is path and history dependent. Cohen and Levinthal (1990: 136) state that ‘accumulation of ACAP in one period will permit its more efficient accumulation in the next’. Their assumption is that new knowledge can only be absorbed when it is somehow related to knowledge already possessed. This implies that the more diverse an organization’s knowledge base – hence its prior knowledge - , the easier the organization can recognize new knowledge, understand its value, transform it to meet the organization’s requirements and apply it into products, services and processes. Contrary, when organizations have a too narrow knowledge base they run the risk to focus on specific competences to which the organization is too dedicated, thereby overlooking new promising opportunities (Ahuja & Lampert, 2001; Cohen & Levinthal, 1990; Zahra & George, 2002). Therefore, a broad and diverse prior knowledge base is considered an important antecedent for ACAP and innovation.

Paradox. The paradox for SMEs, and especially for new and young firms, is that they lack prior knowledge and routines due to their age and size, but need ACAP to acquire external knowledge and resources to develop their new business opportunities. This paradox was already observed by Cohen and Levinthal (1990: 138) who stated that ‘firms may not realize that they should be developing their absorptive capacity due to an *irony* associated with its valuation: the firm needs to have some absorptive capacity already to value it appropriately’ (emphasis added).

Prior knowledge represents the extent and diversity of an organization’s knowledge base, which in turn determines an organization’s search routines. The larger and more diverse an organization’s knowledge base is, the more distant the search for knowledge which increases the likelihood of encountering novel

knowledge. The smaller and more homogeneous an organization's knowledge base is, the more local the search for knowledge which probably leads to more familiar knowledge (Katila & Ahuja, 2002; Laursen & Salter, 2006; Shane, 2000). Following this line of reasoning young and small firms will search locally, as their knowledge base is rather small. Therefore it is expected that they encounter more difficulties in finding novel knowledge. Yet, new and small firms are able to grow and to internationalize with international partners from outside their own sector or industry (Davenport, 2005), and they are able to engage in alliances and learn from these (Almeida et al., 2003; Tether, 2002). So, the question arises how these SMEs with little history build ACAP to recognize and acquire external knowledge for innovation.

ACAP in SMEs. In line with ACAP literature, the studies in our literature review show that firms with high levels of ACAP, which generally concern larger and more established firms, are better able to recognize new knowledge from external sources than firms with low levels of ACAP, which generally concern smaller firms (Bayona, García-Marco & Huerta, 2001; Fernhaber et al., 2009; Flatten, Greve & Brettel, 2011; Larrañeta et al., 2012). However, some of these studies also show that new and young firms with low levels of ACAP are able to benefit faster from external knowledge, compared to their larger counterparts. For instance Fernhaber et al. (2009) studied the effects of top management teams' experience on the acquisition of external knowledge for internationalization of new ventures. Contrary to extant ACAP literature, they found that a high level of top management team's (TMT) prior internationalization experience (as a proxy of the new ventures' ACAP) did not lead to more use of external knowledge sources to increase internationalization success. In fact, their study showed that firms with low ACAP benefitted more from external sources which also contributed to higher internationalization success. Another study of Larrañeta et al. (2012) on the moderating effect of ACAP on external knowledge acquisition and strategic variety in young Spanish SMEs also revealed that SMEs with low ACAP benefitted more from knowledge partners which are rich of diverse and novel knowledge. These counterintuitive findings are explained by the need for and motivations of new and young firms to acquire external knowledge and resources (Barge-Gil, 2010; Fernhaber et al., 2009), and the kind of knowledge required during the firm's life-cycle (Phelps, Adams & Bessant, 2007).

Need and motivations. New firms that internationalize, have high needs and motivations to learn fast about new markets and applied technologies (Deeds, 2001; Freeman et al., 2010; Prashanthan & Young, 2011). Not only do these 'born globals' need to overcome the liabilities of newness and foreignness, they also need to internationalize rapidly to profit from the 'learning advantages of newness' (Autio, Sapienza & Almeida, 2000), which refers to the flexibility of new firms to learn new competencies to stimulate growth, compared to the learning impediments that hamper

growth in more established firms. To take advantage of their newness, born-globals need to invest in ACAP to speed-up their learning curve (Freeman et al., 2010).

Furthermore, the speed of learning is determined by the growth orientation and motivation of the top management team of SMEs. For instance, O'Dwyer and O'Flynn (2005) concluded based on their case study that ACAP is not so much determined by a firm's ability to acquire knowledge, but by its willingness to do so. Further, Gray (2006) found in his study on the effects of the growth orientation of the owner-manager on the development of ACAP that SME owners with growth objectives developed a stimulating culture, which led to higher ACAP. Also, Liao et al. (2003) empirically studied the effect of a pro-active strategic orientation on the effects of ACAP on organizational responsiveness. Their study showed that the impact of a firm's external knowledge acquisition on its organizational responsiveness is contingent on its pro-active strategic orientation.

Where ACAP development in new and small firms is driven by market needs and top management teams' growth motivations, ACAP in large firms develops slower. Larger firms often have an established market position and technology base, which reduces the need for speedy commercialization of new technology and therefore they have less need for new external knowledge (Barge-Gil, 2010; Motohashi, 2008). Some studies even suggest that too much ACAP could hamper innovation when routines of knowledge search and acquisition are so well-established, that new knowledge is only evaluated as being valuable when it relates to the existing knowledge base (Barge-Gil, 2010; Larrañeta et al., 2012; Mowery, Oxley & Silverman, 1996). This suggests an optimal level of ACAP at which firms can benefit most from external knowledge (Barge-Gil, 2010; Larrañeta et al., 2012).

Apart from this optimal ACAP level, there is also a minimum level of ACAP that is required to benefit from external knowledge. Barge-Gil (2010) found that, although smaller firms have a high need for new R&D knowledge, they mainly developed innovations in-house without collaborations or external R&D. This would be due to the lack of ACAP in these small firms (Barge-Gil, 2010). However, some studies from our review contain suggestions on how new and small firms acquire a minimum ACAP level from which they can start developing ACAP further. For instance, the founders of new firms have prior knowledge and experience from which to build their ventures' ACAP (Fernhaber et al., 2009). This is especially the case when new ventures start as spin-offs from universities (Motohashi, 2008; Rothaermel & Thursby, 2005) or as a joint venture from two or more parent firms (Lane et al., 2001). Further, new and small firms can build ACAP through the use of their founders' earlier networks and relationships (Freeman et al., 2010; Prashantham & Young, 2009). So, although the venture might be new, it is based on prior knowledge and experience of its founders. The extent to which this prior knowledge base exceeds a minimum

threshold value will determine a new venture's ability and speed to develop ACAP further.

Required knowledge during a firm's life-cycle. The need for new knowledge also depends on the type of knowledge that is required, like technological, market or managerial knowledge. New and young technology driven firms might be more focused on commercialization of their first product or services and therefore being more engaged in market oriented collaborations instead of R&D oriented collaborations (Motohashi, 2008). Lane et al. (2001) in their study on Hungarian international joint ventures found that over time, the extent of technological knowledge exchange between parents and joint venture remained the same, while marketing and managerial learning increased over time. One could argue that the stage of a firms' life-cycle determines its need for a specific kind of knowledge, hence that development of ACAP routines needs to be targeted towards the absorption of this specific knowledge. Phelps et al. (2007) argued that firms encounter 'tipping points' or problems during their life-cycle, such as obtaining finance, establishing market entry or improving operations, for which they need ACAP to get aware of these problems, to acquire the required knowledge and to implement solutions. The speed of learning and subsequent ACAP-development consequently changes over time per kind of knowledge, depending on the knowledge that is required at that time.

In sum, our review suggests that new firms need a minimal threshold value of ACAP to enable speedy development of ACAP. The speed of ACAP development depends on the need for specific knowledge and the growth orientation of the SMEs' top management team.

Resolving the paradox. The paradox for ACAP in SMEs encompasses the seemingly contradiction that SMEs lack prior knowledge and routines due to their age and size which would hamper new knowledge recognition, yet they are able to acquire external knowledge and develop their business opportunities. Our review shows that new and young firms indeed can acquire and apply new knowledge, for example to internationalize, even when they have low ACAP. This cannot be explained by the *level* of ACAP alone, which is regarded the main antecedent for ACAP and competitive advantage in extant literature. Our review suggests that *speed* of ACAP development is another important factor for competitive advantage. This means that the paradox that new and young firms would need prior knowledge to develop ACAP to acquire external sources for growth, which they lack due to their age, originates from neglecting time issues. According to Poole and Van de Ven (1989) an approach to resolve such paradox is through 'temporal separation'. Here, both assumptions that underlie the paradox are both true, but at different time periods. The key assumptions that ACAP is cumulative and path dependent are not challenged. However, the assumption that this cumulative process would hinder SMEs to acquire external knowledge depends on the speed at which this accumulation process takes place. This

accumulation speed differs between SMEs and large firms, as well as between different life-cycle stages which require different kinds of knowledge, such as technological and marketing knowledge.

Accumulation of knowledge and experience, and the building of ACAP processes to facilitate this accumulation take place at a faster pace when the need for ACAP is higher. This is in line with Zahra and George's (2002) argument that the intensity of internal and external activation triggers will affect the investments made in developing ACAP. For SMEs, the internal activation trigger comes from the growth motivation of the top management team (Gray, 2006; Liao et al., 2003). The external activation trigger in new and young firms stem from the need to quickly commercialize and internationalize new products and services, to benefit from the 'learning advantages of newness' (Autio et al., 2000). Also, new firms have less slack resources regarding R&D activities, which require them to constantly monitor their environment in order to adjust their portfolio of projects timely to minimize odds of failure (Deeds, 2001; Fernhaber et al., 2009).

Where dominant ACAP literature takes a steady state perspective of larger organizations focusing on the accumulated body of knowledge, literature on ACAP in SMEs take a process perspective focusing on the growth of the knowledge base. To resolve the paradox, we argue that both perspectives can be combined in the following proposition:

Proposition 1a: An organization's competitive advantage not only depends on its cumulative level of ACAP, but also on the speed with which new ACAP is developed. In turn, the speed of ACAP development depends on the need for knowledge and the growth ambitions of the top management team.

The time at which external knowledge is required and subsequently acquired differs for knowledge types. For instance, new high tech firms at inception will first collaborate with universities to access research facilities and acquire technological knowledge until a proof-of-concept is reached. To further commercialize, these firms will engage primarily in collaborations to acquire market and management knowledge (Lane et al., 2001; Motohashi, 2008). After a while, technological knowledge becomes important again to create new generation products and services, to ensure long-term survival (Motohashi, 2008). With temporal differences in requirements of different types of knowledge, also the speed at which ACAP develops for these types of knowledge differs over time.

As during a firm's life-cycle knowledge requirements change, over time other routines need to be developed in order to absorb this knowledge. For instance, lack of technological knowledge can be addressed through establishing research initiatives with universities, visiting conferences and engaging in co-creation projects with suppliers. These routines are different from addressing lack of commercial knowledge,

which might include hiring sales personnel, conducting market research and developing distribution channels. We suggest that the speed of developing technology-oriented ACAP routines will be higher at the early proof-of-concept stage and lower at the later commercialization stage. In contrast, the speed of commercialization-oriented ACAP routines will be low in the early proof-of-concept stage and high at the commercialization stage. This leads to the following proposition:

Proposition 1b: The speed of ACAP development is conditional on the kind of knowledge (e.g. technological, market or managerial) required during different stages of a firm's life-cycle .

2.3.2 Paradox 2: In-house R&D complements external knowledge acquisition, yet SMEs have limited in-house knowledge creation capabilities

Key assumption. Cohen and Levinthal (1990:129) argued that ACAP is a 'by-product of a firm's R&D investment'. They not only assumed that prior knowledge is needed to recognize and acquire new external knowledge (as discussed in Paradox 1), but they also assumed that the new knowledge can only be absorbed, when the organization itself engages in in-house knowledge creation, for instance through in-house R&D. In fact, Cohen and Levinthal (1990: 135) stated that 'prior knowledge permits the assimilation and exploitation of new knowledge' and that buying knowledge externally, for instance through hiring new personnel, contracting consulting services or corporate acquisitions, will probably be less effective. This is due to the idiosyncratic and tacit characteristics of a firm's products and processes, which inhibits efficient integration of externally bought knowledge. Therefore, Cohen and Levinthal (1990: 135) state that 'To integrate certain classes of complex and sophisticated technological knowledge successfully into the firm's activities, the firm requires an existing internal staff of technologists and scientists who are both competent in their fields and are familiar with the firm's idiosyncratic needs, organizational procedures, routines, complementary capabilities, and extramural relationships'. Empirical studies found support for this key assumption. For instance, Arora and Gambardella (1990) in their study on external sourcing strategies of biotechnology firms confirmed that large firms with high levels of in-house knowledge creation engaged more in external knowledge acquisition, compared to those with lower levels of internal knowledge creation. Furthermore, Cassiman and Veugelers (2006) empirically found a positive relationship between the innovation performance of Belgium firms in the manufacturing industry and the extent of deploying both in-house R&D and external knowledge acquisition. So, the key assumption is that in-house knowledge creation is needed to complement external knowledge acquisition.

Paradox. When this key assumption is applied to SMEs, the paradox emerges that a large part of SMEs only have limited in-house knowledge creation capabilities such as R&D, yet seem to be able to collaborate and innovate. Literature provides

several reasons for lower R&D capabilities in SMEs compared to larger firms. First, R&D projects often require a minimum size to yield useful results, due to their technological complexity and multi-disciplinary character. This requires SMEs to spend a disproportionate large part of their resources to R&D, which goes at cost of other activities like marketing and operations (Rammer, Czarnitzki & Spielkamp, 2009). Further, R&D costs are mostly fixed costs, that need to be recovered by sales of new products and services. For SMEs the market share is generally small, compared to larger firms, which implies that the costs are spread over fewer products, leading to higher prices and lower margins (Cohen & Klepper, 1996). Also, SMEs have limited access to financial resources and are more vulnerable for failures as they cannot spread risk over large number of projects (Ortega-Argiles, Vivarelli & Voigt, 2009).

Further, SMEs often operate in low-tech or non-technological markets like services which require other in-house knowledge creation capabilities than R&D. Also these firms are able to collaborate with external partners despite their limited size and resources. For instance, Van de Vrande et al. (2009) show in their study on Dutch SMEs that both manufacturing and service firms actively engage in open innovation practices, and that therefore open innovation is not restricted to SMEs that employ R&D activities. So, the question arises how SMEs with limited in-house knowledge creation capabilities are still able to assimilate knowledge from external sources.

ACAP in SMEs. As in most studies on ACAP in large firms, a large part of studies in our review focus on technology-oriented firms, or use R&D-related measures for ACAP (e.g. Barge-Gil, 2010; Bayona et al., 2001; De Jong & Freel, 2010; Lal, 2007; Spithoven et al., 2010), based on Cohen and Levinthal's (1990) aforementioned assumption that internal R&D complements external knowledge acquisition. Some studies explicitly examine this assumption, like Huang and Rice (2009), who found a complementary effect of investment in training and external networking on new product development among Australian manufacturing SMEs. Also, Julien et al. (2004) in their work on Canadian equipment manufacturers found that SMEs with more R&D personnel and higher educated employees were better able to benefit from 'weak signal networks', which are considered networks with potential sources of novel information. Furthermore, Lin et al. (2009) showed that network embeddedness led to better technology transfer, when firms possessed higher learning capabilities. They argued that external networks provide firms an opportunity window, from which they can only benefit when they are able to assimilate and use external technological knowledge through organizational learning. Overall, these studies support the complementarity assumption of internal knowledge creation and external knowledge acquisition as is proposed in extant literature.

Although most studies are technology-oriented and consider mainly R&D as a firm's in-house knowledge creation capability, a few studies explicitly examine non-R&D related aspects of ACAP. For instance, Hervas-Oliver et al. (2011) studied the

differences of ACAP between low-tech and low-medium tech SMEs in relation to innovation performance. They used R&D-related measures of ACAP such as the R&D expenditures and the number of R&D employees, as well as non-R&D related measures such as marketing, design and innovation plans. Their study showed that innovation performance in low-tech SMEs was only explained by the non-R&D ACAP measures. Hervas-Oliver et al. (2011) suggest that low-tech industries are more focused on process, organizational and marketing innovations, instead of product innovations, which is more the realm of high-tech industries. Passiante and Ndou (2006) studied ACAP in the European tourist industry and found that firms with higher ACAP created more value from their external network. They used non-R&D related measures of ACAP like the ability to gain and release resources, the ability to scan the environment and the presence of a communication culture and structure. Further, Branzei and Vertinsky (2006) studied not only the effects of new product development activities on ACAP dimensions of acquisition, assimilation, transformation and exploitation, but also examined the effects of non-R&D capabilities, like process development, human capital development and market activities on these ACAP dimensions. Their study on manufacturing SMEs showed that these non-R&D-capabilities also determine SMEs' ACAP.

In sum, our review shows that internal knowledge creation capabilities – both R&D and non-R&D capabilities - increase firms' own knowledge bases, but also enables firms to acquire new knowledge hence to increase their ACAP. This supports the key assumption that internal capabilities complement external knowledge acquisition (Cassiman & Veugelers, 2006; Cohen & Levinthal, 1990) and that this assumption also applies for SMEs (e.g. Van de Vrande et al., 2009).

In contrast to this conclusion, other studies in our review suggest a substitution effect, instead of complementarity, between internal knowledge creation and external knowledge acquisition. For instance, Spithoven et al. (2010) showed that Belgium collective research centers provide services to SMEs as substitutes for their lack of ACAP. These research centers provided SMEs with recognition capabilities through knowledge intelligence services, like scanning the market for technological developments and technology roadmapping. They provide assimilation capabilities by acting as a knowledge repository, which is partly sourced by other members, third parties and the research centers' own R&D activities. Finally, the research centers substitute for SMEs lack of ACAP by acting as knowledge agencies, providing transformation capabilities by offering contractual R&D-activities. Further, Hervas-Oliver et al. (2011) in their study on Spanish manufacturing firms found a negative moderation effect of in-house R&D and external collaboration with suppliers on innovation performance. They observed a similar negative moderation effect with non-R&D internal knowledge creation capabilities (like marketing, design, new employees with tertiary degrees) and collaboration with suppliers on innovation performance.

These authors argued that firms that have high levels of internal knowledge creation capabilities do not need external knowledge of suppliers and therefore they also suggest a substitution instead of a complementary effect. The question now arises how these contradictory findings can be explained. From studies in our review we derive two possible contingencies that offer alternative explanations, which are the properties of the knowledge absorbed, and the characteristics of the knowledge provider.

Knowledge properties. The first explanation for the complementarity-substitution paradox rests on the properties of knowledge, such as its complexity, tacitness and ambiguity (Wang & Han, 2011). Complexity relates to the number of elements that the knowledge encompasses such as technologies and skills. Tacitness is the extent to which knowledge is codified in documents, and ambiguity captures the ease by which knowledge can be learned by knowledge receivers (Wang & Han, 2011). In general, the more complex, ambiguous and tacit the knowledge, the more difficult it is to transfer and to absorb it. For instance, Wang and Han (2011) studied the moderating effect of ACAP on the relationship between knowledge properties and innovation performance in Chinese SMEs. Their findings suggest that the higher a firm's ACAP, the easier it can translate complex, tacit and ambiguous knowledge into new products and processes. Also, Wu and Liu (2009) in their study on knowledge exchange between local firms and their network 'flagship' in a Global Manufacturing Network found that partners shared manufacturing and management knowledge, but that local firms were not able to assimilate core technology knowledge of flagships due to its complexity and tacitness. Further, Meeus, Oerlemans and Hage (2004) studied the effect of knowledge complexity on the relationship between internal knowledge and interactive learning. They found a U-shaped relationship indicating that firms with weak internal knowledge resources and low complex innovation activities have high probabilities for interactive learning with external partners. Firms with strong internal resources and high complex activities also have high probabilities for interactive learning. Interactive learning decreases when the combination of internal knowledge sources and complexity becomes more moderate.

Support for complexity as a conditional factor for ACAP is also found in studies on industry-university collaboration in our review. Izushi (2003) studied the collaboration between SMEs and Japanese *kosetsushi* research centers. In Japan, these research centers offer 'low information gap' services like product testing and offering production facilities, next to 'high information gap' services like advice, training and contract research. Izushi (2003) found that most SMEs first engage in low information gap services to become familiar with the practices of the research centers and to build trust, before engaging in high information gap services. The offering of low information gap services allows SMEs to build ACAP to benefit from high information gap services later. A similar finding is done by McAdam, McAdam & Brown (2009) whose multiple case study showed how technology oriented

entrepreneurs first needed to develop skills and understanding of key business processes before they could benefit from the services of a technology transfer office that supported commercialization processes. Another study by Kodama (2008) on university-industry collaboration among SMEs showed that internal R&D and collaboration with universities leads to more patent applications, whereas collaborations with other industry-partners leads to more new products. Kodama (2008) suggests that R&D activity aiming at basic research requires the absorption of more scientific knowledge, while R&D activity aimed at new product development requires business relationships that are closer to the market. Put in another way, R&D relating to Research is more complex which requires more internal knowledge creation capabilities to adjust scientific knowledge to firm-specific needs. On the other hand, R&D relating to Development is more application based and therefore less complex, which requires less internal knowledge creation capabilities.

Therefore we suggest that studies that use R&D as a proxy for internal knowledge creation capabilities, but do not specify the properties of the activities (R or D) might find seemingly conflicting outcomes, which can be explained by knowledge complexity. Recall Hervas-Oliver et al.'s (2011) study who found that firms with high R&D are less inclined to collaborate with suppliers. They argue that this is caused by less need of high R&D-intensive firms for external knowledge, as these already possess sufficient in-house knowledge. Our alternative explanation is that these firms need high R&D to absorb complex knowledge from universities (for which Hervas-Oliver et al. (2011) did find support for low-tech firms), but do not need high R&D for new product development which is often done in collaboration with suppliers.

Properties of knowledge provider. A second explanation for the seemingly contradictory relationship between internal knowledge creation and external knowledge acquisition – complementarity versus substitution – can be found in the characteristics of the knowledge provider. Recall that the key assumption that underlies this paradox is that firms need internal knowledge creation capabilities to adjust the new external knowledge to firm specific needs. This assumption views the knowledge receiving organization as the locus of knowledge processing. Yet, several studies in our review point attention to the role of the knowledge providers as well. As mentioned above, Spithoven et al. (2010) argued that research centers can take over activities regarding knowledge acquisition (e.g. market intelligence), assimilation (e.g. knowledge repositories) and transformation (e.g. contract research). Also, Kodama (2008) showed that SMEs that are member of a business association benefit more from university-industry relationships compared to non-members. He suggested that the intermediary functions of business associations relate to reducing search costs, reducing bargaining costs and supplementing managerial and other resources. Lowik et al. (2012) found that business associations offer member firms opportunities to get 're-acquainted' again by meeting each other in non-traditional (business) settings. This

way SMEs can discover new knowledge within existing relationships, hence improving their ACAP. Further, business or research associations are better able to articulate the needs of their member firms, which is often difficult for SMEs to do for themselves (Izushi, 2003).

Besides research centers and business associations, SMEs also use other sources to access resources and capabilities that they lack themselves, like customers, suppliers and venture capitalists (e.g. Larrañeta et al., 2012). For instance, Freeman et al. (2010) showed that born global firms build ACAP on the personal contacts of the entrepreneurs or on new contacts that are based on trustworthy existing network partners. Similarly, Fernhaber et al. (2009) showed that new ventures that seek to internationalize rely on the ACAP of their venture capitalist firms regarding management expertise, reputational benefits, employee recruitment and strategy formulation. They suggested that new ventures that intend to internationalize better choose venture capitalist with an international venture portfolio, as the venture capitalists' knowledge can substitute for the lack of knowledge of the new venture. In sum, our review shows that knowledge providers that are knowledgeable of the problems and needs of their clients can substitute for the knowledge creation capabilities of these clients.

Resolving the paradox. The paradox we examined concerned the assumption that firms need internal knowledge creation capabilities to adjust the external knowledge to their firm-specific needs, while SMEs often have limited in-house knowledge creation capabilities (such as R&D) yet are able to collaborate with external partners. To resolve this paradox, we need to extend the theoretical boundaries of ACAP. In terms of Poole and Van de Ven (1989) the approach used is 'synthesis' of the original perspective with new ones. The original assumption that external knowledge that is not made firm-specific is difficult to absorb (Cohen & Levinthal, 1990) still holds. The implicit underlying assumption comes from dynamic capability literature which argues that external knowledge that leads to competitive advantage is idiosyncratic and difficult to imitate (Barney, 1991; Teece, Pisano & Shuen, 1997). It is argued that knowledge that can be acquired externally could be applied by multiple firms, but that the extent to which it leads to competitive advantage depends on the integration of the new knowledge within each firm. The dominant understanding is that firms with high ACAP are better able to transform external knowledge in such way that it becomes firm-specific and idiosyncratic. Our review suggests that the implicit assumption often made is that the valuable externally acquired knowledge is complex, ambiguous and tacit. However, most studies do not explicitly address the properties of the acquired knowledge (e.g. Huang & Rice, 2009; Lin et al., 2009), which might explain the contradictory findings. SMEs with R&D expenditures could be involved in basic research, leading to a complementary effect in collaborations with universities (Hervas-Oliver et al., 2011; Kodama, 2008), and a

substitution effect with suppliers (Hervas-Oliver et al., 2011). The complementary effect is explained by the complexity of basic scientific knowledge, which requires more internal knowledge creation capability to transform the new knowledge to firm-specific needs (Cassiman & Veugelers, 2006; Izushi, 2003; Kodama, 2008). The substitution effect can be explained by the lower complexity of transferred knowledge (Izushi, 2003), which is often required for new product development and where collaboration takes place with customers and suppliers within the same industry (Kodama, 2008). So, properties of the newly acquired knowledge are a conditional factor that explains the need for internal knowledge creation capabilities, which leads to the following proposition:

Proposition 2a: External knowledge acquisition can act as a substitute for in-house knowledge creation, instead of a complement, under the condition that the external knowledge is not too complex, ambiguous and tacit.

The synthesis with dynamic capability literature leads to the identification of another conditional factor that could resolve the paradox. Although dynamic capabilities are firm-specific and idiosyncratic in their details, these capabilities share commonalities across firms (Eisenhardt & Martin, 2000). These commonalities could be seen as ‘best practices’, which are the more effective ways to execute dynamic capabilities. Taking this notion of best practices explains why SMEs can acquire external knowledge without extensive in-house knowledge creation. When the knowledge provider is well informed about problems and solutions in a specific domain or among certain types of SMEs, it could adjust the knowledge in such way that it fits the SMEs' requirements, like incubators and venture capitalists do. For instance, when a new venture plans to internationalize for the first time, it encounters questions and problems that other new ventures also encountered when they internationalized their first time. A venture capitalist with experience of new ventures internationalizing is knowledgeable of these problems, and can therefore provide tailor-made assistance to the new venture, who has no internationalization experience. This implies the inclusion of ACAP of the partner firms into the discussion to what extent focal firms need ACAP to convert external knowledge into firm-specific knowledge. We propose to add this perspective to resolve the paradox on in-house knowledge development as a necessary condition for external knowledge acquisition. The main assumption that external knowledge needs to be made firm-specific to enable its use in SMEs still holds, however the place where this is done can shift from the focal firm to the external partner. A prerequisite is that these external partners have a high ACAP level. This implies that external ACAP can be bought, hence that external knowledge acquisition can be a substitute for in-house knowledge creation.

Therefore we propose that:

Proposition 2b: External knowledge acquisition can act as a substitute for in-house knowledge creation, instead of a complement, under the condition that the external knowledge provider has a high ACAP level.

2.3.3 Paradox 3: Organizational ACAP depends on individual ACAP of its members, yet SMEs have low employee diversity

Key assumption. In their 1990 paper, Cohen and Levinthal start with the absorptive capacity of individuals. Based on cognitive and behavioral sciences they state that individuals' abilities to recognize, assimilate and apply new knowledge depend on their prior knowledge. However, this prior knowledge needs to meet some requirements to contribute to a firm's ACAP. 'Assuming a sufficient level of knowledge-overlap to ensure effective communication, interactions across individuals who each possess diverse and different knowledge structures will augment the organization's capacity for making novel linkages and associations -innovating-beyond what any one individual can achieve' (Cohen & Levinthal, 1990:133). So, organizational ACAP is built on individuals' prior knowledge that needs to be homogeneous to facilitate knowledge sharing through assimilation and exploitation but also heterogeneous to stimulate the creative ACAP processes of recognition and transformation.

Paradox. In SMEs the number of individuals is rather small, compared to large firms. This has two implications for knowledge diversity in SMEs. First, specialization among employees is rather small compared to larger firms (Vossen, 1989). For instance, SMEs often do not have highly specialized functional departments. This means that on organizational level knowledge diversity of SMEs is smaller compared to larger firms. Second, the intermediary between the SME and its environment are often the owner or the top manager(s) (Raymond, Julien & Ramangalahy, 2001). This means that only a few persons maintain linkages with the external environment, which limits the inflow of new knowledge. Therefore, as a result of the limited number of employees and knowledge heterogeneity the overall ACAP of SMEs is rather small, yet SMEs are able to collaborate and to innovate.

ACAP in SMEs. Several studies in our review support the general assumption that individuals' knowledge and experience are important antecedents for knowledge absorption and that this also applies to SMEs. For instance, the level of education, the number of employees in R&D and the training expenditures are found to enable SMEs to collaborate with external partners (Muscio, 2007), to adopt new technologies (Lal, 2007), to internationalize (Rhee, 2008) and to achieve firm growth (Gray, 2006). Other studies examined the effect of knowledge breadth and knowledge depth on SMEs' capabilities to absorb external knowledge more specifically. For instance, Wang, Wang and Horng's (2010) study on SMEs in the Taiwanese bicycle industry showed

that both breadth and depth of knowledge of owners are important for SMEs' ACAP. Also Descotes and Walliser (2011) found that diversity and complementarity of foreign experience of the managerial team maximized the use of acquired external information. Further, Qian and Acs (2011) argued that entrepreneurs who start a new business not only need scientific knowledge to understand and develop their invention, but that they also need market or business knowledge to create and operate a new firm. Their notion of 'entrepreneurial absorptive capacity' thus encompasses several kinds of knowledge which emphasizes the heterogeneity of knowledge. A similar finding is found by Hayton and Zahra (2005) in their study on the effects of human capital of a ventures' top management team and the acquisition of technological and market capabilities. They found that diversity in top management team members' knowledge and experiences was more important for acquisition of capabilities than their knowledge depth. So, these studies indicate that ACAP in SMEs depends on the diversity of knowledge among the employees, especially when the number of employees is small. This implies that SMEs can increase their ACAP by attracting personnel that have complementary knowledge and experiences.

Although knowledge and experience are important antecedents for individuals' ACAP, the conceptual papers of Freeman et al. (2010) and Witt (2004) draw attention to another individual capability for ACAP, which is the managerial ability to effectively use pre-existing relationships and the ability to establish new ones. They argue that managers of start-ups and 'born-global firms' with the ability to build inter-firm partnerships will establish trust between the collaboration partners, which in turn will facilitate the transfer of tacit and complex knowledge. Therefore, managers need relational capabilities to increase their own ACAP and that of their venture. Also, Malik and Wei's (2011) study on the transition of traditional Chinese medium sized firms to more innovative firms showed the importance of relational competences. Where traditional firms act as manufacturers of goods and relied on bilateral relationships with only a few partners, the more innovation oriented SMEs in China invest in larger networks with more heterogeneous partners. Malik and Wei's (2011) case studies showed that a lack of a coordinated approach to manage more complex multilateral partnerships was a major hindering factor for SMEs to become more innovative. The effect of network diversity on individuals' ACAP is empirically studied by Rejeb-Khachlouf, Mezghani and Quélin (2011). They found that diversity of personal network ties of SMEs' employees had a positive effect on these individuals' ACAP, while the size of the network did not show a significant relationship. This suggests that the relational capability to manage different kinds of relationships is an important individual competence to increase an SME's ACAP.

However, SMEs might face problems regarding their information processing capabilities as their ACAP relies on just a few individuals, which are often the founder or top managers. For instance, Wang et al. (2010) compared the relative importance of

owners and other R&D staff members on SMEs' ACAP and found that owners' knowledge and experience breadth and depth was more critical than that of their R&D staff. Further, the hampering effect of a small number of employees on ACAP is contingent on the volatility of a firm's environment. An empirical study of Liao et al. (2003) on growth-oriented SMEs examined the moderating effect of environmental turbulence on the relationship between ACAP and firm responsiveness. They hypothesized that in turbulent environments, SMEs will engage more in external knowledge acquisition and internal knowledge dissemination to be able to respond effectively to environmental changes. However, they only found a positive moderating effect related to internal knowledge dissemination and no support for the effect of external knowledge acquisition. Liao et al. (2003) suggest that in turbulent environments, SMEs lack the required resources and capabilities to handle the complexity and volume of information, hence turn to internal knowledge dissemination instead of external knowledge acquisition.

A solution to the hampering effect of owner-managers' limited capabilities to manage complex information streams is to create sufficient 'strategic space' (Jones, Macpherson & Thorpe, 2010). In their conceptual paper, Jones et al. (2010) argue that owner-managers in small firms need to create 'strategic space' to be able to access resources, find the motivation and the capability to review existing practices. They state that owner-managers (or the management team) spend most of their time and attention to daily operating issues, leaving too little room for engagement in innovation and change processes. Jones et al. (2010) suggest that establishing systems, structures, and routines that facilitate knowledge sharing in organizations will increase the learning capabilities of the firm as a whole, thereby releasing the top managers from day-to-day responsibilities. This implies that managers need organizing capabilities, such as delegating, to enable themselves to spend time and attention to ACAP processes like the search for new knowledge, assimilation and exploitation. In sum, our review shows that the level of ACAP in SMEs is not only explained by the knowledge breadth of individuals, but also by other individual capabilities that can contribute to ACAP development, such as relational and organizing capabilities.

Resolving the paradox. The paradox addressed here is the assumption that ACAP depends on the diversity of individual ACAP of the organization members, but that SMEs in general have low employee diversity compared to large firms, yet are able to collaborate and to innovate. This paradox can be resolved by 'synthesis' of different perspectives (Poole & Van de Ven, 1989). The studies from our review show that ACAP of SME managers not solely depend on their personal prior knowledge and experience, which is currently the main antecedent in extant ACAP literature, but that they need additional capabilities to develop and maintain ACAP in their firms too. First, from entrepreneurship literature it is understood that managers need the capability to attract new personnel with knowledge and experience that complement

their own and that of the other management team members, in order to establish a diverse knowledge base as possible (Hayton & Zahra, 2005; Qian & Acs, 2011). Second, from social network theories is derived that managers need relational capabilities to use their existing networks and build new networks (Freeman et al., 2010; Malik & Wei, 2011). Third, from a combination of organizational learning and human capital literature it is proposed that managers need organizing capabilities to create sufficient 'strategic space' to allow time for ACAP development, and to avoid information overload in a turbulent environment (Jones et al., 2010; Liao et al., 2003). The assumption that only individuals' prior knowledge would be important for organizational ACAP is insufficient to explain how SMEs develop ACAP. Therefore we propose:

Proposition 3: The extent to which ACAP develops within an organization not only depends on the diversity of prior knowledge and experience of its members, but also on these members' organizing and relational capabilities.

2.3.4 Paradox 4: Organizational ACAP depends on social integration mechanisms, yet SMEs often lack (formal) knowledge sharing systems and routines

Key assumption. Social integration mechanisms (SIM) are key to ACAP as these relate to the knowledge transfer and diffusion processes across and within organizations (Todorova & Durisin, 2007; Zahra & George, 2002). In their seminal paper Cohen and Levinthal (1990) argued that ACAP of an organization is not the mere sum of the ACAP of its individual members, but that it also depends on the communication and coordination structures to assimilate and integrate knowledge. They stated that 'gatekeepers' who function at the interface of the external environment and the organization are the ones who recognize and acquire new knowledge, but that they are often different from the ones that use this knowledge to create new processes, products and services. Therefore, an organization needs structures and mechanisms to build connectedness and shared meanings to diffuse the knowledge internally (Todorova & Durisin, 2007; Zahra & George, 2002). Jansen, Van den Bosch and Volberda (2005) empirically examined the importance of social integration mechanisms for ACAP in their study of a large multi-national firm. They showed that SIM, such as cross-functional interfaces, job rotation and socialization tactics, enhanced business units' ACAP. Also Lenox and King (2004) showed that deliberate and targeted information provision improved knowledge dissemination within firms, thereby increasing a firm's ACAP. Further, Minbaeva et al. (2003) showed that high levels of internal communication between employees of different departments increased a firm's ACAP. So, there is empirical support for the key assumption that SIM are required to ensure knowledge assimilation, dissemination and exploitation within an organization to create new products, services and processes.

Paradox. The paradox that emerges when this assumption is applied to SMEs is that small firms often lack formal communication structures and information systems (Lang, Calantone & Gudmundson, 1997), while still being highly innovative. In fact, lack of these formal structures in SMEs is considered a strength for innovation. For instance, SMEs have fewer hierarchical levels and shorter communication lines, which increase internal flexibility (Nooteboom, 1994; Vossen, 1998). Also, communication is often personal, direct and oral with few and simple procedures which leads to low costs and easy internal communication (Nooteboom, 1994). Further, organically structured firms which are characterized by more decentralized, informal and flatter structures are better in cooperative industry-university research collaborations than firms with more mechanistic structures (Santoro & Chakrabarti, 2002). So, extant literature assumes that SIM are required for ACAP and innovation in larger firms, while for SMEs a lack of SIM is suggested to enhance innovation. The question thus arises what the function of SIM is for ACAP in SMEs.

ACAP in SMEs. Only a few studies in our review address SIM in relation to ACAP. One reason might be that these SIM are more difficult to observe and to study in SMEs, since these are more informal. For instance, McKelvie, Wiklund and Short (2007) examined the relative importance of Zahra and George's (2002) four ACAP dimensions - acquisition, assimilation, transformation and exploitation – in new ventures in Sweden. Their study showed that although each ACAP dimension was linked to innovation output, the dimensions of acquisition and exploitation were most relevant. McKelvie et al. (2007) suggested that the assimilation and transformation processes were less prominent in younger firms as knowledge is more concentrated in just a few individuals in the firm. When owner-managers fulfill several roles like being inventor, sales person, and operator, the assumption of extant ACAP literature that the place of knowledge acquisition in an organization is distant from the place of knowledge application does not hold for SMEs. This is supported by the case study of Descotes and Walliser (2011) on the ACAP processes on export information within eight French and ten Romanian SMEs. They found that the processes of information acquisition, information dissemination and decision making all occurred mostly informal and at the level of the top management team. Their study suggests that 'organizational ACAP' in SMEs in fact is a synonym for the top management teams' ACAP.

However, the observation that ACAP processes are mostly informal and embedded in just a few persons, does not imply that SMEs could not benefit from more structured processes. For instance, Francalanci and Morabito (2008) studied the effects of integration of information technology (IT) resources within Italian SMEs on firms' ACAP. They found that use and integration of several IT resources improved firm-level ACAP. Also, Jones et al. (2010) in their conceptual paper argue that owner-managers in small firms can establish systems, structures, and routines that facilitate

knowledge sharing in organizations thereby increasing the learning capabilities of the firm as a whole. This could release the top managers' from operational activities and day-to-day responsibilities, which gives them space to engage more in entrepreneurial activities. In this sense, SIM are the result of the organizing capabilities of managers as discussed in Paradox 3.

Resolving the paradox. The paradox that SIM promote high ACAP levels, while SMEs only have few coordination and communication structures in place can be resolved with Poole and Van de Ven's (1989) 'spatial separation' approach, which assumes that the paradox is based on two propositions that relate to different levels of analysis. With regard to our paradox the assumption in dominant ACAP literature is that the places of knowledge acquisition and knowledge exploitation are located in different organizational units (Cohen & Levinthal, 1990). The level of analysis is the functionally structured organization. However, the limited studies in our review that address this issue suggest that in SMEs most ACAP processes of knowledge acquisition, assimilation, transformation and exploitation take place at the level of the top management team (McKelvie et al., 2007; Descotes & Walliser, 2011). As ACAP in SMEs is developed mostly by a small team, the establishment of SIM is less relevant for these firms. In conclusion, the paradox regarding SIM is resolved as ACAP processes in SMEs and larger functionally structured organizations take place at different organizational levels.

Yet, as Jones et al. (2010) proposed, applying SIM in SMEs could increase ACAP through relieving managers from day-to-day operations. Here, SIM are not used as a necessary condition to sustain a certain ACAP-level, but as supporting structures and routines to enable SME managers to speed up their ACAP development. SIM provide the necessary structure and control for the innovation process to avoid too much flexibility and an overload of creativity and ideas (Heunks, 1998). Without some structure, SME managers might start several initiatives of which only a few survive not due to lack of quality, but due to lack of management attention and efficiency.

Accordingly, we observe different effects of SIM on ACAP development that relate to opposite effects of efficiency and flexibility. On the one hand, SMEs are known for their flexibility due to their informal communication structure and limited formal structures. On the other hand, SIM increase efficiency of knowledge processing, for instance through formalization and formal and informal linkages (Jansen et al., 2005). However, too much focus of SIM on efficiency might go at cost of flexibility (Sørensen & Stuart, 2000). Therefore, we propose a moderate level of SIM to be the most beneficial to support both ACAP processes for flexibility and for efficiency in SMEs.

To summarize, literature on large and functionally structured organizations shows that SIM are needed for internal knowledge dissemination between

organizational units, based on the assumption that the place of knowledge acquisition is different from the place of knowledge exploitation. In contrast, in organizations that are smaller and more organically structured, the individuals that acquire knowledge are often also involved in the processes of knowledge exploitation. In these organizations SIM are less formalized and structured, as knowledge is more concentrated within a few individuals or only needs dissemination among a small number of employees. However, when organically structured organizations (mostly SMEs) do not install any SIM, key personnel could be submerged in day-to-day operations, which would hamper new explorative activities. On the other hand, too many SIM could introduce bureaucracy, thereby hampering innovation and creativity. This would suggest an inverted U-shape for the effect of SIM on ACAP development in SMEs, indicating that ACAP is best developed at a moderate level of SIM. This leads to the following proposition:

Proposition 4: In SMEs that aim to combine flexibility and efficiency the effect of SIM on ACAP takes the form of an inverted U-shape.

In this paragraph we have explored four paradoxes. Using Poole and Van de Ven's (1989) approaches the four paradoxes were resolved, leading to propositions. A summary of the paradoxes and their propositions is presented in Table 2.3.

Nr	Paradox	Approach to paradox	Solution	Proposition
1	ACAP is path dependent, yet young firms do not have history.	Temporal separation	Learning is path dependent, but experience can be built fast, when firms invest in high learning speed.	<p>1a: An organization's competitive advantage not only depends on its cumulative level of ACAP, but also on the speed with which new ACAP is developed. In turn, the speed of ACAP development depends on the need for knowledge and the growth ambitions of the top management team.</p> <p>1b: The speed of ACAP development is conditional on the kind of knowledge (e.g. technological, market or managerial) required during different stages of a firm's life-cycle.</p>
2	In-house knowledge creation complements ACAP, yet SMEs have limited R&D capabilities.	Synthesis	External knowledge is not as idiosyncratic as assumed, and can be made firm-specific also by knowledgeable external partners like incubators, research centers and venture capitalists.	<p>2a. External knowledge acquisition can act as a substitute for in-house knowledge creation, instead of a complement, under the condition that external knowledge is not too complex, ambiguous and tacit.</p> <p>2b. External knowledge acquisition can act as a substitute for in-house knowledge creation, instead of a complement, under the condition that the external knowledge provider has a high ACAP level.</p>
3	Organizational ACAP depends on individual ACAP of its members, yet SMEs have low employee diversity.	Synthesis	Development of ACAP not only depends on diversity among individuals' prior knowledge and experience, but also on the deployment of other individual capabilities.	3. The extent to which ACAP develops within an organization not only depends on the diversity of prior knowledge and experience of its members, but also on these members' organizing and relational capabilities.
4	Organizational ACAP depends on social integration mechanisms (SIM), yet SMEs often lack (formal) knowledge sharing systems and routines.	Spatial separation	In functionally structured large firms SIM are needed as ACAP processes are organized across levels in separate units, whereas in SMEs ACAP processes are concentrated in just a few individuals on the same (top management team) level. However, some SIM can increase efficiency of ACAP in SMEs.	4. In SMEs that aim to combine flexibility and efficiency the effect of SIM on ACAP takes the form of an inverted U-shape.

Table 2.3: Summary of paradoxes, solutions and propositions

2.4 IMPLICATIONS AND RESEARCH AGENDA

This study aims to resolve four paradoxes that appear when dominant ACAP literature is applied to the context of SMEs. These four paradoxes relate to key assumptions that underlie the ACAP construct regarding prior knowledge, R&D activities, individuals' ACAP and social integration mechanisms. We conducted a systematic literature review to assess how SMEs manage these paradoxes. Combining the results of this review and Poole and Van de Ven's (1989) three approaches to resolve paradoxes has led to propositions that challenge and refine some of the key assumptions in ACAP literature. In this section the implications of these propositions for theory are structured around four research opportunities. A summary of suggested research questions is presented in Table 2.4.

2.4.1 Research opportunity 1: Temporal characteristics of ACAP

The first paradox concerned the assumption of path dependency of ACAP development and the lack of history of SMEs to build ACAP. This paradox is resolved by considering temporal aspects of ACAP development, and more specifically the speed of ACAP development (Proposition 1a) which is conditional on the type of knowledge required during a firm's life cycle (Proposition 1b). These propositions have implications for literature on ACAP and dynamic capabilities.

Zahra and George (2002) reconceptualized ACAP as a dynamic capability consisting of routines and processes that create and deploy knowledge to build other organizational capabilities, such as marketing, production and R&D. They suggested that this dynamic capability perspective would offer researchers and practitioners opportunities to examine the antecedents and processes in more depth. Consequently, this would explain how development and evolution of dynamic capabilities change organizations and how this could lead to sustainable competitive advantage. However, little progress has been made so far due to a limited number of longitudinal and process-oriented studies on ACAP (Lane et al., 2006; Volberda, Foss & Lyles, 2010). Although its path-dependent character is assumed to be a main characteristic of ACAP, most research takes a static approach (Todorova & Durisin, 2007; Volberda et al., 2010) and do not study the accumulating processes over time nor the conditions and decisions that determine their effectiveness. Our review suggests that understanding the development of ACAP processes over time can explain why firms differ in performance and how managers can reconfigure their firms' capabilities.

Nr	Research opportunity	Suggested research questions
1	Temporal characteristics of ACAP	<p><i>Speed of ACAP development differs per knowledge type</i></p> <ul style="list-style-type: none"> • How does ACAP develop over time for each specific kind of knowledge? • What characteristics of ACAP are common across knowledge types, and which of these characteristics are different? • How can firms easily manage the speed differences across different types of ACAP? <p><i>Speed of ACAP development explains dynamization of capabilities</i></p> <ul style="list-style-type: none"> • What factors determine the speed of ACAP development? • How flexible are ACAP routines to facilitate dynamization of capabilities? • What are the differences between incremental ACAP routines and radical ACAP routines?
2	Dynamic capabilities characteristics of ACAP	<ul style="list-style-type: none"> • How are the distinctive ACAP routines affected by knowledge properties as complexity, ambiguity and tacitness? • What are the minimum requirements for ACAP routines for knowledge ‘accessing’ compared to ‘acquiring’? • When is ACAP a firm specific and idiosyncratic capability, and when is it a general dynamic capability?
3	Individual characteristics and managerial decision making	<ul style="list-style-type: none"> • What personal characteristics of individuals determine their ACAP and what is the relative importance of these characteristics? • What is the relative importance of managerial ACAP on organizational ACAP compared to that of other organizational members? • How does managerial decision making affect ACAP development of other individuals and the organization as a whole?
4	ACAP in different organizational configurations	<ul style="list-style-type: none"> • What SIM are needed to develop and maintain team-level ACAP? • What is the relative importance of individuals’ ACAP and SIM to develop and maintain team-level ACAP? • Do SIM affect all ACAP processes in a similar way, and if not, how can these different effects be managed effectively? • What is the most optimal configuration of SIM for an ‘ACAP profile’ that achieves balance between exploration and exploitation?

Table 2.4: Research opportunities and suggested research questions

For instance, our review suggests that the speed of ACAP development is conditional on the kind of knowledge required during different stages of a firm's lifecycle. For managers, this implies that they need to align their investments in ACAP with the challenges at hand (Phelps et al., 2007). However, what processes and routines are needed and how these can be created and (de)activated is still ambiguous. From this, interesting research questions can be derived such as 'How does ACAP develop over time for each specific kind of knowledge?' and 'What characteristics of ACAP are common across knowledge types, and which of these characteristics are different?'. Answers to the latter question would inform managers and researchers on 'best practices' in ACAP development across knowledge types (Eisenhardt & Martin, 2000) and could increase the efficiency of ACAP development.

The speed of ACAP development and differences across knowledge types also raises issues of management of multiple dynamic capabilities. An intriguing research question is 'How can firms easily manage the speed differences across different types of ACAP?'. For instance, when firms first invest heavily in R&D and technological collaborations and after some time shift focus to marketing and sales and commercial collaborations, do they then refrain from technological ACAP routines, or are these routines maintained at a minimum level to be reactivated at a later point in time? For researchers, the conditional effect of knowledge type on the speed of ACAP development is also important for their own research design. When R&D is taken as a proxy for ACAP, while the studied firms are focused on commercialization, erroneous conclusions could be drawn as the speed of technological ACAP development is low at that time.

Our findings also have implications for dynamic capabilities literature regarding the dynamization of capabilities. Dynamization is the radical change of capabilities which is different from the incremental change of capabilities (Schreyögg & Kliesch-Eberl, 2007). It resembles the different innovation processes that occur at industry-level which are classified as 'creative destruction' (Schumpeter Mark I) and 'creative accumulation' (Schumpeter Mark II). Creative destruction relates to entry of new entrepreneurial firms with new ideas and innovations that disrupt established ways of production, organization and distribution, while creative accumulation concerns the prevalence of large and established firms with accumulated stocks of R&D, production and distribution that innovate to strengthen their acquired market position (Malerba & Orsenigo, 1997). These innovation processes at industry level might change over time. In general a period of creative destruction is followed by a more stable period of creative accumulation. However, this could be followed by a new period of creative destruction, which is often led by new entrants with new technologies that outperform existing firms with established technologies (Malerba & Orsenigo, 1997). Established firms might overlook these new developments and opportunities due to path dependency, structural inertia, and commitment to short term success, which could

mark a period of decline (Christensen & Rosenbloom, 1995; Schreyögg & Kliesch-Eberl, 2007). However, some firms are able to adapt to a regime change from creative accumulation to creative destruction (O'Reilly & Tushman, 2008). These firms seem to be able to change their capabilities radically, which requires a different dynamic capability than the 'incremental' dynamic capability as a patterned way of problem solving (Schreyögg & Kliesch-Eberl, 2007).

Our concept of speed of ACAP development can contribute to a better understanding of the dynamization of capabilities. Extant literature that uses a steady state conceptualization of ACAP implicitly takes the perspective of ACAP as an incremental dynamic capability. This assumes an industry setting of creative accumulation. Introducing speed of ACAP development into the academic conversation changes the perspective to creative destruction. More research on how speed of ACAP development can be increased and what challenges need to be addressed will enhance our understanding of how established firms can break their path-dependency and avoid lock-in. Interesting research questions in this respect are 'How flexible are ACAP routines to facilitate dynamization of capabilities?' and 'What are the differences between incremental ACAP routines and radical ACAP routines?'.

2.4.2 Research opportunity 2: Dynamic capabilities characteristics of ACAP

The second paradox we examined in this study is based on the assumption that firms need in-house knowledge creation to be able to absorb external knowledge. Yet SMEs often have limited in-house knowledge creation capabilities, and still are able to acquire and assimilate external knowledge. Our review showed that the key assumption of the need for in-house knowledge creation is based on two underlying premises. First, the external knowledge is complex, tacit and ambiguous which means that it is difficult to transfer and to absorb, as the knowledge needs to be adjusted to firm-specific circumstances to lead to competitive advantage. Second, the translation of new external knowledge to fit firm-specific requirements can only be done by the firm itself. Our study contributes to ACAP theory by challenging these two underlying premises, which are reflected in Propositions 2a and 2b.

The main implication of resolving this paradox on the relation between external knowledge acquisition and in-house knowledge creation is that external knowledge can be bought. This is in contrast with Cohen and Levinthal's (1990) argument that buying external knowledge is very difficult. We argue that this depends on the properties of the knowledge acquired. If knowledge is not too complex, ambiguous or tacit, it can be integrated and used in the own organization without complex modifications. In turn, this has two implications. First, assuming that in-house knowledge creation involves learning, properties of the new knowledge itself determine the *ease* of learning. From organizational learning theory it is known that

codified and simple knowledge is learned easier than tacit and complex knowledge (Huber, 1991; Szulanski, 1996). So, when ACAP literature argues that in-house knowledge creation is needed to absorb external knowledge, it neglects the differences in knowledge properties. Second, the intention of the firm to engage in external partnerships determine the *extent* of learning. This relates to what Grant and Baden-Fuller (2004) called ‘accessing’ versus ‘acquisition’. They argued that learning is not always the aim of collaborations and alliances, and that besides knowledge acquisition firms can also access each others knowledge base in order to exploit the partner’s knowledge with the intention to maintain their own specialist knowledge. In other words, the alliance partners only exchange knowledge at the interface of their complementary activities to enable effective knowledge integration. This way, only limited knowledge is exchanged that needs to be adjusted to firm-specific needs, therefore the extent of learning and its subsequent in-house knowledge creation capability is low.

The implications for ACAP research are that considering the properties of knowledge and the aim of the collaboration or alliance is important as these determine the validity of a key assumption regarding the need for in-house knowledge creation capability. Future research could further examine the effects of knowledge properties of complexity, ambiguity and tacitness on processes of ACAP. Further it would be interesting to examine what aspects of ACAP are minimum requirements to access knowledge.

The second premise that underlies the paradox of in-house knowledge creation and external knowledge acquisition relates to the unit of analysis, which is the knowledge acquiring firm in extant literature. Based on the notion in dynamic capabilities literature that capabilities share some commonalities and are not as idiosyncratic as they seem (Eisenhardt & Martin, 2000), our review indicates that knowledge providers, such as trade associations, research centers and venture capitalists, in some cases are better in articulating needs and requirements of SMEs than these SMEs themselves. Doing so, these knowledge providers can tailor their knowledge provision to the firm-specific needs of the recipients, which reduces the complexity, ambiguity and tacitness of the external knowledge. This reduces the need for in-house knowledge creation capabilities to assimilate this external knowledge. So, we propose to include the ACAP properties of the knowledge provider in the equation when studying ACAP. Although several studies have examined knowledge exchange at the alliance or dyad level (e.g. Lane & Lubatkin, 1998; Szulanski, 1996), these studies mostly addressed the problems that the knowledge recipient encountered to absorb new knowledge. We suggest new research that focuses on the role of the knowledge provider who makes it easier for the knowledge recipient to absorb new knowledge. This offers new research perspectives to study research questions, such as ‘When is ACAP a firm specific and idiosyncratic capability, and when is it a general

dynamic capability?’ and ‘What are the ACAP characteristics of an effective knowledge provider?’.

2.4.3 Research opportunity 3: Individual characteristics and managerial decision making

The third paradox that we examined in this review concerned the role of individuals in ACAP literature. Although individuals are at the heart of organizational ACAP (Cohen & Levinthal, 1990), the extent and content of their contribution to ACAP still needs further examination (Lane et al., 2006; Volberda et al., 2010). Our review adds to extant literature by providing new research opportunities to enhance understanding of individuals’ roles.

First, our review shows that not only diversity of prior knowledge and experience of organizations’ members are important, but also other capabilities, such as organizing and relational capabilities. Several studies in our review provide empirical support for the key assumption made in extant ACAP literature about the importance of prior knowledge and experience (Cohen & Levinthal, 1990; Zahra & George, 2002), such as the studies of Hayton and Zahra (2005), and Qian and Acs (2011). However, other studies introduced personal relational capabilities from social network theory and entrepreneurship as another important antecedent of individuals’ ACAP (e.g. Freeman et al., 2010; Malik & Wei, 2011). These studies answer a call from Todorova and Durisin (2007) to include social networks into ACAP literature to better explain how firms recognize and acquire new knowledge. Further, organizing capabilities were observed as a critical factor for individual ACAP, to ensure sufficient time and management attention for ACAP processes (Jones et al., 2010; Liao et al., 2003).

Whereas literature on ACAP in larger firms calls for more research on the individual level (Lane et al., 2006; Volberda et al., 2010), our review shows that literature on entrepreneurship and SMEs already have recognized the importance of individuals’ ACAP and have studied some of its antecedents. However, these studies still treat individual ACAP as a black box. So, a promising research avenue would be to develop a measure for individual ACAP, and to study its antecedents and outcomes. Then, an interesting question becomes what the relative importance is of the several individual capabilities regarding one’s ACAP. For instance, are relational capabilities more important than one’s prior knowledge and experience? If this is the case, it might explain why small and new firms can grow rapidly or internationalize fast when the top managers have only limited managerial or internationalization experience, but possess a large and diverse personal network.

Further, our review suggests that individual ACAP of managers might be more important than individual ACAP of other organization members (e.g. Wang et al., 2010). For small and young firms this seems logical, as the owner-managers are the

most influential, or even the sole, employees. However, also for larger firms, individual ACAP of managers might be more important for the organization's overall ACAP as these persons often fulfill roles of gatekeepers or boundary spanners (Tushman, 1977), which stand at the interface of organizational units and their internal and external environment (Cohen & Levinthal, 1990: 132) and therefore are better able to recognize external knowledge and diffuse it internally. This implies that personal characteristics of top managers, but presumably also middle managers, could play an important role in establishing, developing and maintaining organizational ACAP. So, we encourage research that specifically examines the characteristics of managers that affect their individual ACAP, as well as the influence of managerial ACAP on organization-level ACAP. Research questions that guide future research are: 'What personal characteristics of managers determine their ACAP?', 'What is the relative importance of managerial ACAP on organizational ACAP compared to that of other organizational members?' and 'How does managerial decision making affect ACAP development of other individuals and the organization as a whole?'. Answering these questions contribute to better understanding of to what extent and how ACAP is developed intentionally by managerial actions. This is one of the underlying assumptions of Zahra and George's (2002) reconceptualization of ACAP as a dynamic capability that has not been studied explicitly, so far.

2.4.4 Research opportunity 4: ACAP in different organizational configurations

The fourth paradox on the role of social integration mechanisms (SIM) on ACAP in SMEs suggests that the implicit assumption in extant ACAP literature is that organizations are large, technology oriented and functionally structured. The assumption is that SIM are needed for internal knowledge diffusion within the organization as the place of knowledge acquisition (for instance by a R&D department) is different from the place where the knowledge is used (for instance by a manufacturing department). Also, SIM facilitate creativity and knowledge recombination and integration which is required for innovative output, such as new products and services. However, our review suggests that need for SIM in SMEs is less obvious as knowledge processing is often restricted to only a few people, mostly at the top management team level (e.g. Descotes & Walliser, 2011; McKelvie et al., 2007). This challenges the general assumption that the place of knowledge acquisition is different from the place of knowledge exploitation. The implication is that new organizational forms around (self-steering) teams or smaller units to facilitate flexibility and fluidity in combination with efficiency (Eisenhardt, Furr & Bingham, 2010 ; Schreyögg & Sydow, 2010) might need other SIM to increase ACAP, in contrast to the larger and 'traditional' functionally structured firm.

This offers new research opportunities on ACAP at the team-level, as in teams the processes of knowledge acquisition and exploitation take place within the same

organizational unit. The questions then arise ‘What SIM are needed to develop and maintain team-ACAP?’ and ‘What is the relative importance of individuals’ ACAP and SIM to develop and maintain team-ACAP?’.

The current scholarly interest in new organizational forms that combine efficiency and flexibility is largely based on the debate around ‘ambidexterity’ (Lavie et al., 2010; Gupta, Smith & Shalley, 2006; O’Reilly & Tushman, 2008.), which is the simultaneous execution of ‘exploration’ and ‘exploitation’ within one organization or unit. Exploration is associated with activities like search, variation, risk taking, experimentation and discovery, whereas exploitation refers to activities like refinement, production, efficiency and implementation (March, 1991). The opponents of ambidexterity argue that exploration and exploitation require different systems, routines and mindsets, and that pursuing both activities simultaneously is ineffective, as these both claim the same scarce resources. Exploration activities generally require organizational units that are organically structured, with decentralized decision making, flexible processes and loose cultures (Lavie et al., 2010). In contrast, exploitation activities need more centralized decision making, clear rules and procedures, tight culture and process management (Benner & Tushman, 2003). Therefore, these opponents argue that exploration and exploitation activities should be organized in separate organizational units (Gupta et al., 2006; He & Wong, 2004).

The advocates of ambidexterity claim that exploration and exploitation can be combined within one organization and that it requires a ‘moderate organizational structure’ (Eisenhardt et al., 2010) that facilitates efficiency and flexibility. This relates to our proposition in which we suggest that the most optimal ACAP level in SMEs is established at a moderate level of SIM. Further research on this relationship between SIM and ACAP contributes to this literature in two ways.

First, in ACAP literature the combination of exploration and exploitation is included in the conceptualization of ACAP. For instance, Lane et al. (2006) and Lichtenthaler (2009) treat March’s (1991) exploration and exploitation capabilities as separate ACAP dimensions. However, they do not address the tensions that inherently are captured in the differences of their processes and routines, and how firms should manage these differences. Our proposition of an inverted U-shaped relationship between SIM and ACAP offers opportunities to study how SIM affect the ACAP processes of acquisition, assimilation, transformation and exploitation differently regarding flexibility and efficiency. A first indication of the challenges that SIM poses on ACAP is found in Jansen et al.’s (2005) study who found opposite (yet partly non significant) effects of formalization and socialization on each of the four ACAP dimensions. However, curvilinear effects of SIM on ACAP have not been studied yet. So, questions for future research are ‘Do SIM affect all ACAP processes in a similar way, and if not, how can these different effects be managed effectively?’. Another interesting question that arises is to what extent different kinds of SIM mitigate or

reinforce each others' opposite and unwanted effects on ACAP. For instance, can informal personal linkages mitigate the negative effects of formalization (efficiency) on creativity (flexibility) during knowledge transformation?

Second, Lavie et al. (2010) argue that ACAP is an important antecedent for the exploration and exploitation activities, where exploration is more related to knowledge acquisition, whereas exploitation is more related to knowledge application (Lane et al., 2006; Lichtenthaler, 2009). Further understanding of how SIM affect ACAP can contribute to the discussion on how ambidextrous organizations should be structured and organized. Here, interesting research opportunities point to the question of what combinations of SIM lead to such 'ACAP-profiles' that facilitates both exploration and exploitation. These ACAP-profiles also refer to Zahra and George's (2002) 'efficiency factor' that could be regarded as a measure for balancing exploration (acquisition and assimilation) and exploitation (transformation and exploitation) activities. More insight in the relative importance of the four ACAP dimensions for innovation strategies and their relation to required SIM would offer managers practical insights in how to design their organization for both flexibility and efficiency.

2.4.5 Conclusion

The aim of this study is to resolve four paradoxes of ACAP in SMEs. Doing so, we identified the limitations of extant assumptions that underlie ACAP theory. Resolving the paradoxes result in the revision of the assumptions concerning the static character of prior knowledge, the need for in-house knowledge creation capabilities, the antecedents of individual's ACAP and the effects of social integration mechanisms on ACAP. These revisions enhance our understanding of ACAP as a dynamic capability and offer new and promising research opportunities. Our review shows not only how SMEs manage the identified paradoxes, but also shows that research on SMEs can contribute to mainstream literature with their primary focus on larger firms. We hope that our study will encourage other researchers to further explore the assumptions of ACAP, both in SMEs and in large firms.

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APPENDIX 2.1

Selected articles and key findings (in alphabetical order of authors)

Journal	Authors (Year)	Paradox nr.	Methodology	Operationalization ACAP	Key findings regarding ACAP
Industry and Innovation	Barge-Gil (2010)	1	Study on 10,875 observations of Spanish firms (> 200 employees)	R&D intensity	Smaller firms have high need for external knowledge but low capacity, large firms have high capacity but low need, middle sized firms profit most from open innovation with medium need and medium ACAP
Research Policy	Bayona, Garcia-Marco & Huerta (2001)	1	Survey of 1,625 large and small Spanish firms	R&D capacity as multi-dimensional construct	ACAP positively affects cooperative R&D, with large firms collaborating more technological and SMEs collaborating more regarding market considerations and innovation processes
Journal of Business Venturing	Branzei & Vertinsky (2006)	2	Survey of manufacturing SMEs (< 100 employees) in Canada	Four capabilities of acquisition, assimilation, transformation and deployment	Different innovation strategies (human capital, process, product or market development) affect ACAP capabilities differently
Journal of Engineering and Technology Management	Deeds (2001)	1	Study of 80 pharmaceutical biotechnology companies after IPO (archival data)	Aggregated number of research communities in which the firm participates	ACAP positively affects entrepreneurial wealth
Journal of Small Business and Enterprise Development	Descotes & Walliser (2011)	3,4	Interviews with 18 managers in Romanian and French exporting SMEs (< 250 employees)	Four dimensions of Zahra & George (2002)	Diversity and complementarity of TMT knowledge is important. ACAP processes are mostly informal and take place at level of TMT
Strategic Entrepreneurship Journal	Fernhaber, McDougall-Covin & Shepherd (2009)	1,2	Study of 206 high tech new ventures in U.S. (archival data)	Prior internationalization knowledge	Internal and external knowledge sources are substitutes instead of complements. New ventures with limited internationally experienced TMT members benefited most from external sources.

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APPENDIX 2.1 (continued)

Journal	Authors (Year)	Paradox nr.	Methodology	Operationalization ACAP	Key findings regarding ACAP
European Management Review	Flatten, Greve & Brettel (2011)	1	Survey of 345 German SMEs	Four dimensions of Zahra & George (2002), developed own measurement scale	Alliances partly mediate the effect of ACAP on firm performance, firm age has a moderating effect, firm size has not
Journal of Information Technology	Francalanci & Morabito (2008)	4	Survey of 466 Italian SMEs (< 500 employees)	Multi-dimensional: process, training, change and flexibility orientation	ACAP mediates relationship between IT integration and firm performance
International Business Review	Freeman, Hutchings, Lazaris & Zyngier (2010)	1,2,3	Conceptual	Multi-dimensional: ability to recognize, absorb and assimilate	Born global firms build ACAP based on international experience and relationship capabilities of managers to access knowledge in established networks or newly created networks which are based on trustworthy established network partners
International Journal of Entrepreneurial Behaviour and Research	Gray (2006)	1,3	Survey of SME-owners in Britain in three waves of 687, 808 and 739 respondents respectively	Potential ACAP to acquire and use external knowledge, measured as levels of education, staff development, growth orientation and propensity to innovate	Graduates are more growth oriented than average and owners with no qualifications more growth-averse, but owners with technical and vocational qualifications are most growth oriented. Owners' strategic objectives and the consequent culture created within small firms are crucial for firm performance
Research Policy	Izushi (2003)	2	Survey of 264 firms and 53 interviews (< 300 employees) collaborating with two public Japanese research institutes	Number of employees	SMEs start with low-information gap services to build ACAP before engaging in high-information gap services. Trade associations can substitute for own ACAP building

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APPENDIX 2.1 (continued)

Journal	Authors (Year)	Paradox nr.	Methodology	Operationalization ACAP	Key findings regarding ACAP
International Journal of Technology Management	Hayton & Zahra (2005)	3	Study of 340 U.S. high technology ventures after IPO (archival data)	Top management education and experience, and top management human capital diversity	ACAP (human capital diversity) of top management team moderates the relationship between venturing activities and performance. Level of human capital has no effect
Technovation	Hervas Oliver, Albors-Garrigos & Gil-Pechuan (2011)	2	Study of 2,023 Spanish firms, both large firms and SMEs, both high and low tech firms (archival data)	Multi-dimensional 1) firms' internal R&D resources 2) marketing, design, employees with tertiary degrees, formal plan for innovation and technology forecast committee	R&D innovators have better internal capabilities and collaborate more. Non-R&D innovators only perform better on process innovation. Internal resources and external acquisition function as substitutes, rather than complementarities
International Journal of Innovation Management	Huang & Rice (2009)	2	Survey of 292 Australian manufacturing SMEs	Training expenditures	ACAP moderates the relationship between networking and innovation performance. Also, ACAP mitigates the negative effects of external technology purchase on future innovation performance
Entrepreneurship and Regional Development	Jones, Macpherson & Thorpe (2010)	3,4	Conceptual	Systems and routines for knowledge sharing	Learning in SMEs depends on creation of owner/managers' strategic space, which depends on the owner/managers' human capital, social capital and the establishment of ACAP as systems, structures and routines
Research Policy	De Jong & Freel (2010)	2	Survey of 316 Dutch high-tech small firms (< 100 employees)	R&D expenditures and R&D intensity	Innovation comes from distant search, but small firms tend to search local unless they have higher ACAP

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APPENDIX 2.1 (continued)

Journal	Authors (Year)	Paradox nr.	Methodology	Operationalization ACAP	Key findings regarding ACAP
Entrepreneurship and Regional Development	Julien, Andriambeloson & Ramangalahy (2004)	2	Survey of 146 manufacturing SMEs (< 250 employees) in Canada	Number of graduate degree employees and number of R&D employees	ACAP moderates effects of weak signal networks on technological innovative intensity
Research Policy	Kodama (2008)	2	Survey of 158 manufacturing SMEs in Japan	R&D expenditures	SMEs with higher ACAP are better able to make effective use of university-industry linkages to achieve R&D outcomes
Science, Technology and Society	Lal (2007)	3	Survey of 67 SMEs in Nigeria	Technological workforce	ACAP positively affects adoption of ICT practices
Strategic Management Journal	Lane, Salk & Lyles (2001)	1	Survey of 78 Hungarian small to mid-sized international joint ventures	Multi-dimensional: ability to understand, assimilate and apply external knowledge	For our review, the post-hoc analysis is most important where it is shown that learning content changes over time. Technological, product development and production process knowledge remained the same over time. Marketing and managerial learning increased and as this knowledge is more tacit, it requires more ACAP
Journal of Business Venturing	Larraneta, Zahra & Gonzalez (2012)	1	Interviews with CEOs of 140 Spanish firms 8 years old or younger	Four dimensions of Zahra & George (2002) based on measurement of Jansen et al. (2005)	ACAP moderates the effect of knowledge novelty and variety on strategic variety (flexibility), but the effect is strongest for low ACAP. Firms with high ACAP do not profit from resourceful environments
Entrepreneurship Theory and Practice	Liao, Welsch & Stoica (2003)	1, 3	Survey of 107 growth oriented SMEs in U.S.	Two-dimensional construct of external knowledge acquisition and intra-firm knowledge dissemination	ACAP leads to higher responsiveness Environmental turbulence leads to more internal dissemination. A strategic proactive orientation leads to more external knowledge acquisition

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APPENDIX 2.1 (continued)

Journal	Authors (Year)	Paradox nr.	Methodology	Operationalization ACAP	Key findings regarding ACAP
Technovation	Lin, Fang, Fang & Tsai (2009)	2	Survey of 110 SMEs in government sponsored R&D consortia in Taiwan	Three items in survey that reflect acquisition, assimilation and application	Network embeddedness provides an opportunity window for technology transfer but only leads to performance advantages when firms have sufficient ACAP
Journal of Small Business Management	Lowik, Van Rossum, Kraaijenbrink & Groen (2012)	2	Multiple case study of 4 technology firms in The Netherlands	Knowledge acquisition	SMEs use specific relational capabilities ('bridging capabilities') to acquire new knowledge from strong ties
Technology Analysis and Strategic Management	Malik & Wei (2011)	3	Interviews with 20 managing directors and R&D managers of 10 Chinese SMEs (< 650 employees)	Internal resources	Chinese firms that innovate have to expand their network from bilateral relationships with a few partners to a more heterogeneous network. Chinese SME managers lack internal capabilities (ACAP) to manage these multilateral relationships
R & D Management	McAdam, McAdam & Brown (2009)	2	Multiple case study of 6 'Proof of Concept' projects within 1 university incubator in U.K.	Four dimensions of Zahra & George (2002)	Development of entrepreneurs' skills and understanding of key business processes (ACAP) is important to enable them to communicate more effectively with the technology transfer office of the incubator, which enhances the commercialization process
Advances in Entrepreneurship, Firm Emergence and Growth	McKelvie, Wiklund & Short (2007)	4	Survey of 318 new firms in Sweden	Four dimensions of Zahra & George (2002)	All dimensions of ACAP in SMEs are related to innovative output. ACAP in SMEs might be better reflected in the behavior of key individuals, rather than the firm as a whole

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Journal	Authors (Year)	Paradox nr.	Methodology	Operationalization ACAP	Key findings regarding ACAP
Industry and Innovation	Meeus, Oerlemans & Hage (2004)	2	Survey of 579 Dutch industrial firms both large firms and SMEs	Internal resources (R&D intensity, higher educated employees and resource deficits)	More ACAP leads to more inter-firm learning, however for SMEs there is an inverted U-shaped relationship between ACAP and inter-firm learning with universities. Complexity of innovation activities also determines inter-firm learning
Asia Pacific Business Review	Motohashi (2008)	1	Survey of 556 Japanese small and large firms	Technological capability reflected in in-house R&D	ACAP and university-industry collaboration have U-shaped relationship, as small firms have low level of ACAP, and need collaborations to compensate for lacking capabilities whereas large firms collaborate with universities for long term and basic research.
Strategic Management Journal	Mowery, Oxley & Silverman (1996)	1	Study on subset of 155 alliances (archival data)	Prior cross citation rate in patents with alliance partners	Larger firms seem to absorb fewer capabilities from alliance partners compared to smaller firms, while R&D intensive firms do not absorb more from alliance partners compared to less R&D intensive firms
Economics of Innovation and New Technology	Muscio (2007)	3	Survey of 276 SMEs in Italy (< 250 employees)	Human capital (share employment in R&D, share employment university degree, continuous learning programs, awareness part of innovation system)	Skills and knowledge of employees, embedded in a firm's ACAP (human capital), positively affects collaboration with external actors

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Journal	Authors (Year)	Paradox nr.	Methodology	Operationalization ACAP	Key findings regarding ACAP
Journal of International Management	O'Dwyer & O'Flynn (2005)	1	Multiple case study of four alliances between SMEs and 1 MNC in Ireland	Learning capacity	The recipients ACAP is not determined by its ability to acquire knowledge but by its intention to acquire knowledge and by the willingness of the knowledge provider to let the recipient acquire knowledge. So for SMEs partner choice is important.
Journal on Chain and Network Science	Passiante & Ndou (2006)	2	Survey of 129 SMEs in tourist industry	Multi-dimensional construct consisting of scanning the environment, communication culture and structure, and gaining and releasing resources	ACAP has a direct effect on value creation in networks in tourism
International Journal of Management Reviews	Phelps, Adams & Bessant (2007)	1	Review study of organically growing businesses	Capacity to find knowledge and implement it to resolve challenges (tipping points) that impede growth	Firms need ACAP in several domains to manage the challenges of growth, such as operational improvement, people management, obtaining finance, establishing systems, strategy and market entry
Entrepreneurship Theory and Practice	Prashantham & Young (2011)	1	Conceptual	Multi-dimensional construct following Zahra & George (2002)	Four dimensions of ACAP are influenced differently by types of social capital (strong vs weak ties and internal vs external ties), regarding speed and content of learning

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Journal	Authors (Year)	Paradox nr.	Methodology	Operationalization ACAP	Key findings regarding ACAP
Small Business Economics	Qian & Acs (2011)	3	Conceptual with empirical test of 305 metropolitan areas in U.S.	Entrepreneur's prior knowledge	Human capital (both technological and market/business prior knowledge) is a main antecedent for individual entrepreneurial ACAP to bring new knowledge to the market through the creation of a new firm
Journal of Small Business and Enterprise Development	Rejeb-Khachlouf, Mezghani & Quelin (2011)	3	Survey of 55 SMEs in export consortia in Tunisia	Four dimensions of Zahra & George (2002), developed own measurement scale	An individual's personal network diversity positively affects one's individual ACAP. Individual ACAP positively affects access to strategic resources and knowledge transfer
Asian Business and Management	Rhee (2008)	3	Survey of 95 internationally operating Korean SMEs	Employees' overall job-related ability following Minbaeva et al. (2003)	Level of employees' ACAP positively affects internationalization performance
Research Policy	Rothaermel & Thursby (2005)	1	Longitudinal study of 79 U.S. incubator firms (1998-2003)	University backward patent citations	ACAP positively relates to new venture performance
Technovation	Spithoven, Clarysse & Knockaert (2010)	2	Interviews with CEOs of 12 Belgium collective research centers and survey of 856 member firms, and secondary data	R&D activities and R&D related activities	Research centers can build ACAP in their client firms by performing functions on knowledge intelligence, knowledge creation and knowledge repository
Journal of Knowledge Management	Wang & Han (2011)	2	Survey of 96 Chinese SMEs	Multi-dimensional: acquisition, assimilation, transformation and exploitation	ACAP mitigates effects of external knowledge characteristics like tacitness, ambiguity and complexity on innovation performance

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APPENDIX 2.1 (continued)

Journal	Authors (Year)	Paradox nr.	Methodology	Operationalization ACAP	Key findings regarding ACAP
Industrial Management and Data Systems	Wang, Wang & Horng (2010)	3	Survey of 49 bicycle companies in Taiwan (55-510 employees)	Four dimensions of Zahra & George (2002), developed own measurement scale	The owner's prior technological knowledge has an important positive effect on a firm's ACAP, and is even more important than R&D staff
Entrepreneurship and Regional Development	Witt (2004)	3	Conceptual	Only using Cohen & Levinthal (1990) as reference	There is an inverted U-shaped relationship between the network of a start-up's founding management team and the net benefits that they receive from their network partners, which is moderated by the ACAP of these founders
International Journal of Technology Management	Wu & Liu (2009)	2	Survey of 160 Chinese manufacturing firms, both large firms and SMEs	Multi-dimensional: ability to understand, to assimilate and to apply knowledge, developed own measurement scale	Strong embedded ties enhance ACAP and firm performance

CHAPTER 3

STRONG TIES AS SOURCES OF NEW KNOWLEDGE: HOW SMALL FIRMS INNOVATE THROUGH BRIDGING CAPABILITIES

While extant literature assumes an inverted U-shaped relationship between tie-strength and new knowledge acquisition, our study suggests a positive, curvilinear relationship. Our multiple case study shows that firms use specific relational capabilities – which we define “bridging capabilities” – to acquire new knowledge. These bridging capabilities mitigate the risk of overembeddedness in strong ties through increasing multiplexity, that is through establishing and leveraging multiple relations within a single tie. Our findings suggest that small firms should invest more in the exploration of strong ties, instead of increasing their weak tie network. Doing so helps them to reduce alliance complexity, thereby increasing alliance management efficiency and alliance ambidexterity.

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3.1 INTRODUCTION

New knowledge acquisition is a key factor that determines a firm's innovation performance (Cohen & Levinthal, 1990; Yli-Renko, Autio & Sapienza, 2001). To acquire new knowledge, small firms rely more and more on their networks (Baum, Calabrese & Silverman, 2000; Groen, Wakkee & De Weerd-Nederhof, 2008; Street & Cameron, 2007). To continuously capture value from these networks, firms are advised to establish heterogeneous alliance portfolios consisting of both strong and weak ties (Ahuja, 2000; Capaldo, 2007; Hansen, 1999; Reagans & McEvily, 2003; Obstfeld, 2005; Tiwana, 2008). For small firms, the management of a broad and heterogeneous alliance portfolio can be problematic, though, because of limitations in resource availability and management attention (Duysters & Lokshin, 2011; Lang, Calantone & Gudmundson, 1997). Despite these problems, small firms still are able to innovate, often through alliances with strong-tie partners, like customers and suppliers (Street & Cameron, 2007; Yli-Renko et al., 2001). Therefore, the question arises how these small firms use their strong ties to innovate.

Extant literature on networks and alliances assumes an inverted U-shaped relationship between tie-strength and new knowledge acquisition (McFadyen & Cannella, 2004; Uzzi, 1996). After a certain point, stronger ties suffer from “overembeddedness”, resulting in diminishing availability of new knowledge as the partner firms become too similar (Hagedoorn & Frankort, 2008; Uzzi, 1996). In contrast, some studies found that firms that applied relational capabilities were able to acquire new knowledge from strong ties over a long period of time (Lorenzoni & Lipparini, 1999). In our study, we aim to integrate both perspectives by answering two research questions: Do specific relational capabilities mitigate the negative effect of overembeddedness? And if so, what are these capabilities?

The results of our multiple case study on four small technology firms show that these firms have established long-lasting relationships, and that they acquire new knowledge from these strong ties through the application of six “bridging capabilities”. These capabilities build and leverage multiple relations within a strong-tie relationship, thereby pro-actively expanding the scope of knowledge acquisition through an increasing level of multiplexity. Based on our findings, we propose that the extent to which strong ties can be sustainable sources of new knowledge depends on the application of bridging capabilities by the focal firm in combination with the innovativeness of the partner firm.

This study contributes to network and alliance literature in three ways. First we extend literature on alliance capabilities by explaining the underlying processes and mechanisms that affect new knowledge acquisition. We provide a taxonomy of bridging capabilities and explain their effect through multiplexity. Second, we challenge the assumption in network literature of an inverted U-shaped relationship

between tie-strength and new knowledge acquisition. Our findings indicate a positive curvilinear relationship, which results from the application of bridging capabilities on innovative strong-tie partners. Third, our study suggests that small firms should engage more in innovative strong-tie partnerships rather than expanding their weak-tie network. This way they can reduce their alliance portfolio complexity and still benefit from increased alliance ambidexterity.

The remainder of this article starts with a brief literature review and conceptual framework that guide our study. After explanation of the research design and method, we present the results of the multiple case study along the lines of the conceptual framework. We discuss the implications for theory and practice, and provide suggestions for future research.

3.2 THEORETICAL BACKGROUND

3.2.1 Tie strength and knowledge acquisition: the effect of overembeddedness

Weak and strong ties are both important for innovation and fulfill different, yet complementary roles. Weak ties are network relations that stimulate significant innovation by providing access to novel knowledge that is distant from the firm's own knowledge base (Burt, 1982, 2000; Granovetter, 1973). However, capturing value from this new knowledge is often difficult as weak ties are generally characterized by few interactions, a low level of emotional intensity and trust, and few reciprocal services (Granovetter, 1973). Although weak ties can facilitate the exchange of simple and codified knowledge, they are not well suited to exchange complex and more tacit knowledge (Hansen, 1999). The latter is often needed for the acquisition of competitive capabilities (McEvily & Marcus, 2005) and for the creation of more significant innovations (Zollo, Reuer & Singh, 2002). For this exchange of tacit and complex knowledge, strong ties are used. These ties are characterized by high levels of interaction, communication, emotional attachment, and trust (Gulati, 1995), thereby reducing the risks of opportunism and facilitating complex knowledge transfer. Examples of the positive effects of strong ties on significant innovations are found in recent studies of Li, Eden, Hitt and Ireland (2008), and Phelps (2010).

However, the effect of tie-strength on new knowledge acquisition seems to be curvilinear, represented by an inverted U-shape (McFadyen & Cannella, 2004; Uzzi, 1996). At the left-hand side of the inverted U-shape the weak tie gradually transforms into a strong tie, thereby establishing collaborative routines, building trust and disclosing ever more knowledge. At a certain point in time the relationship becomes "embedded", which means that repeated collaborations with the known partner firm are preferred over starting new collaborations with strangers (Hagedoorn, 2006; Uzzi, 1996). The advantages of embeddedness entail reduced transaction costs through established trust and collaboration routines, and access to more complex and tacit

knowledge as a result of more fine-grained knowledge exchange (Hagedoorn & Frankort, 2008; Uzzi, 1996). However, over time, embeddedness may lead to diminished knowledge benefits, as the knowledge bases of the firms converge through intensive mutual learning. This effect is represented by the right-hand side of the inverted U-shape, where "*overembeddedness*" in strong ties results in diminished performance of knowledge acquisition (Hagedoorn & Frankort, 2008; Uzzi, 1997).

The curvilinear effect of tie-strength on new knowledge acquisition leads to the so-called "search-transfer-problem" (Hansen, 1999). There it is argued that effective knowledge acquisition does not result from weak or strong ties alone, but results from their complementary nature. As weak ties transform into strong ties to capture value from the new knowledge (Burt, 2009; Hagedoorn & Frankort, 2008), the diminishing knowledge benefits from strong ties forces firms to search for new knowledge through weak ties. This implies that the firm needs to establish a "dual network", which consists of a core of strong ties with a periphery of weak ties (Ahuja, 2000; Burt, 2009; Capaldo, 2007; Hansen, 1999; Reagans & McEvily, 2003; Tiwana, 2008; Obstfeld, 2005). This dual network solution becomes manifest in the firm's alliance portfolio, containing alliances with suppliers and customers - mostly considered as strong ties -, and alliances with research institutes and universities - mostly considered as weak ties (Faems, Van Looy & Debackere, 2005).

Although a broad and diverse alliance portfolio is considered a solution for the search-transfer problem, this solution can sometimes become too complex and counterproductive. When a firm engages in different types of alliance activities simultaneously, this can lead to increased managerial costs and, eventually to inferior performance (Duysters & Lokshin, 2011). Especially in small firms the knowledge acquisition activities are concentrated in a few individuals - mostly managers - who have to divide their attention over several activities (Lang et al., 1997). As such, managing a broad and heterogeneous portfolio of both strong and weak ties can take a large share of these managers' time that they cannot spend otherwise. So, the recommended solution of a broad and diverse network to guarantee sustainable sources of new knowledge for innovation, just might lead to unsatisfying results, due to ineffective alliance management, which in turn is caused by this broad and diverse network.

3.2.2 Relational capabilities to mitigate overembeddedness effects

To manage alliances effectively, literature suggests that firms need to develop two kinds of alliance capabilities: alliance portfolio management capabilities and relational (or single alliance management) capabilities (Wassmer, 2010). Alliance portfolio management capabilities concern the ability to develop the alliance portfolio strategy, establish an alliance management system, and coordinate and monitor the portfolio (Hoffmann, 2005). Their main goal is to learn from prior alliance experiences and to

institutionalize these experiences within the firm, for instance through the establishment of a centralized alliance function, or the provision of alliance trainings (Draulans, de Man & Volberda, 2003; Heimeriks & Duysters, 2007; Kale, Dyer & Singh, 2002).

The second alliance capability mentioned in literature is the relational capability, which is the ability to interact with other companies (Lorenzoni & Lipparini, 1999). Here, the unit of analysis is the dyad, instead of the alliance portfolio, and it concerns the management of a single alliance. When firms repeatedly collaborate, they develop partner-specific routines as they learn from past experiences (Dyer & Singh, 1998), which results in better alliance performance (Zollo et al., 2002). For instance, the study of Lorenzoni and Lipparini (1999) showed that lead firms in the Italian packaging machinery industry developed relational capabilities, leading to a selective number of long-lasting relationships with key suppliers. These lead firms considered the suppliers as ‘knowledge generators’ and as trainers of the lead firm’s capabilities.

Two observations from the alliance capability literature are of primary interest to our study: a) relational capabilities have a positive effect on the acquisition of new knowledge (Lorenzoni & Lipparini, 1999) and innovation performance (Zollo et al., 2002), and b) these capabilities appear in long-lasting embedded relationships (Lorenzoni & Lipparini, 1999). In other words, long lasting embedded relationships – which can be considered as strong ties – can provide new knowledge over a long period of time. In contrast, as referred to before, extant literature assumes that after a certain level of tie-strength, further increase of tie-strength leads to *diminishing* knowledge acquisition benefits. So, on the one hand network literature suggests an inverted U-shaped relationship between tie-strength and knowledge acquisition, while on the other hand alliance capability literature suggests a positive relationship.

The question that arises is to what extent the development and use of relational capabilities could explain these seemingly contradictory findings in literature. Could it be that deployment of specific capabilities mitigate the negative effect of overembeddedness, which is assumed to be one of the main causes of diminished knowledge benefits when ties get stronger over time? And if so, what then are these specific capabilities? These two questions guide our study and are translated into the conceptual model as presented in Figure 3.1. Our review of network and alliance literature shows that with increasing tie-strength the liability of overembeddedness might lead to diminishing returns on the acquisition of new knowledge, represented as an inverted U-shaped relationship. However, we propose that the effects of overembeddedness can be mitigated by the deployment of certain relational capabilities, which is represented in Figure 3.1 by its moderating effect on the relation between tie-strength and new knowledge acquisition.

Figure 3.1: Conceptual model

3.3 RESEARCH SETTING AND DESIGN

This research is designed in two stages. During the first stage we examine the effect of tie-strength on new knowledge acquisition. The question that we answer there is whether strong ties over time still provide access to new knowledge. If this is the case, the assumed inverted U-shaped relationship between tie-strength and knowledge acquisition could be affected by our proposed relational capabilities. The second stage aims to identify the kinds of relational capabilities that firms deploy in these cases, and to examine their underlying mechanisms that might cause the proposed mitigating effect on overembeddedness.

As our research is explanatory in nature, we designed it as a multiple case study (Yin, 2009) of four small technology firms in the Netherlands: Metal, Plastic, Engineer and Micro. The cases were selected based on small firm size (between five and fifty employees), age (over ten years to ensure they had the opportunities to establish strong ties), and innovativeness (Metal and Plastic won several innovation awards, Engineer and Micro develop high tech production platforms). Metal is a manufacturer of customer-specific metal products and markets two own products: block cutters and pipe grinders. Plastic is a manufacturer of high technical polyurethane products. Engineer is an engineering firm, as a subsidiary of a manufacturer of metal components and final assembly of automated production lines. Micro is also a manufacturer of automated production lines with a specialization in micro-assembly.

3.3.1 Data collection and measures

We conducted semi-structured interviews with the CEO or operations manager as the primary source of information on firm-level capabilities. The interviews lasted between one and one and a half hour. Topics that were discussed included the firm's sources of external knowledge, types of relationships, acquisition strategies, partner choices, and kinds of knowledge exchanged. Next to the CEO or operations manager, we interviewed at least two other employees at each company who have frequent

interaction with external knowledge sources, which enabled us to acquire in-depth knowledge on firm-specific capabilities and network ties, and to avoid single respondent bias. Typical functions of the interviewees were sales engineer, product engineer, or project manager. A total of twenty interviews resulted into twenty-four hours of recorded material.

To obtain an overview of the most important ties of the firms, we followed a two-step method during the interviews, starting with the generation of the ten most important external knowledge sources for innovation projects in the last two years (Sammarrà & Biggiero, 2008). We used the fact that the firm received knowledge from an external source for an innovation project as a proxy for *new knowledge acquisition*. The notion that for innovation projects, like new product development, new external knowledge is acquired is generally acknowledged in literature (for instance Cohen and Levinthal (1990), and Yli-Renko et al. (2001)). The second step was to ask specific questions for each relationship mentioned, to determine tie-strength and knowledge acquisition strategy. *Tie strength* was operationalized as a multi-dimensional construct consisting of the duration of the relationship (0 = less than two years, 1 = between two and ten years, 2 = more than ten years), the frequency of contact (0 = at least once a year, 1 = at least once a month, 2 = at least once a week) and the emotional intensity (0 = a business acquaintance, 1 = a business friend, 2 = a personal friend), based on Capaldo (2007), Granovetter (1973), Marsden and Campbell (1984) and Perry-Smith (2006). Tie-strength was calculated by taking the sum of the scores on the three dimensions, with a minimum of zero and a maximum of six. We used the cutoff value of four to define strong ties. To determine the *specific relational capabilities*, we built on the notion of dynamic capabilities. Dynamic capabilities include the routines and processes that are intended to change the firm's knowledge base, which can be used to develop other capabilities to create a competitive advantage (Eisenhardt & Martin, 2000; Zahra, Sapienza & Davidsson, 2006). Eisenhardt and Martin (2000:1108) explicitly mentioned "alliance and acquisition routines" as examples of dynamic capabilities. These routines are characterized by learned and repetitious behavior, which is partly founded in tacit knowledge (Winter, 2003). As we are interested in identifying the relational capabilities that mitigate the effects of overembeddedness, we used a rather broad measure of routines and processes that are applied to identify, access and leverage new knowledge within existing relationships.

3.3.2 Data analysis

The data analysis is conducted in two steps. First, the relation between tie-strength and new knowledge acquisition was examined. Tie-strength was calculated and the relationships were classified as weak or strong.

Second, the types of relational capabilities have been identified using within-case and cross-case analysis (Miles & Huberman, 1994). We built on the notion of Eisenhardt and Martin (2000) that dynamic capabilities are idiosyncratic and firm-specific routines within one firm, but that they share commonalities across firms. So, during within-case analysis we coded firm-specific routines that were related to identifying, accessing and leveraging new knowledge. After that, we used cross-case analysis to compare the coded routines to determine commonalities that could be identified as specific relational capabilities.

3.4 RESULTS

3.4.1 The relation between tie strength and new knowledge acquisition

First we examine the relation between tie-strength and new knowledge acquisition as depicted in our conceptual model in Figure 3.1. During the interviews seventy-seven relationships were identified in total as important sources of new knowledge in the last two years, of which thirty-two were classified as strong ties (forty-one percent). Within the strong ties the distribution of knowledge sources was: customers (forty percent), suppliers (fifty percent), and knowledge institutes (ten percent). For weak ties the distribution was: customers (twenty-five percent), suppliers (fifty percent), and knowledge institutes (twenty-five percent).

The findings show that the studied SMEs use both weak and strong ties to acquire new knowledge, which is in accordance with literature. This supports the dual network solution to have a core of strong ties and a periphery of weak ties. The simultaneous use of both kinds of ties is illustrated with several quotes from our respondents. For instance, the operations manager of Metal said: “Where I search for knowledge when we have a project with new technologies? We use internet, I ask my CEO ‘Have you seen something on trade-fairs lately?’, and I ask our existing business partners”. Another example is Micro who sends its engineers to trade fairs and seminars (weak ties) to expand their general knowledge on available technologies, while at the same time specific and in-depth knowledge is acquired from key suppliers (strong ties). The CEO stated it this way: “On the one hand you need to know what [knowledge] is available, what its possibilities and impossibilities are, and where to find it. (..) On the other hand you get questions from customers that need answers. You try to match the questions with your own knowledge or that of your suppliers. If that does not work, you have to get it elsewhere”.

With respect to strong ties as knowledge sources for innovation, we observed that fifty percent of the mentioned strong ties had a duration of more than fifteen years, up to even twenty-five years. This is in line with the findings of Lorenzoni and Lipparini (1999), who also found that long-lasting embedded relationships (with an average duration of fourteen years in their study) have a positive effect on innovativeness. Furthermore, these findings challenge the assumption of an inverted U-shaped relationship between tie-strength and new knowledge acquisition, as found in the studies of McFadyen and Cannella (2004), and Uzzi (1996).

An explanation that we found for the long-lasting strong relationships as sources of new knowledge is that network partners develop their knowledge base themselves over time. Assuming that strong partners reside at least partially in the same network or industry, these firms also need to renew their capabilities and knowledge bases to stay competitive. As the CEO of Plastic said: “Our raw material suppliers regularly have new products and developments. (..) In the last seven years they made polyurethane antistatic and heat-resistant (..). When we were looking for ultraviolet radiation proof polyurethane it appeared that one of our suppliers had done some experiments in the past. Based on their experience together we developed a new product.” The CEO of Micro explained why he approaches existing relations when he needs knowledge to solve a problem: “You search for new knowledge sources when you reach the limits of what you know. But often it appears that in the meantime existing relations have pushed out their knowledge frontiers”.

In conclusion, our results show that small firms maintain a dual network, consisting of both weak and strong ties, as suggested in literature. However, we also find that strong ties are used as sustainable sources of new knowledge. This finding challenges the assumption of an inverted U-shaped relationship between tie-strength and new knowledge acquisition. An explanation for this is found in the innovative character of these strong-tie partners.

3.4.2 Specific relational capabilities to leverage new knowledge within strong ties

To benefit from the innovative character of strong tie-partners, firms need to get access to their partners' renewed knowledge bases. To do so, firms could apply specific relational capabilities, as suggested in our literature review. In our study we identified the processes and routines that the case study firms use to identify, access and leverage new knowledge within strong ties. In line with Eisenhardt and Martin (2000) we found that the specific relational capabilities are idiosyncratic and firm-specific, which is illustrated in Table 3.1 with illustrative quotes from our single-case analysis. However, Eisenhardt and Martin (2000) also stated that dynamic capabilities share commonalities across firms. With cross-case analysis we determined these commonalities to develop a taxonomy of six relational capabilities.

Table 3.2 shows which capabilities could be identified across the four cases. In this section we will explain each relational capability in more depth.

Specific relational capabilities	Illustrative examples
Systematic meetings with customers to discuss their latest developments	<p>"For customers for which we are preferred supplier, we are part of their technology development" (Marketing manager, Micro).</p> <p>"We invite customers to visit us with their engineers, to discuss mutual activities and developments" (Operations manager, Metal).</p>
Systematic meetings with suppliers to discuss their latest developments	<p>"Most suppliers visit us at least once a year to inform us about their innovations" (Design engineer, Engineer).</p> <p>"Our competitive advantage is mostly based on the constant communication with our suppliers. All our competitors maintain contacts with the raw materials suppliers, but the question is to what extent they challenge these suppliers to come up with new solutions. We are one of the few companies that really challenge our suppliers on technological knowledge" (Sales engineer, Plastic).</p> <p>"We visit the suppliers' application labs to get informed about their possibilities and new developments" (Engineer, Micro).</p> <p>"We visit suppliers to know more about their latest technological developments" (Operations manager, Engineer).</p>
Getting re-acquainted with customers and/or suppliers beyond their regular buyer-supplier relationship	<p>"Besides that Metal and Plastic have a long lasting history together. I know the operations manager of Metal also as fellow board member of the regional industry association. This way you meet in a different setting, discuss different issues, which lead to new ideas" (CEO, Plastic).</p> <p>"We use conferences, sponsor activities, joint subsidiary projects and social media to get to know our partners better" (Marketing manager, Micro).</p> <p>"After a trade fair in Münster [Germany], I went with a customer to the local Christmas market, where we, with a glass of beer in one hand and a 'Currywurst' [curried sausage] in the other, developed a new product on the back of a coaster" (CEO, Plastic).</p> <p>"We share our stand at trade fairs with a key customer to stress that we develop and manufacture products together. We even jointly hold patents"(CEO, Plastic).</p> <p>"I want to get into contact with other companies, like in business club Y, that offers a look behind the scenes at member firms, and strengthens the relationships with these members through the jointly presentation at trade fairs. This increases the understanding of what other member firms do, which has already resulted in jointly attracting and serving a new customer" (CEO, Micro).</p> <p>"We have a good relationship with supplier A, who assists us with technical problems and trainings. They also take part in the same informal business network group, where managers of the member firms discuss and share management best-practices" (Engineer, Metal).</p>

Intentionally establishing relationships with customers and/or suppliers on multiple organizational and/or departmental levels	<p>"Weekly I take an engineer or production worker with me to meetings with customers. Not only to use their technical knowledge to solve customers' problems, but also to make them [Metal's employees] aware of their social interactions and communication skills" (Operations Manager, Metal).</p> <p>"Two weeks ago we send an engineer to Taiwan to evaluate a project with the customer. Normally a director would do that, but the engineer had done the project. He learned and experienced a lot" (Operations manager, Metal).</p> <p>"We try to establish strategic alliances with customers to create more links between the two firms" (Sales engineer, Plastic).</p> <p>"I create formal collaboration projects to bring my engineers in contact with other companies to broaden their experiences" (Operations manager, Engineer).</p> <p>"After design and delivery we offer maintenance programs, to stay connected with our customers through service employees" (Marketing manager, Micro).</p>
Intentionally establishing relationships with organizations to get access to their large networks	<p>"You hire a university student, but get a whole lot more: access to research facilities, research staff, library, etc." (Marketing manager about their summer school, Micro).</p> <p>"We provide workshops to starting entrepreneurs to teach them about manufacturing techniques, but also to get informed about new developments" (Marketing manager, Micro).</p> <p>"A really new contact has been established through our partnership with Micro. (...) They brought us in contact with a reliable Malaysian supplier that we could not have found ourselves" (Operations manager Engineer).</p> <p>"Our welding programmer starts as a teacher at a regional school for secondary professional education. It is not only that he teaches fifteen and sixteen year olds how to weld, but he also learns about these students, who are our future employees. We can select the good ones, and adjust our personnel management to fit the requirements of this new generation" (Operations manager Metal).</p>
Exchanging personnel	<p>"I worked for 4 months at engineering firm X (...). They helped me to improve our project management at Metal by showing their way of working. I learned how to organize a project and how to deal with additional customer requirements during the project" (Engineer, Metal).</p> <p>"My colleague works as a consultant at our customer and is physically located there" (Engineer, Micro).</p> <p>"I temporarily placed my marketing assistant at another firm to let him take a look behind the scenes, and to apply the newly learned things here" (Marketing manager, Micro).</p>

Table 3.1: Illustrative examples of specific relational capabilities

Observed specific relational capability	Case company			
	Metal	Micro	Plastic	Engineer
Systematic meetings with customers to discuss their latest developments	✓	✓		
Systematic meetings with suppliers to discuss their latest developments	✓	✓	✓	✓
Getting re-acquainted with customers and/or suppliers beyond their regular business relations	✓	✓	✓	
Intentionally establishing relationships with customers and/or suppliers on multiple organizational and/or departmental levels	✓	✓	✓	✓
Intentionally establishing relationships with organizations to get access to their large networks	✓	✓		✓
Exchanging personnel	✓	✓		

Table 3.2: Specific relational capabilities across cases

Systematic meetings with customers to discuss their latest developments. Through this first relational capability firms pro-actively explore and leverage the knowledge bases of their customers on a regular basis. This way the existing relations are extended by connecting to new people and by entering new knowledge domains. An example is Metal, who regularly invites customers' engineering departments to discuss their new developments with its own engineers. This way Metal takes the initiative to exchange knowledge beyond the current problems in ongoing projects, and to create new relations among engineers from both firms who otherwise would stay unconnected. Also, Micro collects a lot of information about its customer's products, processes and business case, before designing a new assembly line. At Micro, the relational capability of systematic meetings with customers to acquire new knowledge is part of the project management system, where they intentionally acquire knowledge beyond the mere technological aspects to provide the best solution. This way they increase their market and managerial knowledge, which can be used for future projects. Within the cases we found this capability only applied in strong relationships with key customers for which the firm is a preferred supplier, or with which it has established a strategic partnership.

Systematic meetings with suppliers to discuss their latest developments. All case study firms use strong-tie suppliers not only as a contact to buy products or services, but also as advisor. The multiple roles that these key suppliers fulfill, and the pro-active exploration and leveraging of the suppliers' knowledge domains lead to increased knowledge acquisition. The most used routines to acquire new knowledge are mutual visits to each other's manufacturing sites, and regularly discussing new developments with the suppliers' sales representatives or (sales-) engineers. An

important goal to apply this relational capability is to stay informed on the latest developments that are not on the market yet. As the marketing manager of Micro noted: “They [suppliers] need to tell you what the real new things are they are working on - the things that are not listed in their catalogs yet”.

Getting re-acquainted with customers and/or suppliers beyond their regular business relations. This relational capability aims to get into contact with the partner firm in other settings than usual, offering new perspectives on the capabilities of the partner firm. An example is how Plastic discovered new capabilities of Metal with which they had a business relationship for over a decade, which resulted in an innovative product. When the manager of Plastic attended a company tour at its customer Metal, which was organized by the local business club, he was surprised to see and hear about Metal's manufacturing capabilities. Metal appeared to have operated a tube-laser-cutting machine for five years, and they had a fully automated single-piece welding line – without the manager of Plastic knowing this. Some weeks later, when a customer asked Plastic to provide a solution to substitute a full-metal product for polyurethane, the manager recalled Metal's tube-cutting capabilities. Plastic and Metal developed a new product for this customer, based on Metal's tube-laser-cutting technology and Plastic's polyurethane molding.

Intentionally establishing relationships with customers and/or suppliers on multiple organizational levels. In SMEs, the contacts with external parties are usually maintained by a few persons (Lang et al., 1997), like the CEO or sales representative. However, establishing additional relations on other organizational levels between employees of the partnering firms increases insights in the partners' marketing, manufacturing, logistical and managerial capabilities, and therefore gives access to new knowledge. Examples from our cases are Engineer and Metal where the operations managers actively stimulate their engineers to engage in additional relationships with their counterparts at customers to exchange knowledge and to increase their social and communication skills.

Intentionally establishing relationships with organizations to get access to their large networks. This relational capability concerns the use of strong ties to access the networks of their partners. By using the partner firm as a gateway to new contacts, the firm can tap new knowledge sources. This means that the role of the strong-tie partner changes from a direct knowledge source into a knowledge broker (Hargadon & Sutton, 1997; Yli-Renko et al., 2001). For instance, Micro maintains a strong relationship with the regional university, as a lot of employees have graduated there and have maintained their contacts. Micro uses its strong-tie relationship to get access to the universities' network. For instance, Micro provides workshops within the universities' entrepreneurship training program to teach starting entrepreneurs about manufacturing techniques. This way they get in contact with entrepreneurs and acquire knowledge about new developments these entrepreneurs are working on. Another

example is how Engineer used their strong relationship with Micro to get advise on outsourcing to production facilities in Malaysia. Micro introduced Engineer to a trustworthy manufacturer in Malaysia, which encouraged Engineer to take the first step to expand to Asia.

Exchange of personnel to acquire new knowledge. The exchange of personnel increases the breadth and depth of the relationship and gives access to new knowledge. The externally placed employees get socialized at the partner firm, thereby getting better insight in all kinds of the partner firm capabilities. Examples of personnel exchange as a relational capability is found at Metal who physically locates its engineer at a closely connected engineering agency to acquire new knowledge and project management methods. Also Micro physically locates an engineer at a main customer, which is located in the same city, to get an in-depth insight in the customers' processes to enable joint development of products and manufacturing processes.

In sum, our study shows that the case study firms apply several kinds of relational capabilities to acquire new knowledge within strong ties. Although the routines and processes are idiosyncratic and firm-specific, commonalities across the firms result in the identification of six specific relational capabilities.

3.5 DISCUSSION

This study aims to understand how small firms innovate through the use of strong ties. To guide our research we developed a conceptual model that expressed how the use of specific relational capabilities would enable new knowledge acquisition within strong ties. The findings from our qualitative case study support our assumption that strong ties can be sustainable sources of new knowledge, and that SMEs can use specific kinds of relational capabilities to acquire new knowledge from these ties. We proposed that the use of these relational capabilities could mitigate the negative effects of overembeddedness within strong ties.

However, to understand *how* these capabilities affect overembeddedness, we need to determine the key mechanism that underlies these relational capabilities. Closer examination of our results reveals that the explaining mechanism is found in “multiplexity”. Multiplexity is a tie characteristic that denotes the extent to which multiple types of relations exist between network partners within a single relationship (Burt, 1982: 32). Examples of multiplex relationships are combinations of coworker, adviser and friend relations (Lazega & Pattison, 1999), combinations of buyer-supplier relations, equity relations and director relations (Mahmood, Zhu & Zajac, 2011), or combinations of knowledge exchange relations concerning technological, market or managerial knowledge (Sammarrà & Biggiero, 2008). Several studies have shown that multiplexity improves access to new knowledge and other resources within existing relationships (Beckman & Haunschild, 2002; Coleman, 1988; Mahmood et al., 2011;

Uzzi & Gillespie, 1999). The reasons for this are that multiple relationships create more opportunities to get in contact with new knowledge, and that multiple interactions increase trust, which stimulates further knowledge exchange.

Our study showed that the firms apply relational capabilities to build and leverage multiplex relationships. For instance, the relational capabilities of exchanging personnel and establishing relations on multiple organizational levels, physically connect people who otherwise would stay unconnected. Also, the other relational capabilities - systematically meeting customers and suppliers, getting re-acquainted beyond regular business relations, and using the partner firms' networks -, create new knowledge relations beyond existing ones. By establishing these multiple relations and leveraging the knowledge from these relations, firms expand the scope of knowledge exchange within strong ties over time, which prevent them from the risk of overembeddedness.

From our study we derived a taxonomy of six capabilities that are used to build and leverage multiplexity within strong ties. We introduce the term 'bridging capabilities' to denote the specific character of these capabilities, and to distinguish them from other alliance and relational capabilities. We define bridging capabilities as *the processes and routines that are intentionally deployed to establish multiple relations within a single relationship and to leverage the knowledge from these multiple relations*. They denote the creation of multiple bridges that give access to different kinds of knowledge and resources. We consider bridging capabilities as a specific kind of relational capabilities, with a special focus on the multiplex character of relationships and alliances. In line with relational capabilities, bridging capabilities are considered as dynamic capabilities (Eisenhardt & Martin, 2000).

The main implication of our findings is that the assumption of an inescapable inverted U-shaped relationship between tie-strength and new knowledge acquisition needs refinement. Our cases showed that even over a long period of time – up to twenty-five years - strong ties still provide new knowledge. Further, our findings suggest that the acquisition of new knowledge from strong ties depends on the combination of the innovativeness of the partner firms and the characteristics of their respective networks, and the deployment of bridging capabilities. When the partner firm within a strong tie does not innovate, nor can provide access to an innovative network, we expect an inverted U-shaped relationship between tie strength and new knowledge acquisition as predicted by extant theory.

However, when the partner firm innovates, over time its knowledge base changes and renews, thereby increasing the availability of potentially valuable knowledge. This new knowledge can only be appropriated through the application of bridging capabilities. So the extent to which strong ties keep providing new knowledge over time is a function of the use of bridging capabilities by the focal firm and the

innovativeness of the partner firm. This leads to the following proposition, which is graphically illustrated in Figure 3.2.

Proposition: The use of bridging capabilities will have a mitigating effect on the inverted U-shaped relation between tie-strength and new knowledge acquisition, in such way that the extent of new knowledge acquisition is a function of the application of bridging capabilities by the focal firm, and the innovativeness of the partner firm.

Figure 3.2: Effect of bridging capabilities and partner innovativeness on the relationship between tie-strength and new knowledge acquisition

3.5.1 Contributions to theory and practice

Our study contributes to network and alliance literature in three ways. First, it shows that strong ties can be valuable sources of new knowledge and that the liabilities of overembeddedness can be mitigated by the use of bridging capabilities. This way, our study contributes to alliance capability literature by extending our understanding of what type of relational capabilities enhance knowledge acquisition from strong ties. Where studies of Lorenzoni and Lipparini (1999) and Capaldo (2007) mainly focus on the antecedents and outcomes of relational capabilities, our study examines their processes and routines. In addition to these studies, we provide a taxonomy of six bridging capabilities that firms use to build, develop and maintain multiplex relationships, in order to access and leverage new knowledge from these relationships.

Second, our study challenges the generally assumed inverted U-shaped relationship between tie-strength and knowledge acquisition. Our findings suggest that overembeddedness in strong ties can be mitigated by pro-actively exploring the partner

firms' knowledge base, under the condition that these partner firms innovate themselves. This is in line with earlier work of Yli-Renko et al. (2001) on knowledge acquisition between entrepreneurial high-technology ventures and their key customers. They found that knowledge acquisition is positively related to the level of social interaction, but negatively related to high levels of trust. Their explanation is that too much trust might lead to the expectation of the entrepreneurial firms that their strong-tie partner – the key customer - will provide them the necessary knowledge when required. In relation to our study, we would argue that the entrepreneurial firms lack the required bridging capabilities to pro-actively explore the key customer's knowledge base. This leaves them unable to avoid the overembeddedness-trap.

The lack of application of bridging capabilities might also explain why some scholars did find an inverted U-shaped relationship. For instance, McFadyen and Cannella (2004) studied interpersonal relationships between academic scientists. We expect that on an individual level scientists generally have a specialized knowledge base, which gets more specific over time. In these cases, increased multiplexity does not yield new different insights, which could explain why over time scientists prefer collaborations with new colleagues over known ones. This suggests that the effects of bridging capabilities are contingent upon the knowledge breadth of the alliance partner. This implies that a similar study on organizational level might lead to different results, as knowledge diversity within organizations is larger.

The study of Uzzi (1996) in the dress apparel economy, also found an inverted U-shaped relationship between embeddedness and firm survival. He argued that too much embeddedness bears the risk to get shielded from important developments in the larger network, leading to lower focal firm survival. However, he did show that the knowledge diversity of the partners' network positively affects the likelihood of focal firm survival. This finding implicitly suggests that some firms in Uzzi's (1996) study seem to be able to leverage the knowledge of their partners' networks. We suggest that this could be explained by the fact that some firms applied bridging capabilities to access new knowledge from their direct partners or through these direct partners, thereby increasing their chances of firm survival. Stated differently, the capability to leverage knowledge from innovative strong-tie partners might prevent from the risk of overembeddedness.

The third contribution of our study is to provide an alternative solution for the search-transfer problem as the one given by Hansen (1999). Whereas extant literature suggests to invest in weak ties to ensure sufficient supply of new knowledge, our study suggests to invest more in the development of *innovative* strong ties. Particularly small firms could benefit from this strategy as it reduces complexity in their alliance portfolio and improves alliance management efficiency in three ways. First, firms do not need to invest in the risky and costly process of searching and finding new partners. Second, firms can concentrate on only a few key alliances, which enables

them to manage these alliances more effectively. As Draulans et al. (2003) showed, the number of alliances that can be managed effectively without establishing additional alliance management systems is around six. This implies that investing in only a small number of strong ties, would increase the likelihood of alliance success. Third, the use of strong ties in innovation projects that both provide new knowledge and facilitate knowledge implementation reduces coordination and integration costs, and enhances alliance ambidexterity. For instance, Tiwana (2008) showed that “bridging ties” - that promote creativity and innovations - , and “strong ties” - that facilitate cooperation and coordination - act as complements in alliance tie portfolios. Integration of these two kinds of alliance ties within one innovation project leads to higher alliance ambidexterity (Tiwana, 2008), which reflects the project performance to meet project goals (exploitation) while being adaptive to changes (exploration). Our study suggests that the use of bridging capabilities within strong ties turns these strong ties into “bridging ties”, thereby reducing the number of ties required within an alliance. This, in turn reduces the need for knowledge integration capabilities and lowers coordination and integration costs.

Next to these positive effects of bridging capabilities on alliance management efficiency, there could be a limiting effect as well. In alliance management literature the establishment of a centralized alliance function is considered an important factor for efficient alliance management (Draulans et al., 2003; Kale et al., 2002; Kale & Singh, 2007). The assumption is that capability development depends on learning, and that centralization of alliance management activities would improve the accumulation of experiences. For instance, Hoang and Rothaermel (2005) found that smaller biotechnology firms had better alliance performances than their larger pharmaceutical alliance partners. They suggested that smaller firms have an advantage over larger firms as the management of alliances in smaller firms is often in the hands of only one key individual, mostly the founder or CEO. In contrast to this alliance capability literature, our study just proposes that firms should invest in multiplex relationships and to involve multiple employees on different organizational levels. We encourage further research on the effects of the application of bridging capabilities on overall alliance management efficiency.

3.5.2 Limitations and future research

This study is not without limitations. First, the generalization of our findings should be treated with care. The study had an explorative character and was based on four cases of small firms, operating in the business-to-business activities within the manufacturing industry. We may also not have identified all possible bridging capabilities as our sample was small. We encourage researchers to further explore other manifestations of bridging capabilities and to determine their effect on new knowledge acquisition.

This brings us to a second limitation, regarding the novelty and complexity of the acquired knowledge. In our study we only focused on the fact that the knowledge was new to the firm, neglecting differences in novelty and its impact on innovation performance. Although we observed several instances of the use of strong ties' knowledge in the development of significant innovations by the case study firms, we have not studied the direct relationship between new knowledge from strong ties and innovation performance. An interesting research avenue would be to include knowledge novelty, knowledge complexity, and innovation outcomes in the analysis on the performance of bridging capabilities.

Another limitation of this study is the focus on the dyadic relationship between two embedded partners, thereby neglecting overall network characteristics and dynamics. As we argued, the potential for new knowledge acquisition within strong ties is strongly dependent on the innovativeness of the partner firm and its respective network. Hagedoorn (2006), Hagedoorn and Frankort (2008), and Uzzi (1997) argued that dyadic, network and environmental levels of embeddedness interact, and could jointly strengthen the effect of (over)embeddedness. This can be understood from the perspective of a firm that applies bridging capabilities on a relationship with a partner within a network that suffers from overembeddedness itself. In that case the use of bridging capabilities will not yield any new knowledge. We recommend future studies on the effect of bridging capabilities to explicitly take the network level into account.

3.5.3 Conclusion

The goal of this study is to examine how small firms can use strong ties as sources of new knowledge for innovation. We found that small firms can benefit from strong ties through the application of bridging capabilities to avoid the overembeddedness trap. Our findings suggest that firms should invest more in innovative strong ties, instead of increasing the number of weak ties. This way small firms can simplify their alliance portfolio and increase alliance effectiveness.

3.6 REFERENCES

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CHAPTER 4

THE EFFECTS OF PRIOR KNOWLEDGE, NETWORKS AND COGNITIVE STYLE ON INDIVIDUALS' ABSORPTIVE CAPACITY

Although individual absorptive capacity (ACAP) is mentioned in the literature as a key building block for organizational absorptive capacity, its characteristics are still unclear. This study conceptualizes individual ACAP as the activities of individuals to recognize, assimilate, transform and exploit new external knowledge. We develop a multi-dimensional measure for individual ACAP, examine its outcomes and analyze three of its antecedents: prior knowledge, network diversity and cognitive style. A survey among 147 employees of a Dutch manufacturer of kitchen furniture was administered and analyzed with structural equation modeling using Partial Least Squares (SEM-PLS). This study shows that an individual's bisociative cognitive style is more important than an individual's prior knowledge, and that external network diversity is another relevant antecedent for individual ACAP. Furthermore, it shows that individual ACAP predicts employees' idea generation and implementation activities, and that managers have higher levels of individual ACAP than non-managers. As such, this paper contributes to a better understanding of the micro-foundations that underlie ACAP and dynamic managerial capabilities.

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4.1 INTRODUCTION

Absorptive capacity (ACAP) is an important antecedent for innovation performance (Cohen & Levinthal, 1990; Zahra & George, 2002). ACAP is the ability of a firm to recognize the value of new external knowledge, to assimilate it, to transform it, and to exploit it, to produce an organizational capability (Zahra & George, 2002). Despite the popularity of the construct and its wide use in scholarly contributions, the underlying mechanisms of ACAP are still ambiguous (Lane, Koka & Pathak, 2006; Volberda, Foss & Lyles, 2010). Particularly the role of individuals in relation to the firm's ACAP has hardly been addressed. Yet, Cohen and Levinthal (1990:131) already stated in their seminal work that “an organization’s absorptive capacity will depend on the absorptive capacities of its individual members”. Although ACAP literature has highlighted the importance of antecedents of individual ACAP, like prior knowledge and experience (Cohen & Levinthal, 1990; Hayton & Zahra, 2005; Lane et al., 2006; Lenox & King, 2004; Zhao & Anand, 2009), cognitive models (Cohen & Levinthal, 1990; Zahra & George, 2002) and social networks (Todorova & Durisin, 2007), the effects of these antecedents have hardly been examined empirically. Our study aims to close this gap in the literature by conceptualizing individual ACAP and developing a measure for it, by examining its outcomes and by analyzing three of its antecedents.

Individual ACAP is conceptualized as a multi-dimensional construct that consists of activities to recognize, assimilate, transform and exploit new external knowledge. This conceptualization served as a basis to construct a measure to include in a survey, which was administered among 147 employees of one Dutch manufacturer of kitchen furniture. Analysis of the results with structural equation modeling using Partial Least Squares (SEM-PLS) supports the assumption in extant literature that prior knowledge is an antecedent of individuals' ACAP. However, our results show that a bisociative cognitive style is even more important, next to external network diversity. Furthermore, individual ACAP positively affects employees' innovation performance of idea generation and implementation. Finally, our analysis shows that managers have higher individual ACAP and innovation performance.

These findings contribute to literature in three ways. First, our study addresses the call for research on the micro-foundations of ACAP (Volberda et al., 2010). Through conceptualization of the individual ACAP construct, and through development of its measure, we enable researchers and practitioners to further examine underlying mechanisms of ACAP. This offers opportunities to study antecedents and outcomes of individual ACAP (Todorova & Durisin, 2007), to clarify how ACAP exists on different levels of analysis (individual, group and organizational), and how these are related (Volberda et al., 2010). Such multi-level studies could further examine what aspects of ACAP are distinctly organizational or individual (Cohen & Levinthal, 1990).

Second, we show the relative importance of prior knowledge diversity, network diversity and cognitive style as antecedents of individual ACAP. Our findings imply that a person's cognitive style has a greater effect on individual ACAP, compared to one's prior knowledge and experiences. This refines Cohen and Levinthal's (1990) initial assumption of prior knowledge as the main antecedent for ACAP. The results indicate that scholars and practitioners need to account for cognitive style as well, when examining ACAP. Further, external network diversity is empirically found to be an important antecedent for absorptive capacity, as it secures a continuous inflow of new knowledge into the organization. Our finding supports the arguments of Todorova and Durisin (2007) and Volberda et al. (2010) to draw social network research into the ACAP domain.

Third, our study empirically confirms the important role of managers in ACAP development by showing that managers have higher levels of individual ACAP compared to non-managers. This supports studies on dynamic managerial capabilities that assign a central role to managers in developing these capabilities (Adner & Helfat, 2003; Augier & Teece, 2009) and addresses calls for more understanding of the personal characteristics of managers that contribute to ACAP development (Volberda et al., 2010; Zahra & George, 2002).

The paper is organized as follows. First we theoretically conceptualize and define individual ACAP. Then we derive hypotheses to examine the relationships between individuals' ACAP, its antecedents and its outcomes. After explaining the research method and analysis, we conclude with implications for theory and practice.

4.2 CONCEPTUALIZATION OF INDIVIDUAL ABSORPTIVE CAPACITY

Individuals have two important functions regarding organizational ACAP. First, they are a key building block of organizational ACAP, as Cohen and Levinthal (1990:131) stated that 'An organization's absorptive capacity will depend on the absorptive capacities of its individual members'. Individuals are the primary locus of knowledge creation and learning (Cohen & Levinthal, 1990; Grant, 1996). Their prior knowledge determines the extent in which they are able to recognize and identify the value of new knowledge. The more diverse one's knowledge base, the easier it is to associate the newly encountered knowledge with what one already knows (Cohen & Levinthal, 1990). Further, individuals' problem solving and learning capabilities determine the creativity with which new knowledge is created (Cohen & Levinthal, 1990). So, individuals act as knowledge processing entities who create and store knowledge, and whose characteristics determine the foundations on which organizational ACAP is built.

The second function of individuals regarding organizational ACAP relates to the knowledge exchange processes that are needed to exploit the new knowledge. As

Cohen and Levinthal (1990:131-132) stated: ‘A firm’s absorptive capacity is not, however, simply the sum of the absorptive capacities of its employees, (..). It also depends on transfers of knowledge across and within subunits that may be quite removed from the original point of entry’. This knowledge transfer refers to the exchange of knowledge by individuals that act at the interface of the organization and its environment, so-called gatekeepers (Tushman, 1977), as well as to the knowledge transfer within the organization. So, individuals need to interact with each other to exchange and to integrate their knowledge in order to build organizational ACAP (Cohen & Levinthal, 1990; Grant, 1996; Kogut & Zander, 1992; Kraaijenbrink & Wijnhoven, 2008).

In extant ACAP literature individuals’ ACAP is mostly conceptualized and operationalized as a set of competences consisting of individuals’ prior knowledge and experience (e.g. Hayton & Zahra, 2005; Zhao & Anand, 2009), technical skills, values and beliefs (Matusik & Heeley, 2005), and motivation (Minbaeva et al., 2003). Yet, these competences mainly relate to the knowledge processing function of individuals for organizational ACAP. However, in this study we will conceptualize individuals’ ACAP as a combination of knowledge processing and knowledge exchange functions.

Our conceptualization of individuals’ ACAP is based on the notion that organizational ACAP is a dynamic capability which consists of four routines to recognize, assimilate, transform and exploit new external knowledge (Eisenhardt & Martin, 2000; Zahra & George, 2002). These four ACAP routines are distinctive, yet inextricably inter-related by the flow of knowledge from recognition to exploitation (Zahra & George, 2002), thereby including knowledge exchange processes. Further, taking a dynamic capabilities perspective enables us to use theory on micro-foundations to define individuals’ ACAP (Teece, 2007). Micro-foundations are the factors that determine individual action and interaction in the creation of organization-level routines and capabilities (Abell et al., 2008; Felin & Foss, 2005; Foss, 2011). Abell et al. (2008) argued, based on Coleman’s (1990) framework on micro-macro levels in social science, that organizational routines are built from organizational mechanisms and individuals’ actions. Applying the foregoing to ACAP we infer that organizational ACAP routines are built from organizational mechanisms and individuals’ ACAP activities. As organizational ACAP consists of four distinctive routines (Zahra & George, 2002), we define individuals’ ACAP as the activities to recognize, assimilate, transform and exploit new external knowledge. This conceptualization views individuals’ ACAP as a component of organizational ACAP routines, next to organizational mechanisms (Abell et al., 2008; Felin et al., 2012). In the next sections we will further examine individuals’ ACAP.

Recognition. Individuals’ recognition activities concern searching for new knowledge, identifying it, and evaluating it as opportunities for potential beneficial use. These activities are related to the notion of ‘entrepreneurial alertness’, which

consists of scanning and search, making associations and connections, and evaluating and judgment (Tang, Kacmar & Busenitz, 2012). Scanning and search may start from an encountered problem that needs a solution, but can also be driven by one's curiosity. Ways to search for new knowledge are visiting trade fairs, reading professional literature, searching internet (Kraaijenbrink, 2007), informal industry contacts and participation in professional forums (Ozgen & Baron, 2007). Encounters with new information do not automatically lead to opportunity recognition. The new information needs to be interpreted and associated with knowledge already possessed - 'connecting the dots' (Baron, 2006) -, which lead to new insights and ideas. These new ideas might trigger new search activities for additional information (Tang et al., 2012). Ultimately, the individual recognition process ends when one evaluates the new idea to be potentially valuable, and decides to further develop it within the firm.

Assimilation. Through assimilation activities, the individually recognized and acquired knowledge is transformed into organizational knowledge by making it understandable and transferable to other organization members. The individuals' activities that facilitate assimilation are: interpretation, articulation and codification (Huber, 1991; Zollo & Winter, 2002). Interpretation concerns the processes to give meaning to new information and to translate it to develop shared understandings and meanings (Daft & Weick, 1984). The need for interpretation depends on the extent to which the new knowledge is unclear and is subject to multiple interpretations. To reduce ambiguity, individuals discuss the new knowledge with others to reach a common understanding (Daft & Weick, 1984). To enable discussion, new knowledge needs articulation. This means that the knowledge has to be put into explicit words, to enable communication (Nonaka, 1994; Weick, Sutcliffe & Obstfeld, 2005; Zollo & Winter, 2002). The articulation of knowledge is not always easy as part of the knowledge can be 'sticky', as it contains a large tacit component that cannot be articulated (Polanyi, 1966; Szulanski, 1996). Lastly, codification of the knowledge means that the articulated knowledge is stored in the organizational memory in written procedures, manuals, and digital databases. The aim here is not only to document knowledge for dissemination and future use, but also to improve the understanding of the new knowledge. Through the writing process, the knowledge articulation process is refined, logical steps need to be explained, and causal relations need clarification (Nonaka, 1994; Zollo & Winter, 2002). In sum, assimilation as an individual ACAP activity includes processes of interpretation, articulation and codification to make newly acquired knowledge available for others by incorporating it into the organizational memory.

Transformation. Transformation routines on the organizational level require creativity on the individual level (Lane et al., 2006). To enable alterations of organizational cognitive frames organizational members need to engage in 'frame-braking' activities. Examples of mental activities that individuals use to think 'outside

the box', are looking for the counterintuitive, use of analogies, investigate paradoxes and exceptions, and engage in counterfactual thinking (Amabile, 1988; Gaglio & Katz, 2001). Also, for the creation of new organizational schemas and frames, which result in new organizational capabilities, knowledge and ideas from multiple individuals need to be combined and integrated (Grant, 1996; Kogut & Zander, 1992). This implies that individuals not only need to be creative themselves, but also that they are socially skilled to be creative in groups. These social skills include networking and effective communication, which are critical to develop ideas into feasible solutions and to acquire support and sponsorship (Ford, 1996; Kanter, 1988). In sum, transformation as an individual ACAP activity concerns the generation of new ideas in collaboration with others.

Exploitation. At the individual level exploitation concerns the activities to internalize the knowledge in own work routines (Nonaka, 1994). Internalization occurs through learning-by-doing, on-the-job training, and learning by observation (Sabherwal & Becerra-Fernandez, 2005). Although internalization can be done by oneself, it is generally assumed to be a social process when the knowledge is tacit, or when the project is more complex (Grant, 1996). This often requires alignment of goals and activities, as well as collaboration and communication skills to achieve mutual adjustments and understanding. For this, individuals need the flexibility to adapt to new working methods and a propensity to try new things. In sum, we define exploitation at the individual level as one's activities to apply new knowledge in own work routines.

4.3 ANTECEDENTS AND OUTCOMES OF INDIVIDUAL ACAP

In ACAP literature three antecedents are mentioned as important, which can be related to individual ACAP: prior knowledge diversity, network diversity and cognitive style (Cohen & Levinthal, 1990; Hayton & Zahra, 2005; Lane et al., 2006; Lenox & King, 2004; Todorova & Durisin, 2007; Zahra & George, 2002; Zhao & Anand, 2009). In this section we discuss these antecedents in relation to individuals' ACAP and its outcomes, which leads to the formulation of testable hypotheses.

4.3.1 Prior knowledge diversity

Prior knowledge diversity encompasses the individual's existing knowledge base, based on education, work and life experience. The more diverse one's prior knowledge base, the more likely new knowledge is associated with existing knowledge, enhancing the absorption of new knowledge (Cohen & Levinthal, 1990; Zahra & George, 2002). The assumption here is that learning becomes easier when new knowledge is related to what one already knows. The associations between new and existing knowledge are made easier, which increases the speed of learning (Fiske & Taylor, 2007). The ACAP

processes of recognition, assimilation, transformation and exploitation of new knowledge, all include knowledge transfer and learning to some extent. So, for these processes knowledge transfer and learning is easier when the new knowledge relates to knowledge already possessed. For instance, Lane and Lubatkin (1998) showed that learning was improved when learning partners had similar basic knowledge.

Prior knowledge diversity also affects recognition in another way, as it influences the locus of search (Shane, 2000; Zahra & George, 2002). People tend to search in areas that they already know, and where they had earlier successes (Zahra & George, 2002). This implies that people who are experts in a very specialized knowledge field, tend to search in-depth for new knowledge which is more closely related to their existing knowledge base. Generalists, on the other hand, tend to search more broadly (Katila & Ahuja, 2002; Laursen & Salter, 2006). This implies that individuals with high prior knowledge diversity are inclined to search more broadly, hence have a higher chance to identify new business opportunities.

Exploitation of knowledge is most efficient when individuals integrate knowledge which is highly specialized (Grant, 1996). Particularly when innovations are more complex, more specialist knowledge is involved. However, to enable integration of these specialists' knowledge, a certain level of a common language is needed among individuals (Cohen & Levinthal, 1990; Grant, 1996; Hargadon & Sutton, 1997). This common knowledge requires a minimal level of diversity of one's prior knowledge base, which is also known as the 'T-shaped knowledge profile' (Iansiti, 1993; Madhavan & Grover, 1998). So, next to expertise in a specific knowledge discipline (the vertical stroke of the T), one also needs more general knowledge to enable interaction with others (the horizontal top stroke of the T). Individuals with a T-shaped combination of knowledge and skills can be specialist and contribute to specific solutions on the one hand, while being capable of sharing knowledge with others (Dane, 2010).

In conclusion we propose that individuals with a high level of prior knowledge diversity will exhibit a higher level of individual ACAP, which leads to our first hypothesis:

Hypothesis 1: Individuals with high prior knowledge diversity have a higher level of individual absorptive capacity than individuals with low prior knowledge diversity.

4.3.2 Network diversity

An individual's social network reflects the heterogeneity of knowledge one can be exposed to (Burt, 1992). The larger and more diverse an individual's network, the more likely the person will get in contact with new knowledge (Ahuja, 2000; Todorova & Durisin, 2007). We distinguish an individual's external and internal

network as these both affect individuals' performance differently (Cross & Cummings, 2004).

Studies on external networks generally show that networks that are both sparse (consisting of non-redundant contacts) and heterogeneous (consisting of contacts with a great knowledge diversity) contribute to individual innovative performance (e.g. Baron, 2006; Burt, 2005; Rodan & Galunic, 2004). The reason for this is that individuals with high external network diversity are more likely to be exposed to many sources with potential new knowledge, which has a positive effect on the search and identification of new knowledge (Cohen & Levinthal, 1990; Tushman, 1977). So, more and diverse external contacts increase recognition capabilities, hence enhance individual ACAP (Todorova & Durisin, 2007). This leads us to the following hypothesis:

Hypothesis 2a: Individuals with high external network diversity will have a higher level of individual absorptive capacity than individuals with low external network diversity.

Individuals who recognize and acquire external knowledge are often different from the ones who use this knowledge to create and implement new processes, products and services (Cohen & Levinthal, 1990). This means that the knowledge needs internal dissemination (Tushman, 1977). The larger an individual's internal network, the easier the knowledge is assimilated. Further, organization members with large internal networks outside their own department know better 'who-knows-what' and have more frequent contact with others outside their own functional fields. This eases the retrieval of knowledge from the organizational memory and also increases the likelihood of finding novel combinations, hence increasing transformation capabilities. For instance, Björk and Magnusson (2009) found that individuals with larger internal networks created more high-quality ideas. Also Jansen, Van den Bosch and Volberda (2005) found that 'connectedness', which was the extent to which people were connected within their unit, had a positive effect on assimilation, transformation and exploitation. Hence, we hypothesize that:

Hypothesis 2b: Individuals with high internal network diversity will have a higher level of individual absorptive capacity than individuals with low internal network diversity.

4.3.3 Cognitive style

Individuals' cognitive structures are considered important antecedents of ACAP (Cohen & Levinthal, 1990; Lane et al., 2006; Todorova & Durisin, 2007). Individual cognition refers to the way individuals tend to process information and make decisions (Fiske & Taylor, 2007). This way cognitive style determines what knowledge is identified and acquired, how it is assimilated and how it is transformed. Although

there are multiple classifications of cognitive styles (Hayes & Allinson, 1994), two main cognitive styles can be distinguished, as Miller (1985) quotes Nickerson, Perkins and Smith (1985:50) '... the view that there are two qualitatively different types of thinking is widely shared. Among the terms used to describe one type are analytic, deductive, rigorous, constrained, convergent, formal and critical. Representative of the terms used to describe the other type are synthetic, inductive, expansive, unconstrained, divergent, informal, diffuse and creative. No doubt the partitioning into two types involves something of an oversimplification, but possibly a useful one.'

In ACAP literature, Koestler's (1964) distinction between bisociative and associative cognitive styles is used to explain differences in individuals' information processing and decision making (Todorova & Durisin, 2007; Zahra & George, 2002). Bisociation is a decision making style whereby individuals use imagination and intuition, to seek solutions outside disciplinary boundaries in order to discover connections that are not readily apparent. Bisociation involves unlearning and changing the 'rules of the game' (Payne, Lane & Jabri, 1990). The other decision making style is association. Individuals with an associative style rely on rational thinking and articulate expressions of ideas. They pay attention to those aspects of a problem for which conventional solutions are at hand, and they try to adhere to existing rules and methodologies within disciplinary boundaries (Payne et al., 1990). The cognitive styles of bisociation and association are not bi-polar, as opposed to other cognitive style dimensions (for instance Allinson and Hayes, 1996; Kirton, 1976), but are independent subscales (Jabri, 1991). It is argued that individuals have both styles, but that they might have a tendency to prefer one more than the other, depending on the tasks at hand (Payne et al., 1990).

In ACAP literature, cognitive style is mainly addressed in relation to transformation activities. During transformation processes, new knowledge is combined with existing knowledge to generate new ideas. This creative process is most facilitated by a bisociative cognitive style (Todorova & Durisin, 2007; Zahra & George, 2002). Further, a bisociative cognitive style also stimulates knowledge recognition as individuals with such cognitive style tend to search for differences and unknown solutions. For instance, Gaglio and Katz (2001) argued that opportunity recognition by entrepreneurs is dependent on cognitive heuristics that stimulate 'frame-breaking' processes, which enabled individuals to get loose from their existing frames to derive new insights and business opportunities. Therefore we hypothesize that:

Hypothesis 3a: Individuals with a high bisociative cognitive style will have a higher level of individual absorptive capacity than individuals with a low bisociative cognitive style.

During assimilation new external knowledge is connected to existing knowledge within the organization. This requires the identification of similarities and

the articulation of the initial idea or insight. It is expected that individuals with a tendency for an associative cognitive style are better in assimilation, compared to those with a bisociative cognitive style. For exploitation, the development of routines in which the new knowledge becomes embedded is an important element, as this distinguishes exploitation from one-time application (Zahra & George, 2002). Here it is expected that individuals with an associative style, who adhere to certain rules and standards, will do better in exploitation. Therefore we hypothesize that:

Hypothesis 3b: Individuals with a high associative cognitive style will have a high level of individual absorptive capacity, compared to those with a low associative cognitive style.

4.3.4 Individual innovation performance

At organizational level, outcomes of ACAP are related to strategic flexibility and innovation (Zahra & George, 2002). Strategic flexibility refers to the ability to flexibly reconfigure the organization's resource base to address changing situations (Zahra & George, 2002). It offers firms a portfolio of opportunities from which to choose when the circumstances require corrective action. This portfolio of opportunities could be considered as knowledge outputs of ACAP processes (Lane et al., 2006). These opportunities are the result of individuals' efforts to anticipate on expected problems, and to solve these problems once they occur. These anticipated solutions take form of ideas that are generated by individuals (Kanter, 1988; Scott & Bruce, 1994; West & Farr, 1990).

Innovation refers to the development of new products, services and processes (Zahra & George, 2002). These are the commercial outputs of ACAP (Lane et al., 2006), which are the result of individuals' knowledge integration and exploitation (Grant, 1996; Zahra & George, 2002). On the individual level, innovation is the result of the implementation of ideas generated by individuals themselves or by others (Kanter, 1988; Scott & Bruce, 1994; West & Farr, 1990).

So, in line with strategic flexibility and innovation as outcomes of ACAP at organizational level, we expect that individuals' innovation performance, which is related to the extent to which ideas are generated and implemented, is higher when individuals have higher ACAP. Therefore we hypothesize:

H4: Individuals with a high individual ACAP level will have a higher individual innovation performance, compared to those with a low individual ACAP level.

To summarize, high levels of individuals' ACAP is expected to have positive effects on individuals' idea generation and idea implementation outcomes. Further, high levels of individuals' ACAP are expected to be dependent on high levels of prior knowledge diversity, internal and external network diversity, and on associative and

bisociative cognitive styles. These hypothesized relationships are graphically represented in Figure 4.1.

Figure 4.1: Theoretical model of antecedents and outcomes of individual ACAP

4.4 RESEARCH METHOD

4.4.1 Research setting and design

The research is designed as a single case study, where we administered a survey among organization members on all organizational levels. We choose a single case study to keep organizational effects as constant as possible, as we were interested only in individual differences. The organization was a Dutch manufacturer of kitchen furniture with 197 employees, who approached the authors to conduct a study in order to enhance the firm's social innovation capabilities. The authors developed a self-administered questionnaire, which was administered in June 2011. All employees were assigned to a group of ten employees by the organization's management. For each group a time slot of one hour during working time was reserved to fill out the questionnaire, to assure a high response rate. During two days, the first author was present at the firm to guide the survey process. At the start of each time slot, he explained the goal of the study, discussed confidentiality issues, and gave further directions. When wording or questions were not clear to the respondents, they could

ask the first author for assistance. Finally, 147 questionnaires were useful for further analysis, which represents a response rate of 74.6 percent. Around 60% of the respondents are working for more than 10 years with the firm, around 80% of the respondents has an education level up to intermediate vocational education, while 68% is between 30 and 50 years old. The division of respondents over departments is about 44% production and logistics, 33% sales and back office, 9% operation support (planning, engineering, maintenance) and 14% general support (finance, housekeeping, management team).

Common method bias. To minimize effects of common method bias we followed suggestions by Podsakoff et al. (2003) in our research design. To avoid socially desirable answers the survey was administered anonymously. Also, before the questionnaire was handed over to the respondents they were told that there is no right or wrong answer and that they should answer the questions as honest as possible. After data collection we assessed the issue of common method bias by conducting statistical analysis using Harman's single factor test (Podsakoff et al., 2003). This is an exploratory factor analysis to see whether only one factor emerges or whether one factor accounts for the majority of the covariance. We conducted a Principal Component Analysis without rotation and found 7 factors with eigen values > 1.0. The largest factor accounted for 29.48% of all variance. These findings suggest that common method bias is unlikely.

4.4.2 Measures

Individual ACAP. To measure individual ACAP we first needed to construct a new measurement scale. For this we followed the procedure for scale development as suggested by DeVellis (2003). The first step in scale development is to decide what the new scale is intended to measure, and how it relates to existing scales (DeVellis, 2003). For our study, we needed a measurement scale that could be applied generally to all kinds of employees, irrespective of their specific tasks or positions. Although some measurement scales for individual ACAP were available, these appeared not to be useful as these were specifically targeted to students (Da Mota Pedrosa et al., 2010), ERP-software users (Park, Suh & Yang, 2007) or IT-specialist (Deng, Doll & Cao, 2008).

Next, a pool of items that reflect the scale's purpose was constructed. To ensure content validity, we based our items on the conceptualization of ACAP as a higher-order construct, consisting of four dimensions - recognition, assimilation, transformation and exploitation – as discussed before. We developed an initial pool of thirty-one items which included at least six items for each of the four dimensions of individual ACAP. Including multiple and redundant items in the initial pool is advised to increase the likelihood for a good qualitative final measurement scale (DeVellis,

2003). A 7-point Likert scale from *strongly disagree* (value = 1) to *strongly agree* (value = 7) was selected.

Further, to assess content validity the initial pool of items was reviewed by experts, following the item-sorting method of Anderson and Gerbing (1991). During three rounds, fellow junior and senior researchers in the field of innovation, entrepreneurship and sociology were asked to assign each item of the questionnaire to only one of the individual ACAP dimensions. After each round, feedback from the researchers was used to improve the items. In total 23 researchers participated in these reviews. To assess content validity of the final items the 'proportion of substantive agreement p_{sa} ' and the 'substantive-validity coefficient c_{sv} ' were calculated (Anderson & Gerbing, 1991). The p_{sa} reflects the proportion of respondents who assign an item to its intended construct. In literature a cut-off value of 0.7 is applied (e.g. Linderbaum & Levy, 2010; Helm, Eggert & Garnefeld, 2010). The c_{sv} value reflects the extent to which respondents assign an item to its intended construct more than to any other construct. Here a cutoff value of 0.5 is proposed by Anderson and Gerbing (1991). Items were kept if they satisfied both coefficients. Two items that did not fully meet the required threshold values were kept after careful consideration by the authors (DeVellis, 2003). The final set of items was pre-tested with four employees of the case study firm, who filled out the questionnaire in presence of the first author. Afterwards, ambiguities in wording or meaning were discussed, which led to the final adjustments of the questionnaire. The final items that were kept for analysis are reported in Appendix 4.1.

Prior knowledge diversity. Prior knowledge diversity is operationalized as a formative construct, consisting of age, education and prior knowledge diversity. Most common is to use reflective measurement items, where the items reflect the unobserved underlying construct. In contrast, formative items cause the unobserved construct. This implies that omitting one of the formative indicators would be a misspecification of the construct as a whole (Diamantopoulos & Winklhofer, 2001). As reliability and validity procedures for formative constructs are scarce (Diamantopoulos & Winklhofer, 2001), the specification of the content of the construct and its indicators is very important (Bollen & Lennox, 1991).

Prior knowledge diversity is caused by a diversity of backgrounds which enables fast and easy learning as the object of learning is related to what is already known (Cohen & Levinthal, 1990). This diversity of backgrounds depends on age, education and diversity in work experiences. For instance, Shane (2000) found that entrepreneurs' prior knowledge like education and work experience determined how they recognized business opportunities. Also, literature on internationalization and ACAP emphasize the importance of top managers' education levels and experience for internationalization success (e.g. Descotes & Walliser, 2011; Fernhaber, McDougall-Covin & Shephard, 2009; Hayton & Zahra, 2005). Age captures many aspects of

individuals' human capital (Adner & Helfat, 2003) like general life experience, which is not captured by education and work experience.

To assure anonymity *age* is measured as a categorical variable like '21 - 30 years' and '31 to 40 years'. *Education* is measured as a categorical variable representing the highest level of education at which the respondent has received a degree. For measuring diversity of work experience we adapted Walsh's (1988) and Bunderson and Sutcliffe's (2002), measure of individual *functional diversity*, which is calculated as $1 - \sqrt{\sum(X_i/X)^2}$, where X_i = number of years worked in a particular function and X = total number of years of work experience. We used Bunderson and Sutcliffe's (2002) nine functional areas to classify functional diversity: sales or marketing, manufacturing, finance or accounting, personnel/HR, distribution or warehouse, R&D, equipment management, administrative support, and general management. The values of functional diversity range from near 1, indicating extreme functional diversity, to zero, representing an entire career spent in one function (Walsh, 1988).

Internal and external network diversity. Internal and external network diversity are measured in a similar way as functional diversity. In network literature network breadth is often measured using Blau's (1977) heterogeneity index (see for instance Koka and Prescott (2002), and Lee (2007)). Both internal and external network diversity measure the potential of knowledge sources, irrespective of the use of these sources for innovation. For *internal network diversity* respondents were asked to list the number of people within each of the organizations departments - like sales, planning, service and production - with which they had work related contacts over the past 12 months. Internal network diversity, is calculated as $1 - \sqrt{\sum(Y_i/Y)^2}$, where Y_i = number of people contacted in a particular department and Y = total number of people contacted over the past 12 months. The score varies from nearly one, indicating a high level of internal network diversity, to zero, indicating contacts with people from only one department.

External network diversity is measured by asking respondents to list the number of external parties with which they had work related contacts over the last 12 months. The 11 categories of parties were respondents could choose from were: existing customers, potential customers, existing suppliers, potential suppliers, competitors, trade associations, consultants or accountants, government agencies, research institutes, educational institutes, family and friends. External network diversity, is calculated as $1 - \sqrt{\sum(Z_i/Z)^2}$, where Z_i = number of organizations contacted in a particular category and Z = total number of organizations contacted over the past 12 months. The score varies from nearly one, indicating a high level of external network diversity, to zero, indicating contacts with organizations within only one category, for instance customers.

Cognitive style. In this study we measure cognitive style as decision making heuristics, using Jabri's (1991) distinction between association and bisociation. Association is measured with items like 'I enjoy being methodical and consistent in the way I tackle problems'. Bisociation is measured with items like 'I enjoy pursuing a problem, particularly if it takes me into areas I don't know much about'. Although several measurements scales for cognitive style are available, we choose Jabri's (1991) scale for two reasons. First, most cognitive style measures assume a bi-polar scale (like Allinson & Hayes, 1996), which implies an 'either-or' cognitive style typology. As mentioned before, our study assumes that, although individuals might have a tendency towards a bisociative or associative cognitive style, one might have a combination of both styles. The measurement scale of Jabri (1991) allows to score high on both cognitive style dimensions. Second, Jabri's (1991) measurement scale is based on Koestler's (1964) work on creativity, which is also addressed in the works of Zahra and George (2002) and Todorova and Durisin (2007), regarding the processes during the transformation stage of organizational ACAP. In this way, Jabri's (1991) measurement scale - which is also used in other innovation management studies like Scott and Bruce (1994) and Shalley, Gilson and Blum, (2009)-, closely relates to the theoretical assumptions of the ACAP literature. The ten items of the associative cognitive style scale, and nine items of the bisociative cognitive style scale showed good reliabilities with Cronbach alpha's of 0.81 and 0.84 respectively. However, for further analyses four items of associative cognitive style and six items of bisociative style were kept as these reflected the latent constructs most significantly.

Individual innovation performance. The measure for individuals' innovation performance is intended to reflect Zahra and George's (2002) two outcomes of ACAP: strategic flexibility and innovation. For strategic flexibility at the individual level we used the measure of the number of ideas generated in the last 12 months, and for innovation how many ideas employees helped implementing in the last 12 months (Axtell et al., 2000; Ng & Feldman, 2010; Parker, Williams & Turner, 2006). The respondents were provided a list of six categories of innovations for which they could list the number of ideas generated and ideas implemented, which differed from other studies but covered more general categories of innovations. These categories were: 1) creating completely new products or services, 2) improving of existing products or services, 3) entering completely new markets, 4) extending existing markets, 4) creating completely new working methods or (production) processes, and 6) improving existing working methods or (production) processes. Following Ng and Feldman (2010) we grouped the numbers of the six categories and treated this as the total number of ideas generated and/or implemented.

The applied method of self-reported measures of individual performance showed to be reliable in other studies (Axtell et al., 2000; Parker et al., 2006). However, as we adapted the self-reported measure to the needs of our study, we also

assessed the issue of social desirability for the performance measure. As the questionnaire was administered anonymously, we could not ask supervisors to rate their employees' performances individually. Therefore we asked them to list the number of employees that had generated or implemented ideas in the six innovation categories in the last 12 months. Then we calculated the number of employees that self-reported to have generated or implemented ideas for each supervisor. To assess reliability of the two ratings on continuous scales we calculated the non-parametric bivariate Spearman's correlation coefficient, which showed to be positive and significant ($r_s = .64, p < .001$).

Department. We included department as a control variable. Although we selected one organization to exclude organizational influences on individual ACAP, there could still be differences on departmental level that affect individual ACAP. Respondents were asked to indicate their department out of the 30 departments of the firm's organogram. As several departments had the same manager, we clustered these departments under the assumption that departmental characteristics that could affect ACAP are mainly determined by the manager's strategy and leadership style. This clustering resulted in 10 departments including 'sales', 'service', 'procurement, finance & IT', 'planning and engineering', 'machining' and 'assembly'.

4.4.3 Analytical technique

The analysis technique for our study is Structural Equation Modeling (SEM). Unlike multiple regression techniques, SEM is able to include unobserved (latent) constructs in the model, manages second-order constructs and can simultaneously examine a series of dependence relationships (Chin, 1998; Shook et al, 2004). SEM techniques can be divided into two families: co-variance based techniques and variance-based techniques. Co-variance based techniques, such as LISREL and AMOS, estimate the fit between the co-variance matrix of the model and the sample. In contrast variance-based techniques, such as Partial Least Squares (PLS), optimizes the variance explained in the dependent variables (Chin, 2010).

For this study, we choose variance-based SEM for three reasons. First, covariance-based SEM assumes that all items are reflective, that is they all reflect the same construct and can be used interchangeably. However, covariance-based SEM cannot deal with formative items, which determine or cause the construct. These formative items cannot be changed interchangeably, and all contain specific characteristics that together define the construct (Bollen & Lennox, 1991). Our model contains formative items that define prior knowledge diversity. In contrast to covariance based SEM, PLS can manage formative and reflective items within the same model (Chin, 2010).

Second, the sample size for PLS can be much smaller compared to covariance based SEM (Chin, 2010). In PLS the required sample size is determined by assessing

statistical power according to Cohen's (1988) power tables which is based on the variable that has the highest number of predictors (Chin, 2010). In our study most predictors (5) point to the construct of individual ACAP. The minimum sample size to detect medium to large effect sizes at a .99 confidence interval is 126 observations (Cohen, 1988, 1992). This shows that our sample of 147 respondents provides sufficient statistical power.

Third, covariance-based SEM makes clear distributional assumptions regarding multivariate normality and independence of observations. Satisfying these assumptions are not required for variance based SEM (Chin, 2010). For our data the Kolmogorov-Smirnov test was significantly non-normal ($p < .001$) for all measurement items, therefore covariance-based SEM could not be applied.

For data analysis we used SmartPLS 2.0 software (Ringle, Wende & Will, 2005). To determine the standard errors of the estimates we used non-parametric bootstrapping with 500 replications.

4.5 RESULTS

4.5.1 Reliability and validity of measures

Reliability and validity of the measurement model is assessed by looking at the individual item reliabilities, the convergent validity of the measures associated with individual constructs, and discriminant validity (Hulland, 1999). The reliability measures of the constructs are listed in Table 4.1.

Construct*	Number of items	Average variance extracted (AVE)	Composite reliability (CR)	Cronbach's alpha
Cognitive style Association	4	0.56	0.84	0.74
Cognitive style bisociation	6	0.55	0.88	0.83
Individual Recognition	4	0.60	0.86	0.78
Individual Assimilation	3	0.68	0.86	0.77
Individual Transformation	4	0.65	0.88	0.82
Individual Exploitation	3	0.63	0.84	0.71
Individual ACAP	14	0.49	0.93	0.92
Individual performance	2	0.81	0.90	0.77

* Note: Prior knowledge diversity is not included as it has formative indicators

Table 4.1: Reliability measures of constructs

Item*	CSASS	CSBIS	IAREC	IAASS	IATRA	IAEXP	IACAP	INDPERF	EXTNET	INTNET
CSASS3	0.80	0.20	0.14	0.23	0.12	0.18	0.18	0.04	0.06	-0.01
CSASS4	0.76	0.11	0.09	0.17	0.08	0.17	0.14	-0.06	-0.02	-0.17
CSASS6	0.75	0.03	0.07	0.27	0.04	0.13	0.13	0.05	0.02	0.04
CSASS8	0.68	0.12	0.03	0.29	0.02	0.09	0.10	0.03	-0.04	0.04
CSBIS2	0.07	0.70	0.45	0.39	0.40	0.38	0.47	0.14	0.11	0.12
CSBIS3	0.20	0.80	0.44	0.39	0.45	0.41	0.49	0.16	0.11	0.04
CSBIS4	0.27	0.69	0.34	0.35	0.29	0.34	0.37	0.13	-0.05	-0.17
CSBIS6	0.09	0.72	0.45	0.25	0.38	0.40	0.43	0.06	0.02	-0.12
CSBIS7	0.09	0.80	0.46	0.31	0.38	0.40	0.45	0.16	0.06	-0.01
CSBIS8	0.03	0.74	0.50	0.21	0.47	0.45	0.48	0.12	0.15	-0.04
IAREC2	0.20	0.62	0.79	0.46	0.59	0.71	0.74	0.22	0.18	-0.01
IAREC3	0.15	0.46	0.83	0.50	0.67	0.72	0.79	0.30	0.28	0.19
IAREC4	-0.04	0.36	0.75	0.34	0.63	0.52	0.66	0.32	0.52	0.34
IAREC6	0.05	0.40	0.72	0.43	0.59	0.52	0.66	0.33	0.31	0.18
IAASS2	0.43	0.22	0.43	0.78	0.33	0.47	0.54	0.15	0.15	0.17
IAASS3	0.15	0.49	0.49	0.85	0.49	0.51	0.64	0.23	0.12	0.15
IAASS4	0.21	0.32	0.47	0.85	0.46	0.55	0.64	0.23	0.28	0.26
IATRA2	0.20	0.41	0.66	0.44	0.80	0.62	0.74	0.25	0.20	0.06
IATRA4	-0.03	0.35	0.54	0.33	0.77	0.50	0.64	0.31	0.38	0.22
IATRA5	0.03	0.42	0.65	0.37	0.84	0.61	0.73	0.35	0.27	0.17
IATRA6	0.08	0.54	0.71	0.53	0.80	0.64	0.78	0.24	0.31	0.18

Notes: CSASS = Cognitive Style Assimilation, CSBIS = Cognitive Style Bisociation, IAREC = Individual ACAP Recognition, IAASS = Individual ACAP Association, IATRA = Individual ACAP TransfoRmation, IAEXP = Individual ACAP Exploitation, IACAP = Individual ACAP, INDPERF = Individual Innovation Performance, IDEAIM = Ideas Implemented, IDEAGE = Ideas Generated, EXTNET = External Network Diversity, INTNET = Internal Network Diversity

* Prior knowledge diversity is not included as it is has formative indicators.

Item*	CSASS	CSBIS	IAREC	IAASS	IATRA	IAEXP	IACAP	INDPERF	EXTNET	INTNET
IAEXP1	0.23	0.32	0.53	0.50	0.40	0.73	0.60	0.22	0.22	0.14
IAEXP4	0.08	0.44	0.66	0.44	0.63	0.81	0.73	0.25	0.24	0.04
IAEXP6	0.18	0.51	0.71	0.54	0.70	0.85	0.80	0.23	0.20	0.03
IDEAIM	0.06	0.09	0.33	0.26	0.27	0.23	0.31	0.89	0.35	0.14
IDEAGE	-0.01	0.22	0.35	0.20	0.37	0.29	0.36	0.91	0.37	0.19
EXTNET	0.02	0.10	0.41	0.22	0.36	0.27	0.37	0.40	1.00	0.55
INTNET	-0.03	-0.03	0.22	0.24	0.19	0.08	0.21	0.18	0.55	1.00

Notes: CSASS = Cognitive Style Assimilation, CSBIS = Cognitive Style Bisociation, IAREC = Individual ACAP Recognition, IAASS = Individual ACAP Association, IATRA = Individual ACAP TransfoRmation, IAEXP = Individual ACAP Exploitation, IACAP = Individual ACAP, INDPERF = Individual Innovation Performance, IDEAIM = Ideas Implemented, IDEAGE = Ideas Generated, EXTNET = External Network Diversity, INTNET = Internal Network Diversity

* Prior knowledge diversity is not included as it is has formative indicators.

Table 4.2: Factor loadings of items

Item reliability. Item reliability refers to the extent that a measurement item relates to the unobserved construct which it is intended to represent. A rule of thumb is that these item loadings should be above a threshold-value of 0.7, indicating that more than 50 percent of the variance (i.e. the square of the loading) is associated with the construct (Hulland, 1999). Those factor loadings that were not statistically significant, or had low values were excluded from the analysis. The resulting items and their factor loadings are represented in Table 4.2. It shows that all items are around or above the recommended threshold-value and that all items have the highest loading on their intended construct.

Convergent validity. Not only need the individual items to relate to the construct, the several items that reflect the items also need internal consistency. Two measures are generally used: Cronbach's alpha and Fornell and Larcker's (1981) composite reliability. For both measures a threshold value of 0.7 is recommended (Nunnally & Bernstein, 1994). As is shown in Table 4.1 all constructs have a composite reliability and a Cronbach alpha above the recommended threshold value. Further, the average variance extracted (AVE) of the constructs should be above the cut-off value of 0.5 as proposed by Fornell and Larcker (1981) to indicate that at least 50% of the variance of the indicators is accounted for. Table 4.1 shows that all constructs have an AVE-value around or above the proposed cut-off value.

Discriminant validity. Discriminant validity refers to the extent that measures of a given construct differ from measures of other constructs in the same model (Hulland, 1999). In PLS this means that a measurement item shares more variance with its appointed construct than with other constructs. This is measured as the square root of the Average Variance Extracted (AVE) which should be higher than the inter-item correlations (Fornell & Larcker, 1981). For our study, the results are shown in Table 4.3. It shows that the discriminant validity between the main constructs of the model (antecedents, outcomes and individual ACAP) is sufficient. The discriminant validity between the latent constructs of which individual ACAP is constructed is relatively low, which indicates that there is high correlation between the ACAP dimensions of recognition, assimilation, transformation and exploitation.

Reliability and validity of prior knowledge diversity. The aforementioned criteria for the measurement model apply for reflective items only, in contrast to formative items (Bollen & Lennox, 1991). Therefore, reliability and validity of formative items are assessed by looking at their content specification, their item specification and indicator multicollinearity (Diamantopoulos & Winklhofer, 2001). Content and indicator specification relate to the comprehensiveness of the items to cause the construct.

Construct*	1	2	3	4	5	6	7	8	9	10
1. Cognitive Style Association	0.75									
2. Cognitive Style Bisociation	0.16	0.74								
3. Individual Recognition	0.12	0.60	0.77							
4. Individual Assimilation	0.31	0.43	0.56	0.82						
5. Individual Transformation	0.09	0.54	0.80	0.52	0.80					
6. Individual Exploitation	0.20	0.54	0.80	0.62	0.74	0.80				
7. Individual ACAP	0.19	0.61	0.93	0.74	0.90	0.90	0.70			
8. Individual Performance	0.02	0.17	0.37	0.25	0.36	0.29	0.37	0.90		
9. External network diversity	0.02	0.10	0.41	0.22	0.36	0.27	0.37	0.40	1.00	
10. Internal network diversity	-0.03	-0.03	0.22	0.24	0.19	0.08	0.21	0.18	0.55	1.00
11. Prior knowledge diversity ^a	0.09	0.27	0.47	0.34	0.43	0.35	0.47	0.40	0.45	0.31

* For multiple-item constructs, figures on the diagonal represent the square root of the average variance extracted.

^a Prior network diversity is a formative construct, therefore no value for AVE is calculated. N = 147

Table 4.3: Correlation matrix

The question is whether leaving out one item would change the content of the construct (Chin, 2010; Diamantopoulos & Winklhofer, 2001). This assessment is conceptual and qualitative, which has been covered in our measurement section. Further, for formative items in PLS, the estimates are the weights as in multiple regression (Chin, 2010).

Therefore these estimates need to be in the proposed direction and be significant. All three formative items are positive and significant (Age $\beta = .64$, $p < .001$; Education $\beta = .48$, $p < .01$; Functional diversity $\beta = .61$, $p < .001$). Finally, formative measurement items are not assumed to be interchangeable as each item can cause the latent construct. Therefore multicollinearity between the formative items should not be too high (Diamantopoulos & Winklhofer, 2001). To assess multicollinearity we calculated the Variance Inflation Factors (VIF) for each of the three formative items. The VIF values for Age (VIF=1.04), Education (VIF = 1.17) and Functional Diversity (VIF = 1.16) are all well below the conservative cut-off value of 3.3 (Diamantopoulos & Sigauw, 2006). This suggests that multicollinearity is not a relevant issue, and that the formative measures all explain different aspects of the latent construct prior knowledge diversity.

4.5.2 Individual ACAP as a second order construct

To assess whether individual ACAP can be modeled as a second order construct, we followed the suggestions of Chin (1998). The first question is if the second order construct is reflective or formative. Jarvis, MacKenzie and Podsakoff (2003) defined decision rules to determine whether a construct is reflective or formative, which can be applied to the second-order construct of individual ACAP, where the first-order constructs of recognition, assimilation, transformation and exploitation serve as ‘indicators.’ An important characteristic of a *reflective* construct is that the indicators are expected to covary, that is when a change in one indicator is associated with changes in the other indicators (Jarvis et al., 2003). This is the case for organizational ACAP as Zahra and George (2002:191) stated that the ACAP dimensions ‘coexist at all times (...)’. For example, firms cannot possibly exploit knowledge without first acquiring it’. The dimensions are interrelated by a common theme, that is the absorption of new knowledge, which would also suggest ACAP to be reflective (Jarvis et al., 2003). Also, several studies on organizational ACAP have treated ACAP as a reflective multi-dimensional construct, such as Cadiz, Sawyer and Griffith (2009), Camisón and Forés (2010), Flatten, Greve and Brettel (2011) and Lichtenthaler (2009).

To assess the extent to which the dimensions covary, we determined the multicollinearity between the dimensions by calculating the VIF: recognition VIF = 3.93 ($R^2 = 0.746$), assimilation VIF = 1.68 ($R^2 = 0.405$), transformation VIF = 3.17 ($R^2 = 0.685$), exploitation VIF = 3.48 ($R^2 = 0.713$). Three of the four dimensions have a VIF factor around or above the conservative threshold value of 3.3 (Diamantopoulos & Sigauw, 2006), sharing around 70% of variance with the other dimensions, which indicates that they are distinctive yet interrelated.

The second step to assess a second-order model is to evaluate the implicit assumption that there is no general factor to relate the first-order and second-order constructs (Chin, 1998). As Rindskopf and Rose (1988) show, the second-order factor model is distinguished from the group-factor model or the bi-factor model by the fact that the observed variables relate ‘uniquely’ to their latent construct. This means that all observed variables are not allowed to load on more than one construct. For our second-order construct of individual ACAP the observed items all have higher loadings on their intended first-order construct than on the other first-order constructs or the second-order construct (see Table 4.2 for details).

Third, convergent validity of the paths from the first order to the second order constructs needs to be assessed. The path coefficients are all statistically significant ($p < .001$) and all above 0.7. The AVE of the first order constructs are all above 0.5, and composite reliability all above 0.8. Further, to test convergent validity Chin (1998) recommends at least four first-order latent constructs for each second order construct. The second-order construct individual ACAP consists of four dimensions. And finally,

the paths and model fit should still hold when the second-order construct is applied in the total nomological network with other factors (Chin, 1998). Also this requirement is satisfied.

So, individuals' ACAP can be conceptually and empirically considered as a higher-order construct, consisting of four distinctive, yet interrelated activities regarding recognition, assimilation, transformation and exploitation.

4.5.3 Tests of hypotheses

The aim of our study is to determine the effects of individual characteristics on individual ACAP and performance. We used department as a control variable as differences between departments or units could affect individuals' ACAP and performance. To test whether departmental characteristics affect individual ACAP and individual performance we conducted a multi-level linear analysis. For this we calculated the intraclass correlation coefficient (ICC) to indicate if variance on the individual level is explained by the nesting of the individuals in departments. We tested three random intercept models (Snijders & Bosker, 2004) with department as factor, and individual ACAP, individual idea generation and individual idea implementation as dependent variables. For all three models we find positive, yet non-significant intraclass correlation coefficients (ICC individual ACAP = 0.103 (n.s.), ICC individual idea generation = 0.166 (n.s.), ICC individual idea generation ICC = 0.147 (n.s.)). Therefore, we conclude that for further analysis organizational factors are controlled for sufficiently.

To assess overall model fit, variance based methods such as PLS, do not have general goodness-of-fit measures like covariance based methods (i.e. LISREL or AMOS) (Hulland, 1999). In variance based SEM R^2 values (i.e. explained variance) are used to determine model quality (Chin, 2010). Further, direction, magnitude and statistical significance of the path coefficients in the structural model are evaluated. These path coefficients can be interpreted as the standardized β coefficient in regression analysis.

Our hypotheses are represented by the paths between the latent constructs in Figure 4.2. Hypothesis 1 proposed that prior knowledge diversity would positively affect individual ACAP and is supported ($\beta = .21$, $p < .001$). Hypothesis 2a about the contribution of a diverse external network to individual ACAP is also supported ($\beta = .19$, $p < .01$). The proposed positive effects of a diverse internal network to individual ACAP in Hypothesis 2b is not supported ($\beta = .06$, n.s.). Hypothesis 3a is strongly supported: a bisociative cognitive style leads to high individual ACAP ($\beta = .52$, $p < .001$). However, an associative cognitive style does not significantly contribute to individual ACAP. Hypothesis 3b is not supported ($\beta = .09$, n.s.). These antecedents explain 52 percent of the variance in the individual ACAP construct.

We also examined the effect of individual ACAP on individual innovation performance. Hypothesis 4 is supported as individual ACAP has a positive and significant relationship with individual innovation performance ($\beta = .37$, $p < .001$). The construct individual ACAP explains 14 percent of the variance in individuals' innovation performance.

To examine the magnitude of impact of the significant antecedents on individual ACAP, we determined the contribution of these antecedents to the R^2 of individual ACAP. We calculated the effect size f^2 (Chin, 2010) where values between 0.02 and 0.15 indicate a weak effect, values between 0.15 and 0.35 indicate a moderate effect and values higher than 0.35 indicate a strong effect (Cohen, 1988). For prior knowledge and external network diversity we find weak effects (0.08 and 0.03 respectively). However, bisociative cognitive style showed a strong effect of $f^2 = 0.51$ on individual ACAP.

Notes: *** $p < .001$, ** $p < .01$, * $p < .05$; $N = 147$

Figure 4.2: Structural model results with individual ACAP as second-order construct

4.5.4 Tests of mediation

As the path coefficients in our structural model assume mediation of the antecedents to individual performance through individual ACAP, we further explored the mediation paths of the five antecedents to individual performance. For this, we analyzed the paths in isolation to examine whether the conditions of mediation were met along each path. Baron and Kenny (1986) identified four conditions for mediation. First, the independent variable (antecedent) must affect the mediator (individual ACAP). Second the independent variable (antecedent) must affect the dependent variable (individual performance). Third, the mediator (individual ACAP) must affect the dependent variable (individual performance). Fourth, the direct effect of the independent variable (antecedent) on the dependent variable (individual performance) must be less than the indirect effect through mediation.

The results of the test for mediation are presented in Table 4.4. Here we first determined the path coefficient and its statistical significance, as well as the effect in explained variance R^2 in the dependent variable, of the direct relationship between the antecedent and individual performance. Then, we added the mediating relationship and determined the path coefficients, their significance and the R^2 for individual performance. When the direct relationship between antecedent and individual performance becomes insignificant, then 'full mediation' is established (Baron & Kenny, 1986; Wetzels, Odekerken-Schroder & Oppen, 2009).

In our analysis this full mediation is the case with bisociative cognitive style. When the direct relationship between antecedent and individual performance is still significant, but has lower magnitude, than there is 'partial mediation' (Baron & Kenny, 1986; Wetzels et al., 2009). This is the case for antecedents prior knowledge diversity, external network diversity and internal network diversity. For associative cognitive style, the direct effect is already insignificant, therefore violating one of the conditions to assess mediation (Baron & Kenny, 1986).

To assess the statistical significance of the model improvement of R^2 as result of mediation, we calculated the F-statistic for each examined path (except for associative cognitive style) as suggested by Wetzels et al. (2009), which all were statistically significant. Further we examined the effect size of the model improvement of R^2 by calculating f^2 .

Path a → b → c	Direct Effect Model		Mediation Effect Model				Mediation	Effect f ²	F-test F _{1,144} (Sign.)
	a → c β (Sign.)	Effect R ²	a → b β (Sign.)	b → c β (Sign.)	a → c β (Sign.)	a → b → c Effect R ²			
Prior knowledge diversity → Individual ACAP → Individual Performance	0.449 ***	0.202	0.455 ***	0.221 ***	0.336 ***	0.230	Partial	0.04	5.23 *
External network diversity → Individual ACAP → Individual Performance	0.399 ***	0.159	0.374 ***	0.261 ***	0.301 ***	0.218	Partial	0.08	10.86 **
Internal network diversity → Individual ACAP → Individual Performance	0.186 **	0.035	0.211 **	0.350 ***	0.111 *	0.152	Partial	0.14	35.10 ***
Associative cognitive style → Individual ACAP → Individual Performance	0.109	0.012	0.193 *	0.382 ***	-0.048	0.141	n.a.	n.a.	n.a
Bisociative cognitive style → Individual ACAP → Individual Performance	0.208 ***	0.043	0.609 ***	0.424 ***	-0.086	0.143	Full	0.12	16.80 ***

Notes: *** p<.001, ** p<.01, * p<.05; N = 147

Table 4.4: Results of tests of mediation

Following Cohen's (1988) classification of f^2 threshold values we conclude that the mediation effects vary from weak to the lower section of moderate. From these analyses we conclude that we find support for our theoretical model that individual ACAP mediates between the antecedents - prior knowledge diversity, external and internal network diversity and bisociative cognitive style - and individual innovation performance. However, associative cognitive style does not have a significant direct effect on individual performance, while it does have a significant effect through individual ACAP. Yet, this effect is mitigated by other factors in the total model with all antecedents.

4.5.5 Post-hoc analysis

Effects on individual ACAP dimensions. The results of the analysis so far pose questions regarding the paths in our model. For instance, why do we not find a significant relationship between internal network diversity and individual ACAP in the full structural model, yet does emerge a significant mediation effect when the constructs are treated in isolation? Also, why is bisociative cognitive style fully mediated, while the other antecedents are partially mediated (excluding associative cognitive style)? To examine these questions in more detail, we also performed a PLS analysis on the antecedents and the first-order dimensions of ACAP recognition, assimilation, transformation and exploitation. The results are presented in Figure 4.3, where we omitted the measurement items and non-significant path coefficients for more clarity.

From Figure 4.3 it is seen that *bisociative cognitive style* strongly affects all ACAP dimensions, which explains its full mediation effect. Further the structural model shows that *prior knowledge diversity* does not significantly affect individual exploitation. This is a remarkable result as the exploitation of knowledge requires building on knowledge already possessed. Further, *external network diversity* not only affects individual recognition as is assumed in literature, but also affects transformation and exploitation activities. Furthermore, *internal network diversity* only affects individual assimilation activities, while we would expect that it would also stimulate transformation and exploitation activities which require knowledge integration with colleagues. Also *associative cognitive style* only relates to individual assimilation activities, whereas it was also expected to facilitate knowledge exploitation activities.

Notes: *** $p < .001$, ** $p < .01$, * $p < .05$; $N = 147$

Figure 4.3: Structural model of results with first-order dimension of individual ACAP

Effects due to organizational position. So far, all respondents in our sample have been treated regardless of their organizational position. Yet, some positions are favorable to establish and maintain a high level of individual ACAP. For instance, Cohen and Levinthal (1990: 132) stated that persons at the interface of organizational units and their internal and external environment, so called gatekeepers or boundary spanners (Tushman, 1977), are most important for the firm's ACAP. Therefore we also analyzed if managers have higher levels of individual ACAP compared to non-managers. For this we performed a one-way ANOVA test, which results are presented in Table 4.5. Analysis shows that managers indeed have higher ACAP, $F(1,145) = 29.04$, $p < .001$, $r = .41$, and higher individual innovation performance (for idea generation $F(1,145) = 21.41$, $p < .001$, $r = .034$; for idea implementation $F(1,145) = 20.02$, $p < .001$, $r = .035$), compared to non-managers.

Item/Construct	Manager	N	Mean	Standard error mean	F-value	Sig.	r
Ideas generated	Yes	19	19.42	6.28	21.41	.000	.34
	No	128	3.11	0.95			
Ideas implemented	Yes	19	20.11	7.31	20.02	.000	.35
	No	128	3.55	1.00			
Individual ACAP	Yes	19	77.32	2.24	29.04	.000	.41
	No	128	58.37	1.31			

Table 4.5: Results post-hoc ANOVA-analysis

4.6 DISCUSSION

Extant literature on ACAP has mainly focused on organizational antecedents, dimensions and outcomes of absorptive capacity. Recently, scholars have called for more research on the individual level (Lane et al., 2006; Volberda et al., 2010) and to examine existing and new antecedents of ACAP, and their relative importance (Todorova & Durisin, 2007). Our study answers to this call in three ways, by examining the dimensions that constitute individual ACAP and the creation and validation of a measurement scale for individual ACAP, by examining the outcomes of individual ACAP, and by analyzing the effects of three of its antecedents.

First, our study contributes to the ACAP literature by providing a conceptualization of individual ACAP as composed of four individual activities, each related to one of the four organizational ACAP routines that have been distinguished theoretically (Zahra & George, 2002) and empirically (Jansen et al., 2005). Based on this conceptualization we developed and validated a measurement scale for individual ACAP as a second-order construct. By testing its mediating function between its main antecedents and individual performance this study showed that individual ACAP as a second-order construct has partial and full mediation effects. This indicates that individual ACAP helps to understand how innovation in organizations is achieved. Our analyses further show that the four first-order constructs of recognition, assimilation, transformation and exploitation are distinguished empirically, while being interrelated. This is in line with the conceptualization of ACAP by Zahra and George (2002:198) who argued that “(..) ACAP follows a multidirectional and fluid path, rather than a patterned trajectory of knowledge acquisition and exploitation”. For instance, the sequential character of ACAP is apparent between recognition and assimilation activities, as the individual who recognizes the new knowledge is the only one who can translate it and transfer it to other organization members. Also, its iterative character is understood as those who transform the new knowledge in interaction with others to create new products or processes, often will be consulted by

those who exploit the knowledge, when questions or problems arise. Even during the exploitation stage, new knowledge assimilation could be necessary, when the initially transformed knowledge needs further understanding and articulation.

By conceptualizing individual ACAP and providing a validated measure for it, research on the micro-foundations of ACAP can be extended. For instance, Volberda et al. (2010) called for research that considers ACAP as the dependent variable to explain the impact of individuals on ACAP processes. Our study focused on antecedents of prior knowledge diversity, network diversity and cognitive style, but other individual antecedents could be of interest as well such as leadership style and motivation (Volberda et al., 2010). Further, our measure of individual ACAP enables researchers to study the reciprocity between individual antecedents and organizational mechanisms (Abell et al., 2008; Zollo & Winter, 2002). Such multi-level studies could examine what aspects of ACAP are distinctly organizational or individual (Cohen & Levinthal, 1990).

The second contribution is the understanding of prior knowledge diversity, network diversity and cognitive style as antecedents of individual ACAP. We found positive and significant effects of prior knowledge diversity, external network diversity and a bisociative cognitive style on individual ACAP. Our results show that the effect of bisociative cognitive style on individual ACAP is larger than the effects of prior knowledge diversity and external network diversity. This indicates that, although prior knowledge diversity is a main predictor for individual ACAP in extant literature, external network diversity and bisociative cognitive style are also important.

Our finding empirically supports the original assumption of Cohen and Levinthal (1990) that an individuals' cognitive style is an important antecedent of ACAP. It also supports Lane et al.'s (2006) suggestion that creativity is the individual's most important contribution to organizational ACAP. In line with Zahra and George (2002), we argued that bisociation is especially important for the processes of recognition and transformation, where creativity and 'outside-the-box' thinking fuel the entrepreneurial and innovative activities. Our findings are partly in line with the work of Scott and Bruce (1994) on innovative work behavior. They also used Jabri's (1991) measure of bisociation and association, and found a negative effect for association on innovative work behavior, and no significant effect for bisociation. More recently, Shalley et al. (2009), who used Jabri's (1991) association scale partly, found a significant, yet small and negative effect of associative cognitive style on individual creativity. Although sign, magnitude and significance from these studies differ from our study, we still might conclude that all studies support the argument that a bisociative style is more favorable for innovation, compared to an associative style.

Our study also increases our understanding of the role of prior knowledge diversity as predictor for ACAP. Cohen and Levinthal (1990) included two factors in their conception of prior knowledge – experience and problem solving –, while we

defined these two factors as separate antecedents. We used prior knowledge diversity to resemble Cohen and Levinthal's (1990) accumulation of past experiences. Further, we defined cognitive style as the decision making style, which is the individual's way for problem solving. Our distinction between prior experience and problem solving style appears to be fruitful, as we find a larger effect of bisociative cognitive style over an associative cognitive style, and a larger effect of cognitive style over prior knowledge diversity. This implies that the effect of Cohen and Levinthal's (1990) prior knowledge on ACAP, now can be better understood as an individuals' cognitive style could have a higher effect on ACAP, compared to the breadth of their past experiences. For managers, this result has practical implications for organizational decision making. For instance, to develop and maintain ACAP, they should take into account their employees' problem solving style when staffing departments. Also, when hiring new employees to enhance their organization's ACAP, managers not only need to look at the work experiences of job applicants, which is stated on their curriculum vitae, but they also need to assess the job applicants' creativity.

Further, we find that external network diversity is an important predictor of individual ACAP. This provides empirical support for Todorova and Durisin's (2007) suggestion that a firm's external network is a relevant part of the 'social integration mechanisms' that facilitate the development of organizational ACAP. These social integration mechanisms were introduced by Zahra and George (2002) as important antecedents for ACAP, as these mechanisms facilitate internal knowledge transfer between organization members. The study of Jansen et al. (2005) provided empirical support for the positive effects of these social integration mechanisms on the development of ACAP, like formalization, coordination mechanisms and socialization tactics. However, they did not include external social integration mechanisms in their study. Our study indicates that individuals that have a broad and diverse external network will have higher individual ACAP. As the first activities of organizational ACAP - recognition - are executed at the individual level, we suggest that individuals' external network diversity can be considered as an important 'social interaction mechanism' for organizational ACAP.

Our third contribution to ACAP literature is that we empirically show that managers have higher individual ACAP and innovation performance compared to non-managers. This answers calls from Zahra and George (2002) and Volberda et al. (2010) to explicitly take the role of managers into account when studying ACAP. Managers influence ACAP due to their position as gatekeeper and boundary spanner (Cohen & Levinthal, 1990; Tushman, 1977) at the interfaces between departments and the organization's environment. Managers also are the main change agents within organizations (Jones, 2006), which require them to create, extend and modify the firm's knowledge base (Augier & Teece, 2009; Volberda et al., 2010). For instance, Lenox and King (2004) showed that managers can increase a firm's ACAP by

intentionally disseminating information to those organization members that might adopt a new practice. To do so, these managers also need to assimilate and transform the knowledge themselves, which requires a high level of individual ACAP.

As such, we also contribute to literature on managerial dynamic capabilities. We do this by showing that managers have higher individual ACAP, which is a dynamic capability (Lane et al., 2006; Zahra & George, 2002), but also by examining its antecedents. Adner and Helfat (2003) argued that dynamic managerial capabilities reflect three underlying factors: managerial human capital, managerial social capital and managerial cognition. Their factors reflect the three antecedents of ACAP (prior knowledge diversity, network diversity and cognitive style) and our study showed which of these factors were most important (bisociative cognitive style, external network diversity, prior knowledge diversity). The importance of the role of managers for ACAP development also becomes apparent to explain some unexpected results from our post-hoc analysis on the effects of antecedents on the separate individual ACAP dimensions. This analysis showed that external network diversity not only affects knowledge recognition as expected, but also affects individual transformation and exploitation activities. This was not anticipated beforehand as the knowledge absorption processes after recognition are assumed to take place within the organization. In turn, the absence of significant relationships between internal network diversity and transformation and exploitation are remarkable for this same reason. After all, an individual's internal network provides the potential connections for knowledge flows and idea generation (Björk & Magnusson, 2009; Kijkuit & Van den Ende, 2007). These apparently inconsistent findings might be explained by the role of managers, especially in small and medium sized enterprises (SMEs) like the firm in this study. In SMEs, the effect of managers' individual ACAP on firm-level ACAP is assumed to be higher, compared to larger firms. This is due to the more organic organization structures of SMEs that facilitate informal knowledge exchange and due to the central position of managers within the organization. For instance, Descotes and Walliser (2011) studied the ACAP processes on export information within eight French and ten Romanian SMEs. They found that the processes of information acquisition, information dissemination and decision making all occurred mostly informal and at the level of the top management team. Their study suggests that 'organizational ACAP' in SMEs in fact is a synonym for the top management teams' ACAP. Further, McKelvie, Wiklund and Short (2007) examined the relative importance of Zahra and George's (2002) four ACAP dimensions - acquisition, assimilation, transformation and exploitation – in new ventures in Sweden. Their study showed that although each ACAP dimension was linked to innovation output, the dimensions of acquisition and exploitation were most relevant. McKelvie et al. (2007) suggested that the assimilation and transformation processes were less prominent in younger firms as knowledge is more concentrated in just a few individuals in the firm.

When owner-managers fulfill several roles like being inventor, sales person, and manufacturer, the assumption of extant ACAP literature that the place of knowledge acquisition in an organization is distant from the place of knowledge application does not hold for SMEs. This implies that ACAP routines are different depending on firm size, which might have implications for main assumptions in ACAP literature. We encourage scholars to further explore these differences and their implications for ACAP theory.

An important limitation of our study is that we choose a single case-study. This was appropriate to exclude organizational characteristics as much as possible, to specifically examine individual ACAP and its antecedents. Although we excluded organizational effects as much as possible *within* the case study firm, we expect to find differences *between* firms. Firm characteristics like firm size and innovativeness determine knowledge distribution and communication structures, which in turn affect individual behavior (Cohen & Levinthal, 1990). Therefore, we suggest further studies across firms to examine these effects. Further, the firm size of our case study also bears limitations for generalizability of our results. Due to the smaller size of SMEs, some of the main assumptions of ACAP literature might not fully apply. For instance in SMEs individuals who are at the interface between organization and environment, often are the ones who also get involved in development and realization of new knowledge. In contrast, in large firms more hierarchical structures, task division and physical distance between organization members increase the need for knowledge assimilation, and need for joint transformation and exploitation. We expect that in larger organizations the distinctive characteristics of ACAP activities and the effects of their antecedents are observed better. Therefore, we would encourage researchers to examine the dimensions of individual ACAP in context of larger organizations.

Conclusion

The aim of this study was to contribute to the understanding of the micro-foundations of ACAP. For this we conceptualized individual ACAP and provided a measure for it, examined its outcomes and analyzed three of its antecedents: prior knowledge diversity, network diversity and cognitive style. We see this as a necessary, yet insufficient, first step to disentangle the multi-level construct of ACAP. Therefore we hope that our results stimulate future research on ACAP at the individual level and between organizational and individual levels. Only then we can truly understand its micro-foundations.

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APPENDIX 4.1: Items for individual ACAP

Recognition

I am always actively looking for new knowledge for my work^a

I intentionally search for knowledge in many different domains to look ‘outside the box’.

I am good at distinguishing between profitable opportunities and not-so-profitable information or opportunities^a

I easily identify what new knowledge is most valuable to us

Assimilation

I always make my knowledge available for others to use internally

I frequently share my new knowledge with colleagues to establish a common understanding

I translate new knowledge in such a way that my colleagues understand what I mean

I communicate newly acquired knowledge that might be of interest for our unit

Transformation

I often sit together with colleagues to come up with good ideas

I attend meetings with people from different departments to come up with new ideas

I develop new insights from knowledge that is available within our firm

I can turn existing knowledge into new ideas

Exploitation

I often apply newly acquired knowledge to my work

I exploit new knowledge to create new products, services, or work methods

I constantly consider how I can apply new knowledge to improve my work

^a Derived from Tang, Kacmar & Busenitz (2012)

CHAPTER 5

HOW ABSORPTIVE CAPACITY IS MORE THAN THE SUM OF ITS PARTS.

A MULTI-LEVEL CONFIGURATIONAL STUDY OF MICRO-FOUNDATIONS

This study originates from the proposition that absorptive capacity (ACAP) as a “whole is greater than the sum of its parts”. Extant literature assumes that organizational ACAP is more than just the sum of the individuals’ ACAP, and that social integration mechanisms are needed to integrate knowledge from these individuals. Yet, empirical studies of these micro-foundations to arrive from the “parts” to the “whole” are still scarce. To address this gap, this study applies a multi-level fuzzy set qualitative comparative analysis (fs/QCA) approach to derive multiple configurations which lead to high or low organizational ACAP. The results show that individuals’ ACAP is a necessary, yet insufficient condition for high organizational ACAP, thereby supporting the assumption that ACAP is more than the sum of individuals’ ACAP. Further, it shows that social integration mechanisms are needed as complements to individuals’ ACAP, and that these mechanisms need to support both the ability and motivation for knowledge integration. Furthermore, the results show that there is equifinality in the configurations, indicating that there are multiple ways to achieve high ACAP. These results contribute to a better understanding of the causal complexity of the micro-foundations of ACAP and have implications for managerial dynamic capabilities.

5.1 INTRODUCTION

(..) while the mantra of “the whole is greater than the sum of its parts” has readily been invoked in knowledge and capabilities-based collectivist theories (..), the arithmetic has scarcely been resolved (..). (Felin & Hesterly, 2007: 205).

This study explores the ‘arithmetic’ of absorptive capacity (ACAP). ACAP is the ability of an organization to recognize the value of new external knowledge, to assimilate it, to transform it and to exploit it in order to produce an organizational capability (Cohen & Levinthal, 1990; Zahra & George, 2002). Organization-level ACAP as a ‘whole’ is assumed to be composed of the combination of the individual absorptive capacities of the organization’s members and organizational mechanisms to integrate these individuals’ capabilities (Cohen & Levinthal, 1990). Yet, the interrelationships between these individual and organizational ‘parts’ have not been clarified (Volberda, Foss & Lyles, 2010). Some empirical studies have examined organizational antecedents (Jansen, Van den Bosch & Volberda, 2005; Minbaeva et al., 2003), or have applied multi-level studies to examine the effects of individuals’ characteristics on firm-level ACAP (e.g. Hayton & Zahra, 2005; Lenox & King, 2004; Zhao & Anand, 2009). Although the aforementioned studies examine cross individual-organization-level relationships, they do not study the *joint* effects of organizational and individual factors on organization-level ACAP. To address this gap in literature, we aim to resolve the ‘arithmetic’ of the micro-foundations of ACAP by answering the research question of how joint combinations of individuals’ ACAP and organizational mechanisms affect the level of organizational ACAP.

A reason for the scarcity of studies on the micro-foundations of ACAP could be related to the ‘causal complexity’ which is embedded within the ACAP construct. Due to its multi-dimensional, multi-level and path-dependent characteristics the causal relationships between individual and organizational factors are not straightforward. Instead, the path-dependent character of ACAP implies that the outcomes at the organization-level, such as an extended knowledge base, become antecedents for ACAP at a later stage (Cohen & Levinthal, 1990; Todorova & Durisin, 2007). Furthermore, individuals’ actions determine organizational ACAP (Cohen & Levinthal, 1990) but organizational ACAP also affects individuals’ knowledge and actions (Zhao & Anand, 2009).

To examine these reciprocal causal relationships the traditional research methods, such as hierarchical regression analysis or structural equation modeling, are not appropriate (Berg-Schlusser et al., 2009; Fiss, 2007). Therefore we apply fuzzy set qualitative comparative analysis (fs/QCA) (Fiss, 2007; Ragin, 2008) to derive configurations that represent combinations of individual and organizational factors that are associated with organization-level ACAP of 48 departments within four medium-

sized manufacturing firms in The Netherlands. The individual and organizational factors were measured through a survey among 297 employees of these firms.

The main contributions of this study are the insights in the arithmetic of micro-foundations of organizational ACAP. First, our results show that high levels of individuals' ACAP are a necessary yet insufficient condition for high departmental ACAP, as well as for its underlying dimensions of recognition, assimilation, transformation and exploitation. This finding empirically supports Cohen and Levinthal's (1990) assumption that organizational ACAP is more than the mere sum of individuals' ACAP.

Second, the results show that each configuration for high organizational ACAP includes at least organizational mechanisms that support the ability *and* the motivation of individuals to integrate their knowledge. This means that managers need to fulfill three types of conditions to create and maintain organizational ACAP: high levels of individuals' ACAP, combinative capabilities to establish the conduits for knowledge exchange within the organization, and a supportive management style and/or culture to enhance motivation for knowledge integration.

Third, our study shows that there is equifinality in 'paths' or configurations of factors that lead to high organizational ACAP. This means that there are alternative ways to create and maintain high ACAP. Further, this study shows that there is no causal symmetry in solutions. This means that when a condition is sufficient for high organizational ACAP, its absence does not automatically lead to low organizational ACAP. Our findings on equifinality and causal asymmetry contribute to the development of managerial dynamic capabilities as they offer managers alternative guidelines to build and maintain ACAP.

Finally, this study shows how a systematic configurational research approach can manage causal complexity that is often inherent in studies on micro-foundations. The 'endogeneity' problem and issues of reversed causality are difficult to address when traditional statistical analysis are applied. In contrast, configurational methods acknowledge the complexity of causal relationships and use it as a strength to arrive at multiple solutions (Berg-Schlusser et al., 2009; Fiss, 2007). This study shows how fuzzy set Qualitative Comparative Analysis (fs/QCA) can be applied to better understand the micro-foundations of dynamic capabilities.

In the next section, the theoretical background of the micro-foundations of ACAP is discussed, as well as the individual and organizational factors it comprises. Then the research setting and method are described. We justify the use of the research method fs/QCA and explain how it is applied in this study systematically. After describing the results, we conclude with discussion of the implications for extant and future ACAP research.

5.2 BACKGROUND: MICRO-FOUNDATIONS OF ACAP

Micro-foundations are typically referred to as the factors that determine individual action and interaction in the creation of organization-level routines and capabilities (Abell, Felin & Foss, 2008; Felin & Foss, 2005; Foss, 2011). Although micro-foundations are not restricted to the level of individuals (Foss, 2011), they mostly relate to individual-level heterogeneity to explain firm-level performance (Felin & Hesterly, 2007) and explain how the links between organizational-level and individual level factors shape routines and capabilities (Abell et al., 2008; Gavetti, 2005).

The micro-foundations lens is useful for understanding ACAP for two reasons. The first reason is that the organization-level ACAP is grounded in the prior knowledge and cognitions of the organization's individuals (Cohen & Levinthal, 1990). The premise is that individuals are the key sources of (tacit) knowledge (Grant, 1996), and that individuals span the boundaries across departments and across the environment and the firm which enables them to recognize and acquire new knowledge (Cohen & Levinthal, 1990). Also, the cognition of individuals determines the ability to make creative and novel linkages between new and existing knowledge, which leads to new ideas and innovation (Amabile, 1988; Cohen & Levinthal, 1990). So, characteristics of individuals and their behaviors are key determinants of organizational ACAP.

The second reason why micro-foundations are an appropriate perspective for ACAP relates to the interaction between individuals' behavior and organizational arrangements. Due to limited cognitive capabilities, individuals specialize in knowledge domains. This implies that to create and maintain organizational capabilities knowledge from several individuals needs to be integrated (Grant, 1996). Therefore, ACAP not only depends on the sum of the absorptive capacities of an organization's employees, it also requires communication and coordination structures to facilitate knowledge exchange between the individual organization members (Cohen & Levinthal, 1990). This makes ACAP a multi-level construct by definition whereby individuals' actions are aggregated to the organizational level through the use of organization-level structures.

However, empirical studies on micro-foundations of ACAP are scarce (Volberda et al., 2010). Our review of ACAP literature that focuses on the relationship between organizational and individual factors only leads to a few studies. For instance, Minbaeva et al. (2003) studied the effects of human resource management practices on ACAP, showing that these organizational mechanisms increase the ability and motivation of employees to exchange knowledge. Lenox and King (2004) showed that specifically targeting information to employees positively affect their knowledge absorption. Hayton and Zahra (2005) examined the effects of top managers prior

knowledge diversity on their firm's ACAP and found that the distribution of knowledge diversity within the top management team was more important than the individually held knowledge of the individual top managers. Zhao and Anand (2009) studied the cross-level effects of ACAP on knowledge increase in the automotive industry and found that organization arrangements positively affected both the increase of individuals' knowledge and increase of collective knowledge. These reviewed studies examined the effects of factors at the individual level on outcomes at the organization level (e.g. Hayton & Zahra, 2005; Zhao & Anand, 2009), or the effects of organization-level factors on individual behavior (e.g. Lenox & King, 2004; Minbaeva et al., 2003; Zhao & Anand, 2009). However, these studies have not examined the *joint* effect of individual and organizational factors on organizational outcomes. A probable reason for this gap in the literature relates to the causal complexity of micro-foundations.

Causal complexity refers to causal relationships that can be characterized by equifinality, conjunctural causation and asymmetric causal relationships (Berg-Schlosser et al., 2009). Equifinality means that there is not a single best solution, but that there are multiple paths that lead to the same solution (Gresov & Drazin, 1997). Conjunctural causation refers to situations in which the combined effect of causes leads to solutions which are not achieved when the causes are examined separately. Causal asymmetry means that the causes that lead to the presence of an outcome are different from the causes that lead to the absence of the outcome (Fiss, 2011). These more complex causal relationships stand in contrast to the linear cause-effect relationships that are assumed in most social science research (Berg-Schlosser et al., 2009). The concept of ACAP is inextricably associated with causal complexity, due to its multi-dimensional, multi-level and cumulative character. Causal complexity as a result of its multi-dimensional character is empirically shown by Jansen et al. (2005) who found that an organizational mechanism can have different causal relations with each of the ACAP dimensions of recognition, assimilation, transformation and exploitation. Further, the multi-level character of ACAP creates reciprocal relationships within the construct. For instance, Cohen and Levinthal (1990) clearly stated that organizational ACAP is partly based on the aggregation of individuals' ACAP. Yet, individuals' knowledge and skills are shaped in the social context of the organization (Simon, 1991; Spender, 1996), which was empirically shown by the study of Zhao and Anand (2009). So, there are reciprocal causal relationships between factors on the individual and organizational level. Furthermore, the cumulative character of ACAP is a key conceptual principle (Cohen & Levinthal, 1990) which introduces endogeneity issues of reversed causality: a firm's ACAP is dependent on the knowledge base and routines that have been formed by decisions in the past, which in turn were based on the ACAP at that time (Cohen & Levinthal, 1990). So, ACAP is

inherently complex in nature, which needs to be taken into account (Todorova & Durisin, 2007).

Acknowledging the causal complexity of the micro-foundations of ACAP calls for specific empirical research methods such as longitudinal process studies (Todorova & Durisin, 2007) or configurational approaches (Fiss, 2007), as the more traditional methods such as hierarchical regression analysis or structural equation modeling assume linear causality (Berg-Schlosser et al., 2009; Fiss, 2007). For reasons, that are explained in the research method section, a configurational approach is chosen for this study.

5.3 PARTS: INDIVIDUAL AND ORGANIZATIONAL MICRO-FOUNDATIONS

Micro-foundations include the “parts” at the individual and organization-level that determine individuals’ action and mutual interactions, as well as the interactions between these individual and organization-level factors (Felin et al., 2012), that create the “whole” of ACAP. For this study the individuals’ ACAP activities and organizational social integration mechanisms are of specific interest.

5.3.1 Heterogeneity and distribution of individuals’ ACAP activities

Cohen and Levinthal (1990) considered individuals’ ACAP as key building blocks for organizational ACAP. Individuals’ actions contribute to each organizational ACAP dimension in different ways. First, individuals interact with the external environment and thereby recognize and acquire new knowledge. Especially individuals who operate at the interface of the organization and environment as ‘gatekeepers’ determine what knowledge will enter the organization and what not (Tushman, 1977). Second, individuals store knowledge in their own memory and retrieve the knowledge when needed or when others ask for advice or assistance. To do so, they need the ability to articulate their knowledge and make it understandable for others (Zollo & Winter, 2002). Third, individuals are the main source for knowledge creation which requires creativity (Amabile, 1988) and cognitive skills to (re)combine new and existing knowledge. Finally, individuals turn ideas into practice, by applying the new knowledge to create new products, processes and services.

The contributions of individuals’ actions to organizational ACAP differ due to differences in individual characteristics and due to their organizational position. Regarding individual characteristics, Cohen and Levinthal (1990) argued that the more diverse individuals’ knowledge bases and the higher their cognitive abilities, the better they are able to absorb new knowledge. Next to differences in knowledge and skills, individuals also differ in their motivation to exchange knowledge (Minbaeva et al., 2003; Szulanski, 1996).

Besides heterogeneity of individuals' characteristics, the position individuals take within an organization also determines their individual ACAP activities. This relates especially to managers (Eggers and Kaplan, 2009). Due to their position as gatekeepers at the interface of organization and environment, they are generally more exposed to new knowledge and therefore have more opportunity to recognize and absorb new knowledge (Volberda et al., 2010). Further, they have more opportunities to develop their network and as a result to engage more in ACAP activities.

So, individual ACAP activities lie at the basis of organizational ACAP routines. In essence, without high levels of individual ACAP activities, there are no organizational ACAP routines. As individuals differ in the extent to which they engage in ACAP activities, as result of differences in individual characteristics and organizational position, the level of organizational ACAP is directly dependent on the distribution of individuals which form the organization (Cohen & Levinthal, 1990).

5.3.2 Knowledge integration through social integration mechanisms

Cohen and Levinthal (1990) argued that organizational ACAP not only depends on the distribution of individuals' ACAP, but also on the organizational mechanisms that facilitate communication and knowledge exchange between these individuals. These mechanisms are called 'social integration mechanisms' by Zahra and George (2002) to denote the formal and informal mechanisms that lower barriers for knowledge sharing between individuals and increase the efficiency of knowledge recognition, assimilation, transformation and exploitation (Todorova & Durisin, 2007; Zahra & George, 2002). Several studies showed that these barriers could be divided into two categories: barriers that relate to the ability to integrate knowledge and to the willingness or motivation to integrate knowledge (Zhao & Anand, 2009; Minbaeva et al., 2003; Szulanski, 1996). Organizational barriers concerning the *ability* to exchange and integrate knowledge relate to the lack of organizational infrastructure, or conduits, through which knowledge flows (Cohen & Levinthal, 1990). The social integration mechanisms that can reduce these barriers can be both formal and informal and are called 'combinative capabilities' (Kogut & Zander, 1992; Van den Bosch, Volberda & De Boer, 1999). Organizational barriers concerning the *motivation* to exchange and integrate knowledge relate to the lack of a supportive climate to encourages employees to exchange and integrate their knowledge. Social integration mechanisms that reduce these motivational barriers are a supportive managerial decision making style (Carlile, 2004; Todorova & Durisin, 2007; Zahra & George, 2002) and an integrative culture (Cohen & Levinthal, 1990; Gold, Malhotra & Segars, 2001; Grant, 1996). Each of these social integration mechanisms is discussed in more detail below.

Combinative capabilities to enhance ability for knowledge integration

Combinative capabilities relate to a firm's routines and procedures to transform individuals' knowledge into organizational knowledge by the integration of current and newly acquired knowledge (Grant, 1996; Kogut & Zander, 1992). In ACAP literature, three types of combinative capabilities are discussed: coordination capabilities, systems capabilities and socialization capabilities (Jansen et al., 2005; Van den Bosch et al., 1999).

Coordination capabilities refer to the use of horizontal communication structures, job rotation and participation in decision making to facilitate knowledge exchange between members of a group (Van den Bosch et al., 1999). Coordination through horizontal communication structures and job-rotation stimulates knowledge exchange across boundaries within the organization or with external parties (Cohen & Levinthal, 1990). Participation in decision making relates to participation of subordinates in higher-level decision-making processes (Van den Bosch et al., 1999), which leads to more knowledge exchange and increases the quality of ideas and proposals.

Systems capabilities refer to direction, policies, procedures and manuals that are used to integrate knowledge through formalization and routinization (Van den Bosch et al., 1999). Formalization is considered an efficient way of knowledge integration, as interpersonal interaction is almost unnecessary (Grant, 1996). It further stimulates learning as individuals need to articulate their knowledge to make it understandable and available for others (Zollo & Winter, 2002). Routinization refers to the extent that tasks are invariable, repetitious and stable. This means that employees do not need to search for new knowledge outside their own domain to solve problems (Jansen et al., 2005), which limits the opportunities for knowledge integration.

Socialization capabilities refer to the ability of the organization to establish a shared ideology, values and norms, which offers employees an identity and collective interpretation of reality (Van den Bosch et al., 1999). It relates to the extent to which organizations have strong cultures (Sørensen, 2002) which provide a 'common knowledge' (Cohen & Levinthal, 1990; Grant, 1996) through connectedness and socialization tactics (Jansen et al., 2005). Connectedness is related to the density of networks within the organization. The more frequent interactions between organization members, the easier knowledge flows through the organization (Galunic & Rodan, 1998). Yet, a high level of connectedness might hamper innovation through processes of 'groupthink' and limited connections outside the common network (Granovetter, 1973). Socialization tactics are related to the socialization of newcomers (Jansen et al., 2005). High socialization of newcomers improves knowledge integration as newcomers quickly understand the written and unwritten rules and procedures. Yet, it could hamper innovation as new organization members would become adjusted too easily (March, 1991).

Supportive management style and integrative culture to enhance motivation for knowledge integration

Social integration mechanisms not only enable knowledge exchange, they also can stimulate employees to share their knowledge. Two mechanisms are of interest for this study: a supportive management style and an integrative culture.

Supportive management style. Managers contribute to organizational ACAP not only by their individual cognitive abilities and gatekeeper position, but also through their decision making style. They determine the organization's strategy, the locus of knowledge search, what resources to allocate and what capabilities to develop (Adner & Helfat, 2003, Volberda et al., 2010; Zahra & George, 2002). So, managers can actively create a climate in which employees are motivated to exchange knowledge. First, they can stimulate and facilitate idea generation by encouraging employees to express their opinions and ideas, and taking these into account when making decisions at lower organizational levels. Second, managers can facilitate the implementation of ideas by acquiring and maintaining resources needed for innovation projects and improvements, especially when higher-level management or shareholders need to be convinced to allocate scarce resources that are needed for effective ACAP integration (Carlile, 2004; Todorova & Durisin, 2007; Zahra & George, 2002).

Integrative culture. To stimulate efficient integration of capabilities, organizations need a certain level of common understanding, which relates to shared goals (Carlile, 2004; Lane, Salk & Lyles, 2001), shared norms, cognition and dominant logic (Grant, 1996; Lane & Lubatkin, 1998). One way to achieve this is by socialization capabilities, as an element of combinative capabilities. These socialization capabilities determine the strength of cultures, yet do not relate to the *content* of these values and beliefs. For effective knowledge integration firms need to establish an 'integrative culture' which denotes the shared norms, values and beliefs that promote collaboration and knowledge exchange and where goals are clearly stated and understood by all organization members (Gold et al., 2001; Simsek et al., 2005).

So far, we discussed how micro-foundations apply to ACAP and what individual and organizational factors comprise these micro-foundations. In the next section we will empirically examine our research question on how the joint combination of individuals' ACAP and organizational mechanisms affect the level of organizational ACAP.

5.4 METHOD**5.4.1 Research setting and design**

For this study we applied a multiple case study approach as this method is warranted 'especially when the boundaries between the phenomena and the setting are not clearly evident' (Yin, 2009: 18). As our discussion on causal complexity of micro-foundations

showed, the relationships between individual and organizational factors are not clearly defined which makes a case study an appropriate method (Eisenhardt & Graebner, 2007). The multiple case study included four Dutch medium-sized industrial firms. All four case study firms were approached by the first author to compose a sample of comparable firms with respect to industry type and activities (industrial firms with sales, development and production) and size (medium-sized). Further, the firms were selected on their willingness to invest time to organize data collection among nearly all of their employees, which significantly restricted the availability of case study firms. In Table 5.1 an overview of the main characteristics of the four case study firms is presented, such as the industry, their main activities, organizational form and size in number of employees.

Firm nr.	Industry	Main activities	Organization form	Number departments in study	Total number employees	Responses (%)
1	Kitchen furniture	Sales, development, production and logistics of kitchen furniture for business clients	Family business	23	197	141 (72%)
2	Machine building	Sales, development, production and installation of machines for concrete and brick industry	Business unit of MNC	12	75	52 (70%)
3	Paper machines	Sales, development and production of fabrics for paper machines	Business unit of MNC	4	63	41 (65%)
4	Telecom	Sales, development and production of glass fibre	Business unit of MNC	9	91	63 (69%)
Total				48	426	297 (70%)

Table 5.1: Main characteristics of case study firms

Within the case study firms, a paper-and-pencil survey was administered among nearly all employees to measure the variables of interest. The survey was administered in one-hour-lasting group sessions during working time to assure a high response rate. Each group consisted of about ten employees and the first author was always present to explain the goal of the research and confidentiality issues, to guide the survey process and to provide assistance when needed. To minimize the effects of common method bias the survey was administered anonymously to avoid socially desirable answers (Podsakoff et al., 2003). After data collection common method bias is assessed using Harman's single factor test (Podsakoff et al., 2003). Based on Principal Component Analysis without rotation, we found 23 factors with eigen values > 1.0

with the largest factor accounting for 19% of all variance, which suggests that common method bias is unlikely. In total 297 surveys were used in the final analysis, which represents a response rate of 70%, and relates to 48 departments with two or more employees. The distribution of the respondents and departments for each firm is also shown in Table 5.1.

5.4.2 Measures

Measures for the constructs were derived from existing literature where possible. Only for individuals' ACAP a new scale was developed. The validity and reliability of measures was assessed using the variance-based structural equation modeling (SEM) technique of partial least squares (PLS). PLS was used as it is appropriate when the data does not meet the normal distribution criteria (Chin, 2010). The Kolmogorov-Smirnov test for normality was significantly non-normal ($p < .001$) for all measurement items. To assess reliability of the constructs the threshold value of 0.7 for composite reliability (CR) was applied (Nunnally & Bernstein, 1994). Convergent validity of the construct was assessed by the average variance extracted (AVE) which should be higher than 0.5 (Fornell & Larcker, 1981). Discriminant validity between the constructs was assured by the square root of the AVE of the construct, which should be higher than the inter-construct correlations (Fornell & Larcker, 1981). The values for the constructs at departmental level are calculated as the means of the scores of the individuals within each department.

Individual ACAP. For individual ACAP we developed a new measurement scale, as an appropriate measure was not available in literature that could be applied to all kinds of employees, irrespective of their specific tasks or positions. The procedure for scale development of DeVellis (2003) was followed to arrive at a 14-item scale which is presented in Appendix 5.1. The measurement scale regards individual ACAP as a second-order construct, consisting of the four dimensions recognition (CR = 0.85, AVE = 0.59), assimilation (CR = 0.86, AVE = 0.66), transformation (CR = 0.87, AVE = 0.63) and exploitation (CR = 0.83, AVE = 0.62).

Departmental ACAP. The measure of Jansen et al. (2005) for firm-level ACAP is used. Our intention to study departmental ACAP within firms is similar to Jansen et al.'s (2005) use of their measure of organizational ACAP for organizational units within a large European financial services firm. We adapted their scale slightly to make it appropriate for general use across different departments within industrial firms. From their original 21-item scale we finally kept 12 items for analysis that met the required reliability and validity standards. We used departmental ACAP as a formative second-order construct consisting of recognition (CR = 0.79, AVE = 0.56), assimilation (CR = 0.83, AVE = 0.72), transformation (CR = 0.77, AVE = 0.53) and exploitation (CR = 0.80, AVE = 0.50).

Combinative capabilities. The measures for the variables of combinative capabilities were also derived from Jansen et al. (2005). *Cross functional interfaces* (CR = 0.74; AVE = 0.59) was measured by the use of temporary teams and the use of permanent teams. Jansen et al. (2005) also included liaison personnel as a coordination mechanism, but this item had to be dropped for analysis as it did not meet the validity and reliability requirements. For the same reasons, from the original scale of *formalization* (CR = 0.71, AVE = 0.46) three out of five items were kept. From Jansen et al.'s (2005) *socialization tactics* only the subscale of serial socialization tactics (CR = 0.80; AVE = 0.49) was used. The subscale of collective socialization tactics was dropped as it refers to the way new recruits are socialized within a group of newcomers, and we expected that our case study firms did not hire many newcomers at once. Further, Jansen et al.'s (2005) scales for *participation* (CR = 0.81, AVE = 0.51), *job rotation* (CR = 0.78, AVE = 0.66), *routinization* (CR = 0.84, AVE = 0.51), and *connectedness* (CR = 0.78, AVE = 0.48) were applied.

Integrative culture. The scale for integrative culture (CR = 0.92, AVE = 0.49) was derived from Gold et al. (2001). Their 13-item scale captures aspects of an integrative culture that supports departmental level ACAP: a clear vision and goals, encouraging interpersonal interactions and knowledge sharing, and facilitating knowledge exchange.

Supportive management style. The scale for supportive managements style was constructed based on items that reflected both a participative decision-making style (Arnold et al., 2000) and championing (Howell, Shea & Higgins, 2005). Both aspects showed high multicollinearity with VIF = 3.85, which is above the 3.3 threshold value (Diamantopoulos & Siguaw, 2006), which justified the combination of both scales to reflect the construct of supportive management style (CR = 0.95, AVE = 0.69).

An overview of the final items, their weights and factor loadings on the related constructs, and the composite reliability (CR) and AVE of the constructs are presented in Appendix 5.1.

5.4.3 Analysis

We used 'fuzzy set Qualitative Comparative Analysis'(fs/QCA) to analyze the data. QCA is an analytical method that is 'case-oriented', which means that it can deal with a limited number of complex cases in a configurational way (Berg-Schlosser et al., 2009). A configuration is defined as a specific *combination* of factors that produces a given outcome of interest (Ragin, 2008). As organizations are multidimensional and complex in nature, the configurational approach is very suitable to study strategic and organization management phenomena (Fiss, 2007). Well-known examples of configurations in management literature are those of Miles and Snow (1978), Porter (1980) and Mintzberg (1983).

Due to its specific characteristics QCA is especially suitable for answering our research question of how combinations of individuals' ACAP and organizational arrangements jointly affect an organizational units' ACAP. First, QCA is able to manage the complex nature of organizations and their multidimensional characteristics (Fiss, 2011), taking into account the complementary nature of relationships between organizational factors. This is different from classical linear regression models which assume that independent variables compete in explaining the dependent variable, rather than showing how these independent variables combine to explain the outcome⁵ (Fiss, 2007). Although interaction effects are possible in regression analysis to study the combined effect of variables, when it exceeds three-way interaction it becomes very difficult to interpret the results (Fiss, 2007). As our aim is to investigate the relationship between multiple organizational mechanisms in relation to each other and to individual ACAP, our study is multi-dimensional and multi-level, for which QCA is very appropriate (Berg-Schlusser et al., 2009).

Second, classical linear regression analysis cannot take equifinality into account, whereas QCA is able to define different paths that lead to the same outcome (Fiss, 2007). This is due to the central place of truth tables in QCA. Truth tables represent all theoretical possible combinations based on the factors that are examined. Therefore each combination represents a configuration, which is automatically a possible path to a given outcome (Ragin, 2008). In our study we are interested in the relative importance of organizational mechanisms and individuals' ACAP, which might become apparent in different paths to the same solution.

Third, QCA distinguishes between necessary and sufficient conditions, which is especially valuable to unravel causal complexity (Schneider & Wagemann, 2006). Conditions are necessary for an outcome if it is always present when the outcome occurs. Conditions are sufficient if the outcome always occurs when the condition is present (Ragin, 2008). Insight into which conditions are necessary or sufficient enhances understanding of causal relationships and better guides scholars and practitioners in future decision making.

Fourth, QCA can deal with small and intermediate N-samples, between 10 to 50 cases (Berg-Schlusser et al., 2009). This is also related to the need for in-depth knowledge of the cases, as the researcher needs to make informed decisions to select thresholds for analysis and to interpret the results (Schneider & Wagemann, 2010). As our study comprises 48 cases from four firms with which the researchers are familiar with, QCA is appropriate.

⁵ To distinguish QCA from classical linear regression methods we follow the recommendations of Schneider and Wagemann (2010) to use other terminology. We use 'condition' in stead of 'independent variable', the phenomenon explained is called 'outcome' and not 'dependent variable', and the results in QCA are called 'solution formula' and not 'equation'.

5.5 RESULTS

5.5.1 The application of fuzzy set QCA on departmental ACAP

The analytical method of fs/QCA is based on Boolean algebra and truth tables, and proceeds in five steps, which are summarized in Table 5.2, and are explained in-depth below.

Step 1: Calibrating fuzzy sets. The first step in fs/QCA is to transform the values of the conditions into a range from 0 to 1, where the value of 0 means that the condition falls into the category of ‘full non-membership’ and a value of 1 means that the condition falls into the category of ‘full-membership’. An intermediate value of 0.8 could mean ‘mostly but not fully membership’, and 0.4 could mean ‘more or less out of full-membership’ (Ragin, 2008). To transform interval scales into fuzzy conditions, the fs/QCA’s ‘calibration’ procedure in fs/QCA 2.0 software (Ragin, Drass & Davey, 2006) is recommended (Ragin, 2008). To enable calibration three threshold values for full-membership (fuzzy score = 1), for full non-membership (fuzzy score = 0) and for the cross-over point (fuzzy score = 0.5) need to be determined by the researcher. For these variables we used the upper 25 percentiles as the threshold for full membership and the lower 25 percentiles as the threshold for non-full membership. The cross-over point is set at the 50 percentiles. Percentiles as thresholds are used in several studies (e.g. Fiss, 2011, Ragin, 2008) and is justified as the mean values of the constructs are mostly distributed normally, as is shown by the Kolmogorov-Smirnov test in Table 5.3.

For department size we used the threshold value of 10 employees to be regarded as a large department as Van de Ven, Delbecq and Koenig (1976) found that beyond ten employees the impersonalizing effect becomes apparent leading to more hierarchy, more rules and procedures. The threshold for small department size was set at four employees, which was also used in Van de Ven et al.’s study for the smallest department. The cross-over point is selected in the middle (= 7 employees). The descriptives of the departmental conditions are presented in Table 5.3 which lists the mean values, the standard deviation (SD), the range of the values between the lowest value (Min) and the highest value (Max), the percentiles (25%, 50% and 75%) and the scores of the Kolmogorov-Smirnov (K-S test) normality test. The calibrated dataset for all 48 cases is presented in Appendix 5.2.

Step	Description	Activities
Step 1	Calibrating fuzzy sets	- Use calibration method of fs/QCA software
Step 2	Analysis of necessary causal conditions	- Calculate necessary conditions - Apply threshold value of consistency ≥ 0.80
Step 3	Analysis of sufficient causal conditions	
Step 3a	Remote causal conditions	- Determine remote causal conditions based on theoretical arguments - Calculate Fuzzy set Truth Tables - Select cases frequency ≥ 1 - Select cases consistency ≥ 0.70 - Select Parsimonious model as solution
Step 3b	Proximate causal conditions	- Determine proximate causal conditions based on theoretical arguments - Calculate Fuzzy set Truth Tables for each remote causal condition with all proximate causal conditions - Select cases frequency ≥ 1 - Select cases consistency ≥ 0.80 - Select Complex model as solution
Step 4	Determining solutions for combinations of remote and proximate conditions	- For each Remote solution formula of step 3a determine the corresponding proximate causal conditions in the matrix of step 3b - Calculate Fuzzy sets Truth Tables for each found combination of remote and proximate conditions - Select cases frequency ≥ 1 - Select cases consistency ≥ 0.80 - Select Intermediate model as solution, based on the value of the assessed combination of conditions, and select only those solutions with consistency ≥ 0.90 - Construct a Table that lists solution formula, solution coverage, consistency and the case-numbers (or case names)
Step 5	Determining the final configurations	- Select the solution formula with the highest coverage - Assess how many cases remain uncovered by the solution - Repeat adding solution formulas until a satisfying number of cases is covered - Minimize the solution formulas when possible - Repeat steps 2 to 5 for the negated outcome

Table 5.2: Overview of systematic and reproducible steps of fs/QCA

Variable (CONDITION)	Mean	SD	Min	Max	Percentiles			Normality K-S test
					25%	50%	75%	
Departmental Recognition (DREC)	3.22	0.98	1.50	5.67	2.67	3.00	3.75	.17 *
Departmental Assimilation (DASS)	4.51	0.79	2.25	6.25	4.00	4.39	5.13	.08
Departmental Transformation (DTRA)	3.99	0.77	2.63	5.83	3.44	4.00	4.50	.07
Departmental Exploitation (DEXP)	5.10	0.90	3.50	6.50	4.70	5.13	5.49	.09
Departmental ACAP (DACAP)	4.21	0.60	2.90	5.93	3.85	4.12	4.92	.09
Management style (MANSTYLE)	5.15	0.77	2.50	6.33	4.58	5.27	5.75	.14 *
Culture (CULTURE)	4.72	0.76	2.96	6.58	4.13	4.75	5.15	.07
Coordination (COORDINATION)	3.46	0.70	2.25	5.75	3.03	3.50	3.90	.10
Participation (PARTICIPATION)	3.25	0.81	1.84	5.50	2.64	3.06	3.89	.11
Job rotation (ROTATION)	2.62	1.04	1.00	5.50	1.81	2.41	3.24	.10
Formalization (FORMALIZATION)	4.15	0.57	3.00	5.33	3.70	4.20	4.55	.10
Routinization (ROUTINIZATION)	4.43	0.88	2.70	5.80	3.75	4.64	5.02	.12
Connectedness (CONNECTEDNESS)	5.54	0.64	4.03	6.50	5.24	5.56	6.00	.09
Socialisation (SOCIALIZATION)	4.58	0.70	3.13	6.17	4.10	4.42	5.07	.12
iACAP (IACAP)	61.99	8.84	38.00	80.17	56.33	63.12	68.00	.08
Number employees (SIZE)	6.08	6.83	2.00	38.00	-	-	-	.28 ***

Notes: The conditions as used in fs/QCA are mentioned between brackets (). K-S = Kolmogorov-Smirnov normality test, which tests the null-hypothesis of non normality.

*** p<.001, **p<.01, *p<.05. N = 48.

Table 5.3: Descriptives of departmental conditions

Step 2: Analysis of necessary causal conditions. Analysis of necessary conditions is recommended before the ‘main analysis’ of the truth tables (Schneider & Wagemann, 2010). A condition is necessary when the outcome is present whenever the causal condition is present, while the condition can also be present without the outcome (Schneider & Wagemann, 2006). Stated otherwise, the outcome is a subset of the cause. To assess whether a condition is necessary the consistency value is determined according to formula: $Consistency(Y_i \leq X_i) = \sum[\min(X_i, Y_i)] / \sum(Y_i)$ with X_i as the value of the i-th condition X, and Y_i the value of the i-th outcome Y (Ragin, 2008). The consistency value for necessary conditions denotes the extent to which membership in the outcome is consistently less than or equal to membership in the condition (Ragin, 2008). The analysis is executed with the fs/QCA software for the outcome of ‘high’ departmental ACAP (DACAP)⁶, the inversed outcome of ‘low’ departmental ACAP (dacap), and the conditions in relation to the dimensions of ACAP: recognition (DREC and ‘drec’), assimilation (DASS and ‘dass’), transformation (DTRA and ‘dtra’) and exploitation (DEXP and ‘dexp’). The results are presented in Table 5.4. The threshold for consistency value for necessary conditions is set at 0.80 (Fiss, 2011).

The analysis of necessary causal conditions in Table 5.4 shows that IACAP and SIZE are necessary conditions for high departmental ACAP. Another way to assess the necessity of conditions is use of the graphical X-Y-plot (Schneider & Wagemann, 2010). The X-Y plot shows for each single case how its causal condition (X-axis) falls within the set of the outcome (Y-axis). Cases below the diagonal (lower right part), have higher membership values in the condition than in the outcome, which indicates a necessary condition (Ragin, 2008). Cases above the diagonal line (upper left section) have higher membership in the outcome than in their respective condition, which indicates a sufficient condition (Ragin, 2008).

The X-Y plots for IACAP and SIZE as conditions for departmental ACAP are displayed in Figures 5.1a and 5.1b to show the quality of the necessary conditions. From the Figures it is seen that the majority of cases lies around or below the diagonal, which supports the claim of necessity of the condition. The necessary condition is not ‘perfect’ as there are several cases that are depicted in the upper half of the diagram. This is also reflected in a high consistency value above 0.8, which approaches the ‘perfect’ value of 1.

⁶ We follow the conventions of Boolean algebra in denoting the conditions as used by Schneider & Wagemann (2006). We use uppercase letters to denote variables that represent values near [1], for example ‘MANSTYLE’ denotes the set of conditions in which management style scores high. We use lowercase letters to denote variables that represent values near [0], for example ‘manstyle’ denotes the set of conditions in which management style scores low. We place causal conditions with low fuzzy set values between quotation marks to distinguish them from the causal condition in general (regardless of their fuzzy set value).

Causal condition	Consistency value for necessity									
	DACAP	dacap	DREC	drec	DASS	dass	DTRA	dtra	DEXP	dexp
MANSTYLE	0.79	0.36	0.66	0.45	0.73	0.39	0.77	0.37	0.75	0.39
manstyle	0.33	0.76	0.42	0.62	0.36	0.70	0.33	0.73	0.37	0.73
CULTURE	0.75	0.39	0.63	0.48	0.73	0.39	0.77	0.38	0.74	0.35
culture	0.38	0.75	0.47	0.61	0.38	0.71	0.36	0.75	0.35	0.75
COORDINATION	0.56	0.52	0.64	0.41	0.50	0.56	0.50	0.57	0.51	0.53
coordination	0.56	0.60	0.45	0.68	0.60	0.54	0.61	0.55	0.58	0.56
PARTICIPATION	0.71	0.38	0.60	0.49	0.65	0.42	0.74	0.36	0.66	0.43
participation	0.38	0.71	0.49	0.60	0.42	0.65	0.36	0.73	0.43	0.67
ROTATION	0.48	0.63	0.46	0.64	0.48	0.61	0.54	0.59	0.52	0.59
rotation	0.61	0.46	0.63	0.45	0.59	0.47	0.58	0.52	0.57	0.51
FORMALIZATION	0.56	0.50	0.53	0.55	0.54	0.53	0.63	0.45	0.55	0.49
formalization	0.51	0.57	0.56	0.54	0.54	0.56	0.46	0.64	0.50	0.57
ROUTINIZATION	0.37	0.71	0.43	0.66	0.44	0.62	0.40	0.68	0.51	0.54
routinization	0.70	0.37	0.66	0.43	0.63	0.44	0.69	0.41	0.54	0.51
CONNECTEDNESS	0.67	0.34	0.61	0.40	0.65	0.34	0.63	0.39	0.63	0.37
connectedness	0.41	0.74	0.47	0.67	0.41	0.72	0.45	0.70	0.44	0.70
SOCIALIZATION	0.70	0.42	0.61	0.47	0.63	0.48	0.72	0.39	0.66	0.42
socialization	0.41	0.69	0.46	0.60	0.47	0.62	0.38	0.70	0.42	0.65
IACAP	0.88	0.57	0.79	0.64	0.87	0.54	0.83	0.61	0.80	0.60
iacap	0.29	0.61	0.36	0.51	0.27	0.59	0.33	0.55	0.33	0.53
SIZE	0.21	0.44	0.31	0.35	0.19	0.46	0.23	0.43	0.22	0.44
size	0.85	0.63	0.76	0.73	0.88	0.61	0.85	0.65	0.85	0.63

Note: Values in bold are necessary conditions with consistency threshold value ≥ 0.80 .

Table 5.4: Consistency values for necessary causal conditions for DACAP, dacap and their respective dimensions

Figures 5.1a and 5.1b: X-Y Plots of IACAP (a) and 'size' (b) as necessary conditions for DACAP

For the inverse of high ACAP ('dacap') we find no necessary conditions. This implies that having high individual ACAP is a necessary, yet insufficient condition to establish high departmental ACAP, as it is also possible to have combinations of high individual ACAP and low departmental ACAP. This finding supports Cohen and Levinthal's (1990) suggestion that organizational ACAP is not the mere sum of the absorptive capacities of its members and that also organization-level conditions need to be fulfilled.

Regarding department size as control variable, it is observed that small departments are a necessary condition for high departmental ACAP, but not for low departmental ACAP. This can be explained in two ways. First, by choosing the cross-over point at 7 employees, it is observed that 13 out of 48 departments are considered as large, which represents 27% of the cases. Second, 7 of these cases are production departments which have relatively low departmental ACAP. So, the chance that departments with high departmental ACAP are a subset of small departments is rather high, which is reflected in the necessary condition of 'size'.

Step 3: Analysis of sufficient causal conditions. Causal conditions are sufficient when they are present together with the outcome, but the outcome can also be present without the condition (Schneider & Wagemann, 2006). The cause is a subset of the outcome. To assess whether a condition is sufficient the consistency value is determined according to formula: $Consistency(X_i \leq Y_i) = \sum[\min(X_i, Y_i)] / \sum(X_i)$, with X_i as the value of the i-th condition X, and Y_i the value of the i-th outcome Y (Ragin, 2008). The consistency value denotes the extent to which membership in the condition is consistently less than or equal to membership in the outcome (Ragin, 2008).

The analysis of sufficient causal conditions starts with the construction of the truth table, which lists all logically possible combinations of causal conditions, each combination representing a theoretical configuration. The number of logically possible combinations increases exponentially with 2^k , where k is the number of causal conditions. Then the empirically found cases are assigned to one of these 'logical configurations' and the software calculates the consistency score for each configuration. This is the proportion of cases within the configuration that display the outcome in question. A minimum consistency value of 0.75 is recommended (Ragin, 2008).

In our study, we have 11 conditions which creates 2,048 ($= 2^{11}$) combinations. If every empirical observed case is assigned to a unique configuration we would have 2,000 ‘empty’ configurations or ‘logical remainders’. Although fs/QCA has several strategies to deal with logical remainders⁷, too many of these unobserved cases force the software to make simplifying assumptions which could complicate drawing inferences (Schneider & Wagemann, 2006). Therefore a two-step solution is used in which the conditions are split in two groups and analyzed subsequently and in relation to each other (Schneider & Wagemann, 2006). In our case, this leads to analysis of a maximum of 6 conditions each time, reducing the number of logical combinations dramatically from 2,048 to 64 for each analysis.

The two-step approach by Schneider and Wagemann (2006) distinguishes conditions that are *remote* or *proximate*. Remote conditions are relatively stable over time and almost outside the reach of the conscious influence of present actors (Schneider & Wagemann, 2006: 760). Often this applies to contextual factors. We regard formalization, routinization, connectedness, socialization and culture as remote factors. These organizational factors often take time to establish and to change. For instance, the establishment of a dense network, which represents connectedness, is based on frequent interactions and building of trust among the employees, which is not easily created or changed (Uzzi, 1997). Further, an organization’s culture develops over time and strong cultures often impede adaptation to changing environments (Sørensen, 2002). Also, a high level of formalization and routinization is created over the years (Sørensen & Stuart, 2000) and is difficult to change, especially when firms are becoming more bureaucratic (Mintzberg, 1983). For this same reason control variable department size is also regarded as a remote condition.

In contrast to remote conditions, proximate conditions vary more over time and are more directly affected by actors. These factors are more closely linked to the outcome as they are temporarily and spatially closer to the outcome. We regard coordination, participation, rotation, management style and individuals’ ACAP as proximate factors. Individual ACAP is most obviously affected by actors, as it concerns the behavior of these actors. The factors of coordination, participation, rotation and management style are mainly subject to the actions of managers. For instance, Jones’ (2006) case study showed how middle managers act as change-agents introducing new managerial practices and new ways of working. In his case study the firm could change its learning environment by hiring three external middle managers,

⁷ There are three approaches to deal with logical remainders, each leading to different models. The first approach is to treat logical remainders as if the outcome is ‘0’. This leads to the ‘complex’ solution, which is the most conservative as it only takes the observed cases into account. A second approach is to let the software determine what the best outcome value would be for the logical remainders. This is the most ‘parsimonious’ solution but could lead to oversimplifying solutions. Third, theory can serve as guide to determine the outcome value, based on additional instructions of the researcher. This is called the ‘intermediate’ solution (Schneider & Wagemann, 2006).

who introduced new working methods (like lean manufacturing principles to improve manufacturing efficiency) and helped opening communication channels by establishing regular meetings, and nurturing external contacts. Also the study of Lenox and King (2004) showed how managers affect an organization's ACAP by directly targeting information to specific organization members.

Step 3a. Remote causal conditions. During this step the remote causal conditions are analyzed as a function of departmental ACAP (DACAP). Using fs/QCA 2.0 software (Ragin et al., 2006) the fuzzy set truth table is compiled based on the sufficiency test for the conditions of CULTURE * CONNECTEDNESS * FORMALIZATION * ROUTINIZATION * SOCIALIZATION * SIZE on outcome DACAP. The procedure of Ragin and Davey (2008) was followed, whereby the cut-off value used for frequency is 1 as is recommended by Ragin (2008) for smaller sample sizes and the consistency cut-off value is 0.7 as recommended by Schneider and Wagemann (2008) for the first step. This is a more liberate threshold than 0.75 which is generally recommended (Ragin, 2008) to avoid the exclusion of cases that might be interesting after all. The results of the parsimonious solutions in Table 5.5 show which remote configurations are associated with high ACAP, thereby excluding all other possible combinations of remote conditions from further analysis.

Parsimonious solution	Coverage	Consistency	Number cases > 0.5 membership
CULTURE*CONNECTEDNESS	0.52	0.87	11
CULTURE*FORMALIZATION*routinization*size	0.35	0.93	7
CONNECTEDNESS*routinization	0.49	0.89	11
SOCIALIZATION*culture*routinization	0.16	0.79	2
culture*formalization*routinization*size	0.19	0.75	4
solution coverage: 0.835197			
solution consistency: 0.812979			

Notes: The model used is: DACAP= f(CULTURE, CONNECTEDNESS, FORMALIZATION, ROUTINIZATION, SOCIALIZATION, SIZE). In the first column * represents the logical AND-function. In the second column coverage is the proportion of cases with a positive outcome that are covered by a condition or a combination of these. The third column shows the consistency. The fourth column shows the number of cases which has a fuzzy membership-score of at least 0.5 on all of the causal conditions, indicating that the case is more in than out of the membership-set.

Table 5.5: Parsimonious solution for remote conditions relating to DACAP

Step 3b. Proximate causal conditions. In the next step, the five proximate causal conditions are assessed in combination with each of the relevant contextual factors which are mentioned in Table 5.5. This means that there are 6 causal factors in each separate analysis for which the fuzzy set truth tables are determined. In this second step the cut-off value for frequency is 1, and for consistency it is 0.8 (Fiss,

2011), which leads to more narrowly circumscribed solutions (Ragin, 2009: 115). Selecting the complex solution does not allow the software to make simplifying assumptions (Schneider & Wagemann, 2006). The results of the analyses are summarized in Table 5.6 which shows the proximate solution formulas for DACAP in the rows, which are derived in combination with each of the remote conditions in the columns. From Table 5.6 it is observed that most proximate solution formula appear for several remote conditions.

Proximate solution formulas for DACAP	Remote conditions for DACAP						
	CULTURE	culture	CONNECTEDNESS	FORMALIZATION	formalization	routinization	SOCIALIZATION
IACAP*coordination*rotation*MANSTYLE*		2	5		4	4	
IACAP*coordination*rotation*MANSTYLE							5
IACAP*COORDINATION*PARTICIPATION*MANSTYLE			8	4		4	8
IACAP*COORDINATION*PARTICIPATION*rotation*	4		3	4		4	
IACAP*PARTICIPATION*MANSTYLE*	11					10	
IACAP*coordination*MANSTYLE*	2			2			4
coordination*ROTATION*MANSTYLE*			2			2	

Notes: The numbers in the cells represent the number of corresponding cases. The asterisk ‘*’ behind the solution formulas in the first column denote that the remote condition is part of the configuration. For instance the first row shows four configurations such as ‘IACAP*coordination*rotation*MANSTYLE*culture’ and ‘IACAP *coordination*rotation*MANSTYLE*CONNECTEDNESS’. When the solution formula in the first column does not end with an asterisk, the solution formula does not include any remote condition. In this case the solution appeared from the fuzzy set truth table with the remote condition as cause, yet the solution formula did not include this remote condition. All solution formulas have sufficiency consistency ≥ 0.8 .

Table 5.6: Complex solution formulas for proximate conditions for each remote condition

Step 4: Determining solutions for combinations of remote and proximate conditions. In this step the fuzzy set truth tables are determined for the proximate configurations in step 3b (Table 5.6) *within* the remote configurations of step 3a (Table 5.5). For instance, in step 3a the remote configuration ‘CULTURE * CONNECTEDNESS’ was found. From Table 5.6 is derived that both remote conditions share the proximate solution formula ‘IACAP * COORDINATION * PARTICIPATION * rotation*’. These six conditions are then used for deriving the fuzzy set truth table from the fs/QCA software. Again the frequency threshold is 1 and

the minimum consistency threshold set at 0.8 (Ragin, 2008). The intermediate solution with consistency ≥ 0.9 is chosen to ascertain that the solution formula only relates to cases with the intended outcome, in this case high departmental ACAP (DACAP). This procedure is repeated for all possible combinations of the proximate solutions of Table 5.6 *within* the remote solutions listed in Table 5.5. The results in Table 5.7 show all possible configurations for DACAP and the number of cases that fall into each configuration.

Intermediate solution	Coverage	Consistency	Cases > 0.5 membership
[1] IACAP*PARTICIPATION*MANSTYLE*CULTURE	0.50	0.93	11
[2] IACAP*COORDINATION*PARTICIPATION* CULTURE	0.37	0.90	8
[3] IACAP*MANSTYLE*CULTURE*routinization	0.42	0.96	8
[4] MANSTYLE*coordination*routinization	0.33	0.91	7
[5] IACAP*COORDINATION*PARTICIPATION*CULTURE* routinization	0.30	0.94	6
[6] IACAP*COORDINATION*PARTICIPATION* CULTURE* FORMALIZATION*rotation	0.20	0.94	4
[7] PARTICIPATION*MANSTYLE*routinization*size	0.45	0.97	10
[8] IACAP*MANSTYLE*routinization*size	0.45	0.96	10
[9] MANSTYLE*CULTURE*FORMALIZATION*routinization* size	0.31	0.95	6
[10] IACAP* PARTICIPATION*MANSTYLE*CULTURE* routinization	0.38	0.96	8
[11] IACAP*PARTICIPATION*MANSTYLE*CULTURE* FORMALIZATION	0.33	0.91	6
[12] IACAP*COORDINATION*PARTICIPATION* routinization	0.34	0.89	8
[13] MANSTYLE*CONNECTEDNESS*routinization	0.44	0.92	10

Table 5.7: Configurations for DACAP

Step 5: Determining the final configurations. To determine the final configurations, we set two requirements. First, final configurations need to cover as many empirical cases as possible. Second, the total set of configurations needs to include (almost) all cases with the intended outcome. To determine the configurations that contain most cases as subset of the outcome, we first select the solution formula with the highest coverage form Table 5.7, which is solution formula [1] with coverage of 0.50 and 11 cases. We determine how the 11 cases are distributed over the other solutions [2] to [13] and see which cases remain uncovered. Then we add another solution formula with the next highest coverage [7] and determine again which cases are not covered by this solution. Further we add solution formula [8] through which

we establish total coverage of 13 out of 16 cases with a membership in departmental ACAP ≥ 0.9 . Taking a closer look at solution formulas [7] and [8] it is easily seen that these can be minimized into $MANSTYLE * routinization * size$. This more parsimonious solution formula has a coverage of 0.54 and consistency of 0.94⁸. So the final solution formula for DACAP becomes then: ***IACAP * PARTICIPATION * MANSTYLE * CULTURE + MANSTYLE * routinization * size***.

This solution shows two paths to high departmental ACAP. The first path is the combination of high individual ACAP, participation, a supportive management style and an integrative culture. The second path to high departmental ACAP is the combination of a participative management style, low routinization of tasks and a department of small size. The second path does not show IACAP as a necessary condition, which is common for sufficient solution formulas⁹ (Wagemann & Schneider, 2010). This is the reason why a separate analysis of necessary conditions is performed in step 2. The combined paths account for 81% of the cases with a membership in high departmental ACAP ≥ 0.90 .

5.5.2 Results of fuzzy set QCA for low departmental ACAP and the ACAP dimensions

Once the solution of the positive outcome is determined, the negation of the outcome, which is low departmental ACAP ('dacap'), needs to be examined (Ragin, 2008). It cannot automatically be inferred that when a causal condition is related to the positive outcome, the non-occurrence of the causal condition is related to the negative outcome (Schneider & Wagemann, 2010). To arrive at the negation of the outcome, the steps 2 to 5 are replicated for 'dacap'. Due to space limitations, the intermediate results of the analysis are not presented here, but are available on request from the corresponding author. The final solution formula for 'dacap' is: ***iacap * ROUTINIZATION***. This means that low levels of departmental ACAP is caused by a combination of low levels of individuals' ACAP and high levels of routinized work.

For the departmental ACAP dimensions recognition, assimilation, transformation and exploitation the solution formulas are determined following the steps 2 to 5 systematically. The final results are presented in Table 5.8.

It can be seen that the consistency of the solutions is high (≥ 0.86) and that for most dimensions the coverage of cases with membership ≥ 0.9 in the outcome is above 70% (last column of Table 5.8). For DREC, DEXP and 'dexp' the solution formulas

⁸ The calculations to determine coverage and consistency value of $MANSTYLE * routinization * size$ are derived by constructing fuzzy set truth tables in fs/QCA software and are not shown here, but are available on request.

⁹ Three out of 13 cases in solution formula $MANSTYLE * routinization * size$ have membership in $IACAP < 0.5$. This is why IACAP is not part of the solution formula. Yet 10 out of 13 cases have membership in $IACAP > 0.5$, indicating that it is a rather consistent factor, which relates to the consistency score > 0.8 for necessity.

have high consistency but low coverage. This implies that for the cases that are not covered by solution formulas, there is less clarity about relationships between conditions and outcomes.

Table 5.8 further shows that for DACAP, ‘drec’, DASS, ‘dass’, DTRA and ‘dtra’ the solution contains two ‘paths’ separated by the ‘+’ sign which represents the Boolean function ‘OR’. This means that there is equifinality in the solutions that lead to the same outcome. Furthermore the results show that IACAP or its negation (‘iacap’) is included in almost all solution formulas, confirming its position as a necessary condition. Finally, it can be observed that the solution formulas for the outcome and its negation are different, and that the formulas differ across the four dimensions. This shows the ‘causal complexity’ in which causation is equifinal (different paths to the same solution), conjunctural (multiple conditions within one path) and asymmetric (conditions for positive and negative outcomes differ) (Berg-Schlosser et al., 2009).

To evaluate the empirical and theoretical relevance of the solution formulas X-Y plots of all solution formulas in Table 5.8 were constructed using the fs/QCA software as suggested by Schneider and Wagemann (2010). The X-Y graph for DACAP and ‘dacap’¹⁰ are depicted in Figures 5.2a. and 5.2b. respectively. The graphs show that the solution formulas are in the upper triangle indicating that the solution is sufficient for the outcome and display good quality. All other X-Y graphs for the solutions of Table 5.8 show the majority of cases in the upper triangle, indicating sufficient solutions with good quality (graphs are not shown here but are available on request).

¹⁰ Initially following the steps 2 to 5 for ‘dacap’ systematically led to the solution formula: $\text{manstyle} * \text{connectedness} + \text{iacap} * \text{ROUTINIZATION} \leq \text{dacap}$. However, assessment of the X-Y-plot of the solution showed relatively low quality of the solution. Therefore only the most robust solution is kept.

Solution formulas	Coverage	Consistency	Percentage cases > 0.9 membership in outcome
High Departmental ACAP (DACAP)			
IACAP*PARTICIPATION*MANSTYLE*CULTURE +	0.50	0.93	81 %
MANSTYLE*routinization*size $\leq$ DACAP	0.54	0.94	
Low Departmental ACAP (dacap)			
iacap*ROUTINIZATION $\leq$ dacap	0.50	0.96	71 %
High Departmental Recognition (DREC)			
IACAP*COORDINATION*PARTICIPATION*rotation $\leq$ DREC	0.30	0.92	33 %
Low Departmental Recognition (drec)			
ROTATION*culture*connectedness*socialization +	0.32	0.90	75 %
iacap*ROUTINIZATION $\leq$ drec	0.44	0.86	
High Departmental Assimilation (DASS)			
IACAP*MANSTYLE*routinization*size +	0.42	0.87	75 %
IACAP*CONNECTEDNESS*CULTURE $\leq$ DASS	0.45	0.86	
Low Departmental Assimilation (dass)			
iacap*connectedness +	0.47	0.92	82 %
participation*culture*SIZE $\leq$ dass	0.37	0.95	
High Departmental Transformation (DTRA)			
IACAP*PARTICIPATION*MANSTYLE*CULTURE +	0.51	0.93	77 %
MANSTYLE*coordination*routinization $\leq$ DTRA	0.36	0.96	
Low Departmental Transformation (dtra)			
participation*culture*ROUTINIZATION +	0.44	0.91	75 %
iacap*participation*manstyle $\leq$ dtra	0.38	0.94	
High Departmental Exploitation (DEXP)			
SOCIALIZATION*ROUTINIZATION*CULTURE $\leq$ DEXP	0.30	0.90	35 %
Low Departmental Exploitation (dexp)			
iacap*manstyle*connectedness $\leq$ dexp	0.40	0.91	50 %

Notes: The last column lists the proportion of cases with the solution formula *and* a membership score > 0.9 in the outcome from the total number of cases with a membership score > 0.9 in the outcome. So, 81% means that 19% of the cases with high DACAP (membership > 0.9) are not covered by either of the two solution formulas.

Table 5.8: Summary of final solution formulas

Figures 5.2a and 5.2b: X-Y-Plots of solution formulas for DACAP (a) and 'dacap' (b)

5.5.3 Robustness analysis

We performed a sensitivity analysis by calibrating of fuzzy sets through setting the full-membership and full non-membership at 90 and 10-percentiles respectively, instead of the 75 and 25-percentiles thresholds, which led to minor deviations from our earlier findings. We also performed sensitivity analysis by setting the cross-over point for all conditions at value 4, as this is the intermediate position on a 7-point Likert scale. Setting the full-membership threshold at 5.5 and the full non-membership threshold at 2.5 resulted in theoretically inconsistent results, which suggest that the choice for percentiles as cross-over point and thresholds seems appropriate.

As fs/QCA is a relatively young analysis technique in the management field (Fiss, 2007; Wagemann & Schneider, 2010) the robustness of our findings is compared to more accepted techniques of hierarchical regression analysis and cluster analysis. Although these techniques and QCA are different in their research approach and epistemological foundations, results from both methods should be theoretically sound and mutually consistent. Therefore we compared the significance and the sign (positive/negative) of the variables of Jansen et al.'s (2005) study, who used hierarchical regression analysis, with the conditions in our final solution configurations (Table 5.8) and found similar results¹¹.

Furthermore, the results of the fs/QCA analysis are compared with the method of cluster analysis, following the method by Fiss (2011). The cluster analysis identified three clusters, yet the cases assigned to the cluster with highest ACAP showed too much inconsistency in displaying the intended outcome, which shows the limited ability of cluster analysis to deal with the contribution of individual variables to the outcome (Fiss, 2007).

5.6 DISCUSSION

The reason for this study was found in the suggestion of Cohen and Levinthal (1990) that organizational ACAP is not merely the sum of the individuals' ACAP, but that it has to be complemented with organizational mechanisms that facilitate communication and knowledge integration among the organizations' members. This raised the question whether "the whole is greater than the sum of its parts", and what the arithmetic is between the parts and the whole (Felin & Hesterly, 2007). Therefore, we examined the joint effects of individuals' ACAP and organizational mechanisms on organizational ACAP at the department-level in four medium-sized manufacturing

¹¹ Only for the condition job rotation in relation to the dimension of recognition the signs were different. Jansen et al. (2005) found a significant positive effect of job rotation on recognition, while our solution formulas for DREC show low levels of job rotation and for 'drec' show high levels of job rotation. This might be caused by the relative small size of most departments in this study, for which job rotation is less useful, compared to larger departments. As suggested before in this study, department size is negatively related to high ACAP.

firms. Through the use of fuzzy set Qualitative Comparative Analysis the causal conditions for high and low ACAP, and their respective dimensions, were determined. The results contribute to literature on ACAP and micro-foundations in four ways.

The first contribution to ACAP theory is that this study empirically supports the suggestion of Cohen and Levinthal (1990) that organizational ACAP is more than the sum of the individuals' ACAP. Our results show in two ways that individuals' ACAP are a necessary, yet insufficient condition for high departmental ACAP. First, the presence of high individual ACAP is identified as a necessary condition for high departmental ACAP, yet low individual ACAP is not necessary for low departmental ACAP. So, high individual ACAP alone, does not explain high departmental ACAP. Second, the solution formulas show that IACAP leads to high departmental ACAP *in combination* with other organizational conditions, such as an integrative culture, participation practices and supportive management style. So, our findings support Cohen and Levinthal's (1990) and Zahra and George's (2002) suggestions that organizational mechanisms are needed to complement individuals' ACAP.

Second, this study contributes to ACAP literature by showing empirically the relevance of supportive management style and integrative culture as social integration mechanisms. It improves our understanding of the function of social integration mechanisms to not only enable knowledge exchange (Jansen et al., 2005), but also to motivate individuals to exchange knowledge. Our results show that paths to high organizational ACAP are conjunctural as they need to include at least three elements: high individual ACAP and social integration mechanisms to support both ability and motivation for knowledge integration.

A third contribution to ACAP literature is that our results show that there is equifinality in the paths that lead to high or low departmental ACAP. This indicates that there are 'multiple roads to Rome', and that there is 'not one best way to organize'. This finding contributes to the development of managerial dynamic capabilities (Adner & Helfat, 2003) as they offer managers guidelines to build and maintain ACAP. For instance, consider ACAP development in a production department in which routinization is high. According to earlier work of Jansen et al. (2005) the manager could only decide to lower routinization as their results showed that only low level of routinization would lead to high ACAP. Based on our study, managers are presented two alternatives to achieve high ACAP: they can develop individuals' ACAP *and* participation *and* a supportive management style *and* an integrative culture, *or* develop individuals' ACAP *and* a supportive management style *and* a low level of routinized jobs. When choosing the first alternative, the manager can achieve high ACAP in combination with a high level of routinization. This suggests that establishing specific organizational mechanisms might mitigate contradicting effects of a certain causal condition.

Finally, this study contributes to literature on micro-foundations by showing how fuzzy set Qualitative Comparative Analysis can be applied in a systematic and reproducible way to deal with ‘causal complexity’. By examining organizational phenomena in a holistic way, issues of equifinality (different paths to the same solution), conjunctural causation (multiple conditions within one path) and asymmetric causal relationships (different conditions for positive and negative outcomes) can be addressed properly (Berg-Schlosser et al., 2009).

5.6.1 Limitations and future research

This study is not without limitations. First, the sample for this study was restricted to four industrial firms in The Netherlands. The aim of this study was to contribute to new theory building by exploring the joint effects of individual and organizational factors on organization-level ACAP. Such explorative and multi-level character justifies a multiple case-study approach (Eisenhardt, 1989; Yin, 2009). However, to arrive at more normative prescriptions for managers on how to create and maintain ACAP more quantitative research is needed. Doing so, the causal complexity of micro-foundations should be kept in mind when choosing appropriate research methods. An interesting research avenue could include large scale studies to test our findings and to identify other possible configurations that relate to other industries or service-oriented firms. A promising development is the use of QCA for large-N samples (Berg-Schlosser et al., 2009).

Second, our sample consisted of medium-sized firms with relatively small departments. Department size could have affect on the overall characteristics of ACAP, which could affect the relevance of the factors in our solution formulas. For instance, in larger departments or organizational units tasks are often more specialized and routine which might lead to lower individuals’ ACAP and more need for social integration mechanisms. Future research could examine to what extent social integration mechanisms could substitute for individuals’ ACAP.

A third limitation relates to the application of fs/QCA. Although this study showed the appropriateness of this technique to deal with the complexity of causal relationships that are attached to micro-foundations, it certainly also has its limitations (see De Meur, Rihoux and Yamasaki, 2009 for elaborate discussion). Of special interest for our study is the assumption of fs/QCA that the conditions in the solution formula are all weighted equally (De Meur, et al., 2009). This is the ‘black box’ problem of fs/QCA as it does not explain ‘how’ the causal conditions explain the outcome, while more traditional statistical methods like regression analysis give information about statistical relevance and contribution to the solution (for instance through the value of β). However, fs/QCA does not aim to examine the contribution of individual causes to the outcome (De Meur et al. 2009). Instead its strength is to

examine the causes in combination. So, we encourage future large-scale research with quantitative statistical methods to complement large-scale research on configurations.

5.6.2 Conclusion

This study shows that the “whole” of organizational ACAP is more than the sum of its “parts” of individuals’ ACAP. The arithmetic of organizational ACAP in the form of configurations shows that individuals’ ACAP need to be complemented by social integration mechanisms that support both the ability and motivation of individuals to integrate their knowledge. Further, the results suggest that there is equifinality in the solutions, which means that there are multiple ways to achieve high organizational ACAP. This offers scholars and practitioners new insights in the micro-foundations of ACAP, which could provide guidelines for developing and maintaining dynamic capabilities taking account of their inherent causal complexity.

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APPENDIX 5.1: Overview of items and constructs

Construct/Items	Weight	Factor loading	Comp. rel (CR)	AVE
Individual ACAP				
<i>Recognition</i>			0.85	0.59
I am always actively looking for new knowledge for my work	0.35	0.79		
I intentionally search for knowledge in many different domains to look 'outside the box'	0.35	0.82		
I am good at distinguishing between profitable opportunities and not-so-profitable information or opportunities	0.30	0.74		
I easily identify what new knowledge is most valuable to us	0.30	0.71		
<i>Assimilation</i>			0.86	0.66
I frequently share my new knowledge with colleagues to establish a common understanding	0.36	0.77		
I translate new knowledge in such a way that my colleagues understand what I mean	0.45	0.86		
I communicate newly acquired knowledge that might be of interest for our unit	0.41	0.81		
<i>Transformation</i>			0.87	0.63
I often sit together with colleagues to come up with good ideas	0.31	0.78		
I attend meetings with people from different departments to come up with new ideas	0.26	0.77		
I develop new insights from knowledge that is available within our firm	0.32	0.83		
I can turn existing knowledge into new ideas	0.38	0.79		
<i>Exploitation</i>			0.83	0.62
I often apply newly acquired knowledge to my work	0.34	0.69		
I exploit new knowledge to create new products, services, or work methods	0.44	0.81		
I constantly consider how I can apply new knowledge to improve my work	0.48	0.85		
Departmental ACAP (adapted from Jansen et al., 2005)				
<i>Recognition</i>			0.79	0.56
Employees of our department regularly visit other firms.	0.36	0.69		
Our department periodically organizes special meetings with customers or third parties to acquire new knowledge	0.43	0.69		
Employees of our department regularly approach third parties	0.54	0.85		
<i>Assimilation</i>			0.83	0.72
In our department new opportunities to serve our (internal) clients are quickly understood	0.56	0.83		
Our department quickly analyzes and interpret changing external conditions	0.62	0.86		
<i>Transformation</i>			0.77	0.53
In our department employees record and store newly acquired knowledge for future reference	0.44	0.74		
Our department quickly recognizes the usefulness of new external knowledge to existing knowledge	0.54	0.81		
Our department periodically meets to discuss consequences of new developments	0.37	0.63		

APPENDIX 5.1 (continued)

Construct/Items	Weight	Factor loading	Comp. rel (CR)	AVE
<i>Exploitation</i>			0.80	0.50
It is clearly known how activities within our department should be performed	0.25	0.66		
Our department has a clear division of roles and responsibilities	0.36	0.77		
Our department constantly considers how to better exploit knowledge	0.48	0.74		
In our department employees have a common language regarding our products, services or processes	0.31	0.63		
Social integration mechanisms (Jansen et al., 2005)				
Cross functional interfaces			0.74	0.59
Our department often uses temporary task forces to coordinate activities	0.78	0.88		
Our department often uses permanent teams to coordinate activities	0.49	0.64		
Participation			0.81	0.51
In our department employees participate in the decision to hire new staff	0.23	0.65		
In our department employees participate in decisions on the promotion of any of colleagues	0.37	0.65		
In our department employees participate in decisions on adoptions of new policies	0.44	0.82		
In our department employees participate in decisions on adoptions of new work methods/processes	0.34	0.73		
Job Rotation			0.78	0.66
Employees in our department are regularly rotated between different functions	0.28	0.61		
Employees in our department are regularly rotated between different departments	0.86	0.97		
Formalization			0.71	0.46
Whatever situation arises written procedures are available for dealing with it	0.31	0.55		
Rules and procedures occupy a central place in the department	0.60	0.83		
Employees are hardly checked for rule violations (R)	0.52	0.63		
Routinization			0.84	0.51
Tasks in our department are the same from day-to-day	0.21	0.68		
The work in our department is routine	0.26	0.76		
People in this department do about the same job in a same way most of the time	0.08	0.60		
Basically, people in this department perform repetitive actions in doing their jobs	0.37	0.79		
The duties in our department are <i>not</i> repetitious (R)	0.43	0.73		

(continued)

APPENDIX 5.1 (continued)

Construct/Items	Weight	Factor loading	Comp. rel (CR)	AVE
Connectedness			0.78	0.48
In our department. there is ample opportunity for informal 'hall talk' among employees	0.16	0.50		
In our department employees from different subunits feel comfortable calling each other when the need arises	0.49	0.84		
My manager discourages employees discussing work related matters with others than him/her (R)	0.19	0.51		
People around here are quite accessible to each other	0.48	0.85		
Socialization tactics			0.80	0.49
Experienced colleagues see advising or training newcomers as one of their main job responsibilities	0.41	0.69		
Newcomers gain a clear understanding of their roles from observing senior colleagues	0.42	0.77		
Newcomers receive little guidance from experienced members as to how perform the job (R)	0.31	0.68		
Newcomers are generally left alone to discover what their role in the department should be (R)	0.28	0.66		
Integrative culture (Gold, Malhotra & Segars, 2001)			0.92	0.49
In our department. employees understand the importance of knowledge to corporate success	0.11	0.62		
In our department employees are encouraged to ask others for assistance when needed	0.10	0.68		
In our department high levels of participation are expected in capturing and transferring knowledge	0.11	0.70		
In our department employees are encouraged to explore and experiment	0.11	0.71		
In our department the overall vision is clearly stated	0.12	0.66		
In our department on the job training and learning are valued	0.11	0.63		
In our department employees are encouraged to interact with other departments	0.10	0.73		
In our department employees are valued for their individual expertise	0.12	0.76		
In our department employees are encouraged to discuss their work with other departments	0.12	0.80		
In our department employees are encouraged to share knowledge with other organizations	0.11	0.64		
In our department we believe that the benefits of sharing knowledge outweigh the costs	0.12	0.69		
In our department the objectives are clearly stated	0.11	0.69		
In our department senior management clearly supports the role of knowledge in our firm's success	0.11	0.73		

APPENDIX 5.1 (continued)

Construct/Items	Weight	Factor loading	Comp. rel (CR)	AVE
Management style (Arnold et al., 2000. and Howell et al., 2005)			0.95	0.69
My manager encourages us to express ideas/suggestions	0.13	0.79		
My manager listens to our ideas and suggestions	0.12	0.87		
My manager uses our suggestions to make decisions that affect us	0.15	0.89		
My manager considers our ideas when he/she disagrees with them	0.15	0.83		
My manager gives all of us a chance to voice their opinions	0.14	0.84		
My manager gets the right people involved in innovation and improvement projects	0.18	0.84		
My manager gets key decision makers involved in innovation and improvement projects	0.20	0.82		
My manager gets problems into the hands of those who can solve them	0.12	0.78		

Note: (R) = reversed item

APPENDIX 5.2: Overview of departments and corresponding fuzzy set values

Firm	Department	Name department	DACAP	DREC	DASS	DTRA	DEXP	MANSTYLE	CULTURE	COORDINATION	PARTICIPATION	ROTATION	FORMALIZATION	ROUTINIZATION	CONNECTEDNESS	SOCIALIZATION	IACAP	SIZE
1	1	sales front office	0.54	0.97	0.05	0.63	0.03	0.02	0.09	1	0.01	0.01	0.95	0.47	0.22	0	0.48	0.98
1	2	sales back office	0.16	0.95	0	0.09	0.2	0.96	0.12	1	0.32	0.2	0.05	0.56	0.95	0.28	0.44	0.98
1	3	order processing	0.01	0.25	0.02	0.08	0.01	0.79	0.25	0.97	0.43	0.81	0.15	0.85	0.86	0.96	0.36	0.98
1	4	sales back office	0.3	0	0.39	0.5	0.96	0	0.02	0.5	0.06	0.41	0.01	0.99	0.15	0.17	0.98	0.02
1	5	sales front office	0.34	0.99	0.7	0.01	0	0.1	0.01	0.68	0.1	0	0.01	1	1	0.05	0.72	0.12
1	6	ICT	0.67	0.02	0.96	0.66	0.42	0.53	0.03	0.11	0.99	0.01	0.04	0	1	0.17	0.99	0.02
1	7	reception	0	0	0	0.01	0.73	0.4	0.95	0.87	0.1	0.95	1	1	0.12	0.89	0.19	0.01
1	8	controlling	0.07	0	0.86	0.01	0.98	0.27	0.37	0.11	0.03	0.11	0.02	1	0.83	0.01	0.32	0.02
1	9	procurement	0.32	0	0.47	0.22	0.99	0.97	0.98	0.02	0.96	0.06	0.1	1	1	0.59	0.32	0.05
1	10	service	0.99	0.5	0.99	1	1	0.99	1	0.02	0.97	0.01	0.1	0.94	0.98	0.99	0.99	0.05
1	11	secretary	1	1	1	0.99	0.99	0.99	0.43	0.01	0.02	0	1	0	0.95	0.99	0.65	0.01
1	12	planning	0.57	0.86	0.99	0.06	0	0.01	0.18	0.11	0	0	0.01	1	0.12	0.28	0.96	0.02
1	13	proces engineering	0.99	0.95	0.97	0.99	0.97	0.66	0.98	0.97	0.92	0.94	0.05	0.07	0.99	0.43	0.92	0.88
1	14	maintenance	0.23	0	0.92	0.5	0.89	0.24	0.26	0.5	0.92	0.95	0.76	0	0.02	0	1	0.01
1	15	logistics	0.01	0	0.07	0.06	0.12	0.14	0.83	0	0.45	1	0.9	0.05	0.01	1	0.46	0.73
1	16	manufacturing	0.44	0.5	0.65	0.01	1	0.81	0.36	0.92	0.02	0.95	0.16	0.95	0.02	0.65	0.44	0.88
1	17	manufacturing	0	0.35	0	0	0	0	0.01	0.26	0	0.99	0	0.97	0	0	0.36	0.88
1	18	logistics	0.8	0.9	0.39	0.5	0.92	0.05	0.82	0.92	1	0.11	0.76	0.36	0	0.31	0.99	0.02
1	19	manufacturing	0.37	0.18	0.81	0.16	0.35	0.48	0.77	0.37	0.03	1	0.98	0.95	0	0	0.46	0.27
1	20	manufacturing	0.07	0.05	0.25	0.16	0.21	0.04	0.05	0.08	0	0.93	1	0.99	0.08	0.03	0.29	0.05

APPENDIX 5.2 (continued)

Firm	Department	Name department	DACAP	DREC	DASS	DTRA	DEXP	MANSTYLE	CULTURE	COORDINATION	PARTICIPATION	ROTATION	FORMALIZATION	ROUTINIZATION	CONNECTEDNESS	SOCIALIZATION	IACAP	SIZE
1	21	manufacturing	0	0.06	0	0.02	0.58	0.02	0.01	0.19	0.01	0.34	0.05	1	0	0.05	0.41	0.88
1	22	manufacturing	0.01	0.02	0.22	0.01	0.05	0.06	0.07	0.08	0.08	1	0.48	0.36	0	0.25	0.35	0.88
1	23	manufacturing	0	0.13	0.07	0	0	0.01	0.03	0.4	0.04	1	0.12	0.13	0	0.01	0.66	0.73
2	24	sales	1	1	0.94	0.88	0.4	0.81	0.76	0.04	0.9	0.04	0	0.05	1	0.28	0.81	0.5
2	25	proces engineering	0.92	0.86	0.86	0.79	0.92	0.99	0.75	0.78	0.87	0.72	0.13	0.04	0.95	0.82	0.6	0.02
2	26	planning	0.82	0	0.95	0.95	0.93	0.99	0.99	0.72	0.83	0.98	1	0.1	0.35	0.96	0.99	0.05
2	27	procurement	1	1	1	1	1	0.93	1	0.5	1	1	0.98	0.03	1	0.94	0.44	0.01
2	28	project mngt	0.75	0.98	0.51	0.5	0.07	0.76	0.88	0.98	0.98	0.02	0.91	0.01	0.05	0.9	0.9	0.12
2	29	engineering	0.98	0.99	0.95	0.78	0.94	0.97	0.95	0.62	0.71	0.02	0.76	0.57	1	0.03	0.88	0.73
2	30	engineering	0.99	0.79	0.99	1	0.58	0.98	1	1	0.83	0.72	1	0.02	0.09	0.91	1	0.02
2	31	quality control	0.94	0.09	0.95	0.99	0.89	0.74	0.32	0.01	0.07	0.04	0.06	0.21	0.8	0.06	0.82	0.05
2	32	logistics	0.98	1	0.61	0.66	1	0.43	0.99	0.26	0.06	0.94	0.23	0.9	0.99	0.97	1	0.02
2	33	manufacturing	0.04	0.5	0.02	0.28	0.05	0	0.01	0	0	0.27	0.54	0.64	0.33	0	0.49	0.5
2	34	logistics	1	0.88	0.99	1	1	1	1	1	0.99	0.01	1	0.88	0.05	1	0.99	0.01
2	35	controlling	0.04	0	0	0.99	0.93	0.91	0.9	0	0.98	0.06	0.76	0.97	0.45	0.82	0.36	0.05
3	36	logistics	0	0	0.01	0	0	0.48	0	0	0.89	0.58	0.76	0.94	0.87	0.96	0.49	0.01
3	37	manufacturing	0.45	0.31	0.14	0.82	0.42	0.49	0.49	0.59	0.65	0.54	0.95	0.92	0.28	0.93	0.37	1
3	38	maintenance	0.98	0.18	0.97	1	0.89	0.66	0.97	0	0.99	0.77	0.98	0	0.45	0.94	0.89	0.01
3	39	sales backoffice	1	0.5	0.97	1	1	0.87	1	0	0.39	0.98	0.93	0.61	0.98	0.99	0.95	0.01

(continued)

APPENDIX 5.2 (continued)

Firm	Department	Name department	DACAP	DREC	DASS	DTRA	DEXP	MANSTYLE	CULTURE	COORDINATION	PARTICIPATION	ROTATION	FORMALIZATION	ROUTINIZATION	CONNECTEDNESS	SOCIALIZATION	IACAP	SIZE
4	40	sales	0.96	0.5	0.98	0.99	0.73	1	1	0.5	0.98	0.01	0.04	0.03	1	1	1	0.02
4	41	engineering	0.12	0.88	0.09	0.36	0	0.02	0.73	0.96	0.17	0.31	0.05	0.06	0.05	0.54	0.45	0.27
4	42	manufacturing	0	0.05	0	0.05	0	0.03	0	0.75	0.02	0.85	0.77	0.2	0.05	0.15	0.4	1
4	43	quality control	0.13	0.27	0.15	0.5	0.07	0.05	0.67	1	0.6	0.99	0.95	0.99	0.05	0.09	0.45	0.02
4	44	planning	0	0.18	0.01	0.01	0.07	0.03	0.01	0.98	0.76	0.31	0.23	0.88	0.02	0	0.33	0.01
4	45	procurement	0.56	0.99	0.05	0.88	0	0.98	0.61	0	0.39	1	0.93	0.01	0.87	0.99	0.43	0.01
4	46	logistics	0.77	1	0.01	0.95	0.03	0.66	0.04	0.17	0.97	0.89	0.04	0.24	0	0.89	0.24	0.01
4	47	sales back office	0.93	0.95	0.81	0.4	0.98	0.97	0.5	0.98	0.97	0.46	1	0.06	0.7	1	0.65	0.05
4	48	sales engineering	0.9	1	0.05	0.06	0.29	0.43	0.03	0.99	0.52	0.11	0	0.01	0.7	0.01	0.95	0.02

CHAPTER 6

DISCUSSION

6.1 INTRODUCTION

This research originated from the observation that small and medium sized enterprises (SMEs) have difficulties to create breakthrough innovations due to limitations in resources and management attention (Jones, Macpherson & Thorpe, 2010; Rothwell & Dodgson, 1994; Ortega-Argiles, Vivarelli & Voigt, 2009; OECD, 2010). One way to overcome these liabilities of smallness is to engage in collaborations and alliances (Baum, Calabrese & Silverman, 2000; Groen, Wakkee & De Weerd-Nederhof, 2008; Van de Vrande et al., 2009). However, to benefit from these collaborations and alliances SMEs need sufficient ‘absorptive capacity’ (ACAP). ACAP is the ability of a firm to recognize valuable external knowledge, to assimilate it, to transform it and to exploit it, in order to produce an organizational capability (Cohen & Levinthal, 1990; Zahra & George, 2002). Yet, ACAP literature does not provide clear suggestions on how SMEs could improve their ACAP. Therefore the overall research question for this thesis was: *How can small and medium sized enterprises develop their absorptive capacities to improve their innovation performance?*

To answer this research question, one literature review and three empirical studies were conducted during the period from 2008 to 2012, which are described in Chapters 2 to 5. In this final chapter the results of these studies are integrated to provide a coherent answer to the research question. Further the contributions and implications for theory and practice are discussed. Finally, the limitations of this research are addressed and avenues for future research are presented.

6.2 ANSWERING THE RESEARCH QUESTION

In this paragraph the results of the literature review and the three empirical studies are integrated in order to answer the research question of how SMEs develop ACAP to improve innovation performance. In the next sections two strategies to improve innovation performance are discussed. This paragraph concludes with a summarizing model that graphically integrates the results.

6.2.1 Two strategies to improve innovation performance

In Chapter 1 of this thesis is explained that the main assumption in literature is that SMEs need to collaborate with external partners to acquire external knowledge for innovation, in order to overcome their liabilities of smallness and newness. However, to increase the chance for novel products and services SMEs should collaborate with partners from other industries, markets and technological domains. This would give them access to new information and ideas that are different from what is generally known in their current market, which could give these SMEs an advantage over their competitors. In other words, the novelty value of new knowledge increases when it is

provided by partners at larger cognitive distance. Yet, this larger cognitive distance hampers the absorption of the novel knowledge, due to differences between the collaboration partners in (technical) language, culture and problem solving logic. These two counteracting forces of increasing novelty value and simultaneously decreasing effects of absorptive capacity at increasing cognitive distance lead to an inverted U-shape regarding the overall innovation performance (Nooteboom et al., 2007), as is graphically represented in Figure 6.1.

Figure 6.1. A firm's innovation performance, novelty value and absorptive capacity as function of cognitive distance between alliance partners (Nooteboom et al., 2007)

From Figure 6.1 it is concluded that a moderate level of cognitive distance between collaboration partners results in the highest achievable innovation performance. Therefore, the challenge for SMEs that aim to increase their innovativeness is to either increase the novelty value at a certain cognitive distance, or increase their ACAP to engage in collaborations with partners at larger cognitive distance. This PhD research offers suggestions for both strategies.

6.2.2 Strategies to increase novelty

The study in Chapter 3 examined how SMEs recognize new knowledge. In accordance with literature, it was found that SMEs find new knowledge through 'weak ties', which are linkages with external parties that are distant from the firm's own knowledge base (Burt, 1982; Granovetter, 1973). These weak ties are considered a valuable source of novel knowledge as the external parties come from other industries, markets or technological fields (Burt, 2000). The empirical study in Chapter 3 showed that SMEs find new knowledge through weak ties, such as internet, trade fairs, seminars, incidental suppliers and customers. So far, this study supports the widely held assumption that novel knowledge comes from distant partners.

However, the empirical results also show that SMEs acquire new knowledge from business relations that are regarded ‘strong ties’. These are linkages with partners which are frequent, reciprocal and long-lasting and are characterized by high levels of trust and even friendship (Granovetter 1973; Marsden & Campbell, 1984). It shows that the case study firms frequently acquired new knowledge from business partners with which they maintained relationships for more than 15 years, up to even 25 years. This finding is in contrast to the assumed relationship between cognitive distance and novelty, as strong-tie partners are assumed to have frequent interaction, are knowledgeable about each others competences and have developed shared communication routines (Hagedoorn & Frankort, 2008; Uzzi, 1996; Zollo, Reuer & Singh, 2002), hence have a low cognitive distance. So, apparently SMEs are able to acquire novel knowledge from partners with low cognitive distance. In Figure 6.2 this is represented by the arrow that shifts the novelty value-line upwards. As a consequence the firm finds more novel knowledge at shorter cognitive distance, that is within strong ties, which improves innovation performance, leading to an upward shift of the inverted U-shape curve in Figure 6.2.

Figure 6.2: Effects of knowledge acquisition within strong ties on innovation performance

The next question is how SMEs acquire this novel knowledge from strong ties. The study in Chapter 3 provides two conditions that SMEs need to fulfill to acquire new knowledge from these strong ties. First, SMEs need to select alliance partners that are innovative themselves. When alliance partners are innovative, they continually renew and extend their own knowledge bases by recognizing new technological and market opportunities. This implies that these alliance partners have high ACAP which allows them to be at the forefront of new developments. Second, SMEs need to develop and apply so-called ‘bridging capabilities’ to frequently explore and access

their partners' knowledge bases. The establishment of strong-tie relationships with innovative partners is not enough. SMEs need to pro-actively explore the opportunities for new knowledge from their established relationships. To do so, the following bridging capabilities can be developed and deployed, as described in Chapter 3 in more detail:

- systematic meetings with customers and/or suppliers to discuss their latest developments;
- getting reacquainted with customers and/or suppliers beyond their regular business relations;
- intentionally establishing relationships with customers and/or suppliers on multiple organizational and/or departmental levels;
- intentionally establishing relationships with organizations to get access to their large networks;
- exchange of personnel.

The advantages of applying bridging capabilities within strong ties are that SMEs acquire novel knowledge at low cost which does not require very high levels of ACAP, thereby mitigating the liabilities of smallness. As strong ties are characterized by trust and established communication routines, knowledge exchange between the alliance partners is relatively easy. Also, when the new knowledge initially is too complicated to absorb, the alliance partner who provides knowledge is much more willing to assist the knowledge receiver in explaining and understanding the new knowledge. Further, maintenance of established relationships reduces the risks and complexity of alliance portfolio management. For instance, SMEs can focus on the management of just a few key alliances, which enables them to effectively allocate attention to the management of alliances (Draulans, de Man & Volberda, 2003). Further, SMEs do not need to invest in risky and costly processes of searching for new alliance partners and investing in collaboration routines and trust with these new and unknown partners (Zollo et al., 2002). In sum, SMEs can improve their innovation performance through an increase of novelty value at low levels of cognitive distance, by the use of bridging capabilities in strong-tie relationships.

6.2.3 Strategies to increase ACAP

Another strategy to increase innovation performance is to increase SMEs' ACAP. This is mainly the topic of the empirical research in Chapters 4 and 5. In Chapter 4 the characteristics that determine individual ACAP are examined. The study shows that individuals' ACAP depend on three characteristics:

1. *prior knowledge diversity* is the breadth of knowledge individuals develop as result of age, education and work experience. The more diverse one's knowledge base, the easier it is to relate new knowledge to what one already knows (Cohen & Levinthal, 1990). This enables individuals to recognize the value of new knowledge and to combine it with knowledge from others (Shane, 2000; Zahra & George, 2002).
2. *external network diversity* is the breadth of personal contacts that individuals maintain with people outside their own organization, for instance customers, suppliers, universities, family and friends. The more diverse one's external network, the more likely individuals meet people with other interests, ideas and knowledge (Ahuja, 2000; Todorova & Durisin, 2007). This increases the probability to recognize new interesting knowledge.
3. *bisociative cognitive style* is a person's preference to process information and make decisions based on imagination and intuition, and to search for solutions outside disciplinary boundaries (Payne, Lane & Jabri, 1990). This bisociative cognitive style, which is the opposite of associative cognitive style whereby individuals rely on rational thinking and adhere to established rules and methodologies, enables individuals to be creative, think 'out-of-the-box' and to come up with novel linkages between existing and new knowledge (Todorova & Durisin, 2007; Zahra & George, 2002).

In Chapter 2 the literature review on paradoxes of ACAP in SMEs proposed two individual capabilities next to prior knowledge, which are relational capabilities and organizing capabilities. Relational capabilities relate to the extent to which individuals use their external networks to access new knowledge and to expand their network (Freeman et al., 2010; Malik & Wei, 2011). This very much coincides with the external network diversity as a relevant individual antecedent as found in the empirical study of Chapter 4. The organizing capabilities concern the extent to which individuals are able to organize their work in such way that there is sufficient 'strategic space' to allow time for ACAP development and to avoid information overload (Jones et al., 2010; Liao, Welsch & Stoica, 2003). Examples of organizing capabilities are time-management and the ability to delegate tasks and responsibilities.

Thus, increasing prior knowledge diversity, external network diversity and organizing capabilities of employees, and selecting newcomers on their type of

cognitive style are ways to increase an SME's ACAP. Yet, Cohen and Levinthal (1990) also argued that firm-level ACAP is not just the sum of the individual ACAP of its members. Instead, it is a combination of individuals' ACAP and organizational arrangements. This statement led to the third empirical study of Chapter 5 in which the *joint* effects of organizational mechanisms and individuals' ACAP were examined. This study showed that to establish a high level of organizational ACAP high levels of individuals' ACAP are a necessary, yet insufficient condition. Stated otherwise, without high levels of individuals' ACAP there is no high level of organizational ACAP. Therefore SME managers are advised to stimulate development of their employees' knowledge, external networks and cognitive skills.

Further, the study in Chapter 5 showed that there are certain organizational mechanisms that lead to high ACAP in combination with high individuals' ACAP. In general, these mechanisms need to fulfill two functions. First, organizational mechanisms are needed to *enable* employees to share their knowledge across horizontal and vertical intra-organizational boundaries. These mechanisms operate as conduits through which the knowledge can flow, such as formal participation in decision making to facilitate vertical knowledge flows, and routinization, socialization and coordination by teams to facilitate horizontal knowledge flows. Second, organizational mechanisms are required to *stimulate* employees to share knowledge through a supportive management style and an integrative culture.

In sum, an organization's ACAP can be improved in two ways. First, it is achieved by improving the individual ACAP of the SMEs' employees by increasing the diversity of their personal knowledge base, external network and organizing capabilities, and by selecting new employees with bisociative cognitive styles. Second, managers need to develop and maintain social integration mechanisms that enable and stimulate employees to exchange knowledge. The effects of increasing organizational ACAP on innovation performance are graphically illustrated in Figure 6.3. Here the arrow depicts the increase of ACAP. Assuming that the line for novelty value stays the same, increasing ACAP facilitates the acquisition of more novel knowledge, thereby enabling a higher cognitive distance between the alliance partners. This increases the firm's innovation performance as the likelihood for breakthrough innovations increases with access to more novel knowledge.

Figure 6.3: Effects of increased level of organizational ACAP on innovation performance

6.2.4 Contingency factors

The studies also revealed some contingency factors that determine the need for ACAP and the speed of ACAP development. These are discussed below.

Characteristics of knowledge and their providers

In ACAP literature most empirical studies take the knowledge receiving SME as the unit of analysis. The underlying assumption is that the SME is in need for external knowledge to enhance its innovation performance. Yet, the knowledge is acquired from other parties, whose characteristics could affect the knowledge exchange process. One of these partner characteristics is the extent to which partner firms have (dis)similar characteristics as the focal SMEs in terms of cognitive distance, as discussed in the previous sections.

The study on strong ties and knowledge acquisition in Chapter 3 drew attention to another characteristic of the partner firm, next to cognitive distance, which is innovativeness. It was argued that SMEs can access novel knowledge from partners with which they maintained long-lasting relationships, under the condition that these partner firms are innovative themselves. Here, the assumption is that the partner firms have established knowledge sharing routines and mutual understanding, which implies a low cognitive distance. Yet, the partner firm can develop new knowledge over time which then can potentially be accessed by the focal SME. So, the benefits of ACAP of the focal firm also depend on the innovativeness of the knowledge provider.

Further, from the literature review on paradoxes of ACAP in SMEs it is proposed that the ACAP-level of the partner firm determines the need for ACAP at the focal SME. In extant literature it is assumed that an organization needs own

knowledge-creation capabilities to adjust the new knowledge to firm-specific requirements, for instance through own R&D activities (Cohen & Levinthal, 1990). However, the literature review in Chapter 2 showed that knowledge providers that are knowledgeable about the needs and requirements of the focal SME as knowledge recipient can offer knowledge which is tailor-made and does not need further firm-specific adjustments (e.g. Spithoven, Clarysse & Knockaert, 2010). So, under the condition that the knowledge provider has a high ACAP of its own, the focal SME does not need to invest in high ACAP itself.

Besides characteristics of the knowledge provider, the properties of the knowledge itself determine the need for ACAP of the receiving SME. When the knowledge is more complex, tacit or ambiguous, the need for ACAP is higher (Wang & Han, 2011). On the other hand, when the knowledge is less complex, tacit or ambiguous the knowledge, lower levels of ACAP are required (Meeus, Oerlemans & Hage, 2004). In general, the more complex, tacit and ambiguous knowledge the more likely the deployment of the knowledge leads to innovation (Zollo et al., 2002) and competitive advantage (Barney, 1991; McEvily & Marcus, 2005). So, ACAP development is most beneficial when it relates to this complex kind of knowledge.

Determinants of speed of ACAP development

A key characteristic of ACAP which has received little attention in literature so far is that it is cumulative and develops over time. This path-dependent and cumulative character is explicitly addressed by Cohen and Levinthal (1990) and is re-emphasized by Todorova and Durisin (2007) who added a feedback-loop to the conceptual model of Zahra and George (2002). From the literature review of Chapter 2 it is proposed that the speed with which ACAP develops explains why SMEs that initially have low levels of ACAP are able to absorb new knowledge within a short period of time, thereby sometimes outperforming large and established firms with higher levels of ACAP (Freeman et al., 2010; Prashantham & Young, 2011). The results of the review suggest two contingencies that determine the speed of ACAP development in SMEs. First, the speed of ACAP development depends on the need for knowledge and the growth ambition of the top management team. Especially new firms try to benefit from the 'learning advantages of newness' (Autio, Sapienza & Almeida, 2000) with a need for speedy commercialization (Barge-Gil, 2010; Motohashi, 2008). Second, the speed of ACAP development changes over time per specific type of knowledge which is required at that moment. For instance, technology driven start-up firms first might need technological knowledge to achieve a proof of concept or prototype, after which they are in need of market knowledge to find launching customers, and after that they need financial and managerial knowledge to enable large-scale production. So,

dependent on the need for specific types of knowledge over time, SME managers need to adjust their actions to develop ACAP for the right types of knowledge.

6.2.5 Integrated model

The relationships between the results from the Chapters in this thesis are graphically represented in the model of Figure 6.4. Here, the straight lines represent the empirically investigated relationships. The dotted lines are the theoretically assumed relationships, which have not been investigated empirically.

At the center of Figure 6.4 is organizational ACAP. The concept of organizational ACAP is discussed in Chapter 2 where it is applied to the context of SMEs. This chapter showed that ACAP should be considered as a multi-dimensional and multi-level construct. The multiple ACAP dimensions of recognition, assimilation, transformation and exploitation have been examined separately in this research. For instance, the bridging capabilities in Chapter 3 can be regarded as the routines that relate to the recognition dimension of organizational ACAP. Further, in Chapter 5 the joint combinations of individuals' ACAP and organizational mechanisms have been examined for the four ACAP dimensions separately. The configurations for high and low levels of ACAP were different for the four ACAP dimensions, lending support for Zahra and George's (2002) assumption that the dimensions are distinctive.

The upper right-hand side of Figure 6.4 shows that the innovation performance of an SME depends on the interaction between a firm's organizational ACAP and the external knowledge sources (such as customers, suppliers, universities). This moderating relationship, which is represented with arrows (*a*) in Figure 6.4, means that innovation performance depends on a combination of an organization's ACAP and characteristics of the knowledge source and the kind of knowledge exchanged. For instance, high levels of ACAP are beneficial when the external knowledge is new and valuable (Cohen & Levinthal, 1990). In Chapter 2 it was proposed that knowledge which is complex, tacit and ambiguous, often has the potential to create competitive advantage (Barney, 1991). Yet this kind of knowledge generally is difficult to transfer (Szulanski, 1996), hence requires high ACAP to acquire and absorb.

The studies in this research also suggested instances in which *lower* levels of ACAP are sufficient to acquire novel knowledge. For instance, in the study on bridging capabilities in Chapter 3 it is proposed that novel knowledge can be acquired from strong ties when the knowledge source is innovative itself. As strong ties generally are characterized by small cognitive distance, low levels of ACAP are sufficient for SMEs to acquire new knowledge from these ties. Another example of knowledge acquisition by SMEs with low ACAP levels is discussed in Chapter 2. Here it is proposed that external knowledge providers, such as research centers and venture capitalists, are knowledgeable of the needs and requirements of SMEs. Due to the high

ACAP of these knowledge providers, they can provide tailor-made knowledge to the knowledge receiving SMEs, which lowers the need for high ACAP levels at these SMEs. These two examples show how SMEs can overcome liabilities of smallness by selecting alliance partners that have high ACAP and/or are innovative themselves.

Figure 6.4: Integrated model of the empirical and theoretical studies in this thesis

The left-hand side of Figure 6.4 shows the multi-level aspects of the ACAP construct, consisting of individual ACAP and its antecedents on the individual-level, and the social integration mechanisms on the organization-level. From the study in Chapter 5 it is suggested that individual ACAP is a necessary condition for organizational ACAP. In Figure 6.4 this is depicted with arrow (b). Individuals' ACAP concern the behavior and actions of individuals regarding the recognition, assimilation, transformation and exploitation of external knowledge. They depend on individuals' antecedents which were examined in Chapter 4, and which relationship with

individuals' ACAP is depicted with arrow (*c*). From the review in Chapter 2, organizing capabilities were proposed as another individual antecedent for individuals' ACAP. As this antecedent is not examined empirically, it is depicted with the dotted arrow (*d*). In Chapter 4 the effects of individuals' ACAP on their individual innovation performance was examined and showed to be positive, as is indicated by arrow (*e*).

For SMEs, especially for very small firms, the direct relationship between individuals' ACAP of the founders or top management team and the organization's ACAP is rather obvious (e.g. Hayton & Zahra, 2005; Descotes & Walliser, 2011). However, when organizations grow, the need for social integration mechanisms becomes apparent. The multi-level study in Chapter 5 shows that the joint combination of individuals' ACAP and social integration mechanisms determines organizational ACAP, which is illustrated with arrow (*f*) in Figure 6.4. This is in line with the suggestion of Cohen and Levinthal (1990) that ACAP is not the mere sum of individuals' ACAP, but that organizational mechanisms are required to link these individuals.

At the top of Figure 6.4 the dotted arrow (*g*) from innovation performance to social integration mechanisms and individual antecedents represents the cumulative character of ACAP over time (Todorova & Durisin, 2007). This feedback loop also represents the 'speed of ACAP development' which is determined by the need for knowledge acquisition, the growth ambition of the top management and the type of knowledge required, as discussed in Chapter 2.

6.3 IMPLICATIONS FOR THEORY

6.3.1 A refined conceptual model of ACAP

The findings of the theoretical and empirical studies in this thesis, as graphically summarized in Figure 6.4, have several implications for ACAP theory. The main implications are illustrated in the conceptual model of Figure 6.5, in which the grey-colored components represent the contributions of this PhD research to ACAP literature¹². The model in Figure 6.5 is based on the model of Todorova and Durisin (2007) which is a refinement of the original model of Zahra and George (2002), which are both explained briefly in Appendix 6.1. The implications of this PhD research for ACAP theory relate to the 1) characteristics of external knowledge sources as an additional contingency factor, 2) the addition of individuals' ACAP as antecedent on ACAP in combination with social integration mechanisms, 3) further refinement of social integration mechanisms, and 4) the activation triggers that determine the speed of ACAP development.

¹² In line with the definition of ACAP in Chapter 1 the four ACAP dimensions in Figure 6.5 are recognition, assimilation, transformation and exploitation

Figure 6.5: Refined conceptual model of ACAP

Characteristics of external knowledge sources

Both Zahra and George (2002) and Todorova and Durisin (2007) regarded external knowledge sources as an antecedent of ACAP. This stems from the input-process-output view on ACAP in which external knowledge sources deliver the input for ACAP, in the form of external knowledge, which is processed through ACAP, and results in outputs which might lead to competitive advantage. The studies in this PhD research suggest that external knowledge sources also can be considered an additional contingency factor on ACAP processes besides their function as suppliers of new knowledge. This is depicted in Figure 6.5 as an interacting relationship with ACAP which leads to higher competitive advantage. This additional relationship is motivated in three ways.

First, the first dimension of ACAP is recognition, which includes the search for new knowledge sources. This implies that the extent to which the firm has developed ACAP determines this search and its subsequent finding of external knowledge sources. Only after the search process, the new knowledge can be acquired as input for further processing. Thus, firms first need ACAP before knowledge from external sources can be acquired (Cohen & Levinthal, 1990). This implies a more complex relationship between ACAP and knowledge sources, than the assumed sequential relationship of input-process-output.

Second, to explain how ACAP leads to better firm performance the characteristics of external knowledge sources need to be taken into account. Not every external knowledge source provides valuable knowledge. For instance, the study in Chapter 3 showed that the more innovative the external partner, the more likely it provides novel knowledge, which in combination with high ACAP leads to better innovation performance. Further, the innovativeness of the knowledge source and high ACAP of the focal firm is not sufficient for knowledge exchange. The external partner also needs to be willing to provide the new knowledge (O'Dwyer & O'Flynn, 2005; Szulanski, 1996). Accordingly, the extent to which high ACAP leads to competitive advantage depends on contingencies that relate to specific characteristics of the external knowledge sources.

Third, the study in Chapter 2 showed that SMEs with low ACAP can benefit from knowledge which is provided by knowledge sources with high ACAP, such as research centers, trade associations and venture capitalists. In these situations, the external source substitutes for the lack of own ACAP, and therefore cannot be regarded as a knowledge source as input for ACAP processes. On the contrary, the tailor-made external knowledge from these sources can be used almost instantly by the SME and therefore is easily integrated with other knowledge, some of which results from ACAP processes, to build organizational capabilities that create competitive advantage.

In sum, this research highlights the relevance of characteristics of external knowledge sources for the effects of ACAP on firm outcomes. These external sources are not merely the providers of new knowledge as input for ACAP processes. They also determine the type of knowledge and the extent to which this knowledge is exchanged. So far, extant literature has focused on the knowledge recipient and its ACAP, thereby largely neglecting the knowledge provider. The results of this PhD research suggest more research attention for the role of these external knowledge sources.

Extending the model with individuals' ACAP

One of the main implications of this PhD research is the extension of the conceptual model of ACAP with individuals' ACAP. Although both Zahra and George (2002) and Todorova and Durisin (2007) acknowledged the importance of individuals in the ACAP construct and encouraged further research on this topic, they did not explicitly include individuals in their conceptual models. In Figure 6.5 individuals' ACAP is added as an antecedent for firm-level ACAP and its underlying four dimensions. This PhD research shows that individuals not only need to be regarded as a prior knowledge repository as input for ACAP processes, as is often assumed in extant literature. Instead, individuals are important drivers of knowledge search through personal networks, of creative processes through their cognitive abilities, and of innovative

activities through their organizing capabilities. These individuals' characteristics explain differences in levels of individuals' ACAP and therefore need to be accounted for in future ACAP research.

Unraveling social integration mechanisms

Whereas Zahra and George (2002) only focused on the role of social integration mechanisms between the processes of assimilation and transformation, Todorova and Durisin (2007) argued that social integration mechanisms affect all four dimensions of ACAP. The latter has been empirically supported by Jansen, Van den Bosch and Volberda (2005) who showed how social integration mechanisms affected the four dimensions differently. The study in Chapter 5 extends the findings of Jansen et al. (2005) in three ways. First, it showed that social integration mechanisms complement individuals' ACAP in building organizational ACAP. Second, the study highlights two different functions of social integration mechanisms, which are enabling and motivating knowledge exchange. Third, the study shows equifinality in combinations of social integration mechanisms with individuals' ACAP, indicating that there are multiple ways to achieve high ACAP levels. These findings enhance understanding of micro-foundations to build and develop organizational ACAP, and provide explanations on how firms differ in their ways to achieve competitive advantage.

Activation triggers of speed of ACAP development

The review in Chapter 2 highlighted the relevance of time as explanation for the development of ACAP in SMEs. These SMEs were able to acquire external knowledge despite their initial low level of prior knowledge and experience, due to the speed with which they developed ACAP. This dynamic aspect of ACAP was explicitly recognized by Todorova and Durisin (2007), who added a feedback-loop to the original model of Zahra and George (2002). This PhD research not only emphasizes the importance of development speed of ACAP to explain differences in firm performance, it also addresses the activation triggers that determine the speed of ACAP development. These activation triggers are the need for external knowledge as result of the growth ambition of the top management team, and as result of the life-cycle stage of the firm. These findings suggest that future longitudinal studies on ACAP processes should take account of these activation triggers.

6.3.2 Micro-foundations of ACAP

This PhD research used a micro-foundations lens to examine the assumptions that underlie ACAP processes and routines. As discussed in Chapter 1, the micro-foundations stream originated from critiques on organization-level studies that neglected heterogeneity at the individual-level (e.g. Abell, Felin and Foss, 2008; Felin

& Hesterly, 2007). Although initially the focus of micro-foundations was restricted to individuals' actions and interactions only, more recently their interactions with organizational processes and structures are included into the micro-foundations domain (Felin et al., 2012; Hodgson, 2012). The study in Chapter 5 on the joint interaction of individuals' ACAP and social integration mechanisms empirically supports this recent development in micro-foundations literature. As explained earlier, the study shows that individuals' ACAP is a necessary, yet insufficient, condition for ACAP and that it needs to be complemented with organization-level social integration mechanisms.

In turn, the study in Chapter 5 empirically supports Cohen and Levinthal's (1990) assumption that organizational ACAP is more than the sum of the individuals' ACAP. Although Cohen and Levinthal (1990) explicitly acknowledged the importance of individuals' ACAP for organization-level ACAP, their main focus was on the organizational mechanisms to facilitate knowledge exchange. However, the results of this PhD research suggest a more prominent role for individuals as key building blocks of ACAP as it appears a necessary condition for organization-level ACAP. These findings relate to SMEs as these were the focus of this research. The question arises whether individuals' ACAP as necessary condition for organizational ACAP also holds for large firms. Could it be that in SMEs individuals' ACAP are more important, as in smaller firms individuals' actions relatively have more impact on organizational outcomes, while in large firms social integration mechanisms are more relevant for ACAP, as is implicitly suggested by Cohen and Levinthal (1990)? More research is needed to further unravel the inter-relationships between individuals' ACAP and social integration mechanisms.

The focus on individual-level factors of ACAP leads to specific attention regarding the role of managers in ACAP development. Although some empirical work has been done on the effects of managerial actions on firm-level ACAP (Jones, 2006; Hayton and Zahra 2005, Lenox & King, 2004), the managerial antecedents of ACAP are still unclear (Volberda, Foss and Lyles, 2010). The study on individual ACAP in Chapter 4 contributes to a better understanding of these managerial dynamic capabilities (Adner & Helfat, 2003). It shows that managers have higher individual ACAP compared to non-managers and that a higher individual ACAP is associated with higher levels of prior knowledge diversity, external networks, and a bisociative cognitive style. These findings empirically support Adner and Helfat's (2003) key characteristics of managerial dynamic capabilities: human capital (prior knowledge), social capital (external networks) and managerial cognition (bisociative cognitive style). The findings also extend earlier research which mainly focused on prior knowledge of top management team members (e.g. Hayton & Zahra, 2005) by adding network diversity and cognitive style as managerial antecedents.

The high level of individual ACAP of managers in combination with the necessary condition of high individual ACAP for high organizational ACAP suggests that managerial antecedents are important determinants of organizational ACAP. For instance, the empirical study of Wang, Wang and Horng (2010) on ACAP in Taiwanese SMEs showed that an owner's prior knowledge was more important for the firm's ACAP than the prior knowledge of its R&D staff. Yet, when providing suggestions on how to influence these managerial antecedents, the question arises whether these managerial antecedents are determined by the individuals' characteristics or by the organizational context. Do managers have high individual ACAP due to their social skills to maintain a large personal network, or is the large personal network the result of their managerial position in which they act as an intermediary between organization and its environment? This question relates to the debate in micro-foundations literature on the primacy of levels in cross-level interactions: does organization-level factors affect individual-level factors, or is it the other way around?

Advocates of the primacy of the organization-level are found in the 'methodological collectivism' tradition that argues that individual action is socially constructed (e.g. Brown & Duguid, 2001; Spender, 1996; Tsoukas, 1996). From this stream it can be understood that individuals' positions within organizations determine their behavior, and the subsequently their opportunities to develop individual ACAP. For instance, managers are boundary spanners by position as they link hierarchical levels, and operate as contacts for external sources. This organizational position enables them to build a large personal network and to expand their knowledge base, which increases the likelihood to encounter novel knowledge. Thus, organization-level factors shape individual-level antecedents and actions of ACAP.

In contrast, supporters of the 'methodological individualism' tradition argue that organizations are a collection of individuals who differ in cognitive abilities and intelligence, and should be considered the locus of knowledge creation (e.g. Abell et al., 2008; Felin & Hesterly, 2007; Simon, 1991). From this perspective, the study in Chapter 4 showed that employees differ in bisociative cognitive style, which explains differences in ACAP activities. In turn, these individuals' actions affect ACAP at the organization-level, as is shown in the study of Chapter 5.

The study of micro-foundations inherently confronts the researcher with these two conflicting theories. Although it seems that a kind of consensus is found that both theories apply (e.g. Felin et al., 2012; Hodgson, 2012), in empirical studies the researcher needs to address these issues regarding endogeneity, such as reversed causality. This reversed causality problem is even more apparent in ACAP studies through the path-dependent and cumulative character of ACAP. ACAP literature explicitly assumes a recursive process in which individuals exchange knowledge,

thereby enriching their own knowledge base and that of the organization, which forms the prior knowledge base for the next ACAP cycle (Cohen & Levinthal, 1990). This is why Todorova and Durisin (2007) emphasized the dynamic character of ACAP and introduced a feedback-loop in the conceptual model, making the cause-effect relationship between antecedents and processes more complex. However, as they stated (2007: 783) ‘Lacking this more complex view of causality, the analytical models of absorptive capacity (Cohen & Levinthal, 1990; Zahra & George, 2002) do not correspond to their descriptive ideas of how absorptive capacity functions’.

Accordingly, the study of micro-foundations in general, and that of ACAP in particular, calls for specific attention to research methodologies and analytical techniques. In general, reversed causality can be addressed through the use of panel data sets (instead of cross-sectional data) or the use of an experiment (Echambadi, Campbell & Agarwal, 2006). In Chapter 5 the method of Qualitative Comparative Analysis was used to address reversed causality, as it does not make inferences about the causal direction between variables. However, in Chapter 4 the endogeneity issue is not fully solved as it relates to cross-sectional data and applies structural equation modeling techniques which assume one-directional cause-and-effect relationships. The aforementioned discussion highlights the need for awareness of scholars that micro-foundations of ACAP inhibit causal complexity which needs to be accounted for.

6.4 IMPLICATIONS FOR PRACTICE

This study aimed to provide guidelines for SME managers on how to enhance their firm’s ACAP, in order to improve innovation performance and their competitive position. As explained in paragraph 6.2 the results show that there are two ways to improve innovation performance through collaborations: 1) increase novelty of knowledge acquisition within established relationships by the application of bridging capabilities, and 2) develop ACAP to enable collaborations with partners at larger cognitive distance.

To acquire new knowledge from established relationships, managers can develop 'bridging capabilities' by a) systematic meetings with customers and/or suppliers to discuss their latest developments, b) getting reacquainted with customers and/or suppliers beyond their regular business relations, c) intentionally establishing relationships with customers and/or suppliers on multiple organizational and/or departmental levels, d) intentionally establishing relationships with organizations to get access to their large networks, and e) exchange of personnel. However, as the study in Chapter 3 shows, the collaboration partner needs to be innovative to ensure sufficient new knowledge development over time. So, managers should take the

overall innovativeness of a potential collaboration partner into account when selecting alliance partners.

To develop ACAP this study suggests that three factors need to be present simultaneously: 1) high individual ACAP, and social integration mechanisms to 2) enable and to 3) motivate employees to acquire and exchange knowledge. High individual ACAP is achieved by a) investing in individuals' knowledge breadth, for instance through training and education, by b) supporting development of diverse networks, for instance through sending employees to trade-fairs and network meetings, or by c) hiring new employees with a bisociative cognitive style. Having employees with high individual ACAP appeared to be a necessary yet insufficient condition. Managers also need to create the conditions under which employees are able and motivated to recognize and exchange new knowledge.

For creating these conditions there are no clear normative guidelines. The results of this research show that there is equifinality in the ways to create these conditions. For instance, a high level of organizational ACAP can be achieved in two ways, either through the combination of high individual ACAP *and* high participation *and* supportive management style *and* an integrative culture, or through the combination of high individual ACAP *and* low routinization. These two solutions leading to the same outcome of high organizational ACAP offers managers the possibility to choose the best 'path' to account of the firm-specific situation. For instance, consider ACAP development in a production department in which routinization is high to achieve high efficiency. According to extant literature the manager that strives for high ACAP would have a problem as high routinization is associated with low ACAP (e.g. Jansen et al., 2005). However, the equifinality in solutions for high ACAP offers the manager another option, which is to invest in the combination of individuals' ACAP, participation, management style and culture. So, the manager is presented two alternatives which lead to the same outcome but have different implications for the allocation of organizational resources. An overview of the combinations of factors that lead to high or low ACAP was presented in Table 5.8 in Chapter 5.

Further, from the literature review in Chapter 2 it is understood that the focus of ACAP development within the SME might shift over time. For instance, when the SME develops a new product, ACAP activities need to focus on technological knowledge which might require contacts with universities. Here the cognitive distance between the SME and the universities could be large, due to differences in language, goals, business models and problem solving logic. So, SMEs need to increase their ACAP, for instance by hiring employees with an academic background, by attending academic conferences and by engaging in scientific research. Then, when the newly developed product needs to be commercialized SMEs need to understand the new

market and its potential customers. Here, SMEs can apply ACAP activities such as hiring a market consultancy bureau, attending trade-fairs and meeting potential customers. From this example it follows that managerial decision making regarding ACAP development depends on the life-cycle of the firm and its products or services. Therefore managers need to be aware of these changes associated with the different life-cycle stages and need the flexibility to change ACAP routines and processes accordingly.

6.5 LIMITATIONS AND FUTURE RESEARCH

This study is not without limitations. First, it is based on multiple case studies in eight Dutch industrial SMEs. It is obvious that generalizations should be made with caution. The eight Dutch SMEs cannot be considered as a representative sample of Dutch industrial SMEs, nor of firms in other sectors or in other countries. Due to the research approach the cases were selected based on their willingness to participate in this study as it required serious investments in organization and time for the company-wide survey and interviews with multiple respondents within the firm. Further, the results of this study apply to SMEs, although the theoretical implications are expected to hold for large firms as well, for instance regarding the causal complexity of ACAP. Yet, applying the results on large firms should be done with care. For instance, the effects of social integration mechanisms on individuals and organizational capabilities are likely to be different for large firms and SMEs. One could think of the effects of horizontal coordination which is more likely to be an important factor for high ACAP in large firms compared to SMEs where communication can be more informal. Furthermore, as theory on micro-foundations assumes that organizational performance is affected by individual-level and organizational-level factors, this performance is also affected by higher-level factors, such as industry dynamics. The focus in this research on one industry reduces the variance in higher-level effects on organizational factors which makes comparisons across cases more reliable, but reduces the generalizability of the results beyond this industry. Therefore, future research in other industries, in larger firms and with larger sample sizes are recommended to further explore the micro-foundations of ACAP.

A second limitation relates to the use of fuzzy set Qualitative Comparative Analysis (fs/QCA) to identify configurations that lead to high and low ACAP. As explained in Chapter 5 fs/QCA has many advantages to deal with causal complexity, which is conceptually embedded in the ACAP construct. Yet, a disadvantage is that fs/QCA does not inform about the relative importance of the conditions that are included in the configuration. So, here lies an interesting research opportunity in which configurational approaches and more traditional statistical analysis techniques could

complement each other. For instance, based on mid-sized samples one could determine which conditions in combination lead to which configurations. Then in another large-scale study, one could examine the individual effects of these factors within a configuration. This two-step approach takes account of the causal complexity of relationships, and informs about the relative relevance of these relationships.

Another limitation relates to the characteristics of knowledge. In the empirical studies of this PhD research knowledge was treated as a broad concept, including information, data, ideas and insights. However, from the literature review it is proposed that the properties of knowledge (like complexity, tacitness and ambiguity) and the kind of knowledge (market, technological, managerial) affect the need for ACAP. Further research is needed to get better insight into the effects of these knowledge properties on individuals' and organizational ACAP.

Furthermore, this research has not empirically examined the effects of ACAP on innovation performance, as is illustrated with the dotted arrow (*a*) in Figure 6.4. The dependent variable in the empirical studies of Chapters 3 and 5 was organizational ACAP. Although this addresses the call of Volberda et al. (2010) to study ACAP as a dependent variable, more research is needed on the mediating effect of ACAP between its antecedents and firm-level outcomes such as innovation performance and long-term competitive advantage.

This PhD research provides opportunities for future research in two more ways. First, the complexity of ACAP as a multi-dimensional, multi-level and path-dependent construct needs further understanding. This requires research approaches that complement the traditional statistical regression methods. This PhD research showed in Chapter 5 how a configurational approach can be applied to take causal complexity of the ACAP construct into account. However, this configurational approach also has its limitations. Therefore, studies that combine research approaches that use their strengths to compensate the weaknesses of each other are recommended. For instance, a large scale study on the joint effects of organizational and individual factors could identify configurations by using Qualitative Comparative Analysis. Then, to examine the relative importance of the factors on the outcome, statistical techniques such as regression analysis or structural equation modeling could be applied. Further, configurational approaches could also inform scholars and practitioners on the relative importance of the four ACAP dimensions - recognition, assimilation, transformation and exploitation - regarding firm-level outcomes. For instance, Zahra and George (2002) and Jansen et al. (2005) argued that differences in firm performance could be explained by different levels of ACAP dimensions. Configurational research methods could be used to examine this further.

Second, the development of a measurement-scale of individuals' ACAP offers new research directions to understand the micro-foundations of ACAP. In this

research, only a few antecedents of individuals' ACAP were examined concerning prior knowledge, personal networks and cognitive style. Yet, there are other factors at the individual-level that could affect individuals' ACAP, such as organizing capabilities, strategic orientation or personality traits. Further, individuals' ACAP is also influenced by organization-level factors. The study in Chapter 4 showed that a person's organizational position, such as a manager, affects his or her individual ACAP. This is in line with the collectivist research stream which assumes that human behavior and learning is internalized from the social context (Spender, 1996). So, organizational mechanisms affect ACAP in two ways. First, these mechanisms affect individuals' behavior towards ACAP activities, which is assumed but not examined in this PhD research. Second, these mechanisms determine organizational ACAP routines in joint combination with individuals' ACAP activities, as shown in Chapter 5. In turn, future research on organizational antecedents of ACAP should account for these two different effects to determine 'what aspects of absorptive capacity are distinctly organizational' (Cohen & Levinthal, 1990: 131).

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APPENDIX 6.1 Models of Zahra and George (2002) and Todorova and Durisin (2007)

Model of Zahra and George (2002)

The model of ACAP of Zahra and George (2002) is presented in Figure 6A1. ACAP is conceptualized as four dimensions which can be combined into two higher-order constructs. 'Potential ACAP' (PACAP) is composed of the capabilities acquisition and assimilation of new knowledge, which might offer firms timely access to a diverse set of new knowledge, that can contribute to the firm's strategic flexibility. 'Realized ACAP' (RACAP) is composed of the capabilities transformation and exploitation, which are associated with the application of knowledge in new products and services, therefore contributing to the firm's innovation performance.

Figure 6A1: Model of Zahra and George (2002)

Knowledge diversity and complementarity of external knowledge sources are considered antecedents for ACAP as these increase the likelihood of exposure to new knowledge. Further, the level of prior knowledge and experience determine the locus and direction of external knowledge search. This relates to the path-dependent character of ACAP, which assumes that new knowledge is primarily searched for in domains with which the firm is familiar or in which it has achieved earlier successes.

Activation triggers moderate the effects of knowledge sources on ACAP development. The kind of internal or external activation trigger influences the kind of knowledge searched for, while the intensity of the activation trigger affects the investments made in developing ACAP.

The social integration mechanisms are needed to promote the sharing and integration of knowledge across organizational units' boundaries. Zahra and George (2002) propose that social integration mechanisms are needed to link PACAP to RACAP. The extent to which this is achieved determines the efficiency of ACAP.

Finally, the regimes of appropriability determine the extent to which firms are able to protect the advantages of new products and processes. They moderate the competitive advantage that can be achieved from ACAP. Under strong regimes of appropriability there are few knowledge spill-overs, which implies that high ACAP will lead to competitive advantage through high imitation costs by others. When appropriability regimes are weak, high ACAP only leads to competitive advantage when firms use other mechanisms to protect their knowledge. Otherwise, the likelihood of knowledge leakage will ease imitation by others.

Model of Todorova and Durisin (2007)

The model of Todorova and Durisin (2007) is presented in Figure 6A2. They refined and extended Zahra and George's (2002) model in the following ways.

Figure 6A2: Model of Todorova and Durisin (2007)

The four dimensions of ACAP are extended with a fifth dimension: 'recognition'. Todorova and Durisin (2007) argued that recognition is the first step of ACAP, as was originally intended by Cohen and Levinthal (1990). They state that identifying and understanding the value of knowledge precedes the acquisition of the knowledge, and that these processes need specific attention. Further, they argued that

assimilation and transformation are not sequentially ordered, as assumed by Zahra and George (2002), but interact with each other, depending on the novelty of the external knowledge and the need to change existing cognitive frames. According to Todorova and Durisin's (2007) assimilation is used when new knowledge relates to exiting knowledge in such way that cognitive schemas do not need to be changed. However, when new knowledge does not fit existing cognitive frames, the process of transformation is needed to absorb the new knowledge.

In contrast to Zahra and George's (2002) assumption that social integration mechanisms affect the relation between PACAP and RACAP, Todorova and Durisin (2007) argue that knowledge transfer exists between all dimensions of ACAP and therefore that social integration mechanisms affect all ACAP dimensions. Further, they propose that social integration mechanisms affect the ACAP dimensions differently.

Further, in addition to Zahra and George (2002), Todorova and Durisin (2007) argued that regimes of appropriability also affect the availability of new knowledge as input for ACAP. In turn, a weak appropriability regime would be beneficial for ACAP as it offers opportunities to acquire and apply new knowledge. This positive effect of weak appropriability regimes on ACAP is in contrast with its negative effect on the outcome of ACAP, as proposed by Zahra and George (2002). Todorova and Durisin (2007) suggest further research on this issue.

Power relationships are added as antecedents to the model of Zahra and George (2002). Todorova and Durisin (2007) argue that intra-organizational power relations determine the resources that are allocated to exploit new knowledge, thereby explaining why some firms benefit from new external knowledge, and why others fail. Furthermore, they state that external power relations determine the locus of search for new knowledge. For instance, powerful customers might claim too much attention to existing business, thereby inhibiting firms to explore new business opportunities.

Finally, Todorova and Durisin (2007) add a feedback-loop between the new absorbed knowledge (as output) and the prior organizational knowledge (as input) to emphasize the path-dependent and cumulative character of ACAP.

SUMMARY

Research problem

Innovation is important for long-term survival of small and medium sized firms (SMEs). However, due to their smallness and newness, SMEs encounter specific challenges to engage in innovation activities. These challenges relate to limitations in resources, management attention and capabilities. To circumvent these limitations, SMEs engage in collaborations with external partners, such as suppliers, customers, universities and competitors. However, to benefit from these collaborations SMEs need sufficient ‘absorptive capacity’ (ACAP), which is the ability of a firm to recognize the value of external knowledge, to assimilate it, to transform it, and to exploit it, in order to produce an organizational capability. ACAP enables firms to acquire novel knowledge and to use it to create breakthrough innovations, which will lead to sustainable competitive advantage and long-term survival.

However, extant ACAP literature assumes that SMEs have *low* ACAP and encounter difficulties in developing it, due to the same liabilities of smallness and newness that urge SMEs to engage in collaborations and to develop ACAP to benefit from these collaborations. In contrast, literature shows empirical evidence that SMEs are successful in collaborations with external partners and create breakthrough innovations, which would imply that they have *high* ACAP. Thus, paradoxes arise when ACAP literature is applied to SMEs. The aim of this research is to resolve these paradoxes and to provide suggestions on how SMEs can improve their ACAP. Therefore, the research question that guides this research is: How can small and medium sized enterprises develop their absorptive capacities to improve their innovation performance?

Theoretical perspective

In this research a theoretical perspective of ACAP as dynamic capability is chosen. The dynamic capability literature builds on the resource based view, which assumes that firms achieve sustainable competitive advantage through the development and deployment of their resources. In resource based literature, knowledge is regarded a key resource that can provide firms with sustainable competitive advantage. Yet, the possession of such resources is not sufficient for competitive advantage. The dynamic capabilities literature suggests that firm performance is determined by the ability to integrate, build and renew internal and external competences to address changing environments. This dynamic capability perspective on ACAP provides opportunities to study the processes and routines of ACAP and their underlying factors.

These underlying factors are denoted ‘micro-foundations’, which are the individual and organizational factors that determine the creation of organization-level routines and capabilities. Better insight into these micro-foundations will enhance understanding of underlying assumptions of the ACAP theory, thereby providing answers to the research question on how SMEs can develop their ACAP.

Research approach

This research consists of one systematic literature review and three empirical studies. The literature review takes stock of extant ACAP literature regarding SMEs. Further, the study identifies four paradoxes that arise when key assumptions of ACAP theory are applied to SMEs, provides suggestions to resolve the paradoxes, and derives propositions and a research agenda.

The research setting for the three empirical studies is the manufacturing industry in the Eastern part of The Netherlands. To study the micro-foundations of ACAP a qualitative multiple case-study approach is combined with quantitative research methods. The first empirical study examines the routines that SMEs use to recognize and acquire new knowledge from external partners. Twenty interviews are taken in four technology-oriented SMEs of which data is examined through coding of the qualitative data and through within-case and cross-case analysis. The second empirical study investigates the antecedents, outcomes and dimensions of individuals’ ACAP, which is regarded a key micro-foundation of ACAP. A survey is administered among 147 employees of a Dutch kitchen manufacturer. Data is analyzed using structural equation modeling using Partial Least Squares (PLS) to account for formative measures, relatively small sample size and non-normal distribution of the data. The third empirical study explores the joint effects of individual and organizational factors on ACAP. A combination of qualitative and quantitative research methods is used. A survey is administered among 297 employees of four manufacturing SMEs to assess organizational ACAP of 48 departments within these four firms. To explore the joint and multi-level relationships of individual ACAP (at the individual level) and social integration mechanisms (at the departmental-level) on departmental ACAP, a configurational approach is used to account for sample size and causal complexity. The data is analyzed with fuzzy-set Qualitative Comparative Analysis (fs/QCA) to find combinations of individuals’ ACAP and social integration mechanisms that jointly determine the level of departmental ACAP.

Results

The research shows two strategies for SMEs to improve their innovation performance through collaborations with external partners. First, in contrast to extant literature, this study shows that novel knowledge is not only found by creating linkages with new and

distant sources, so-called ‘weak ties’, but that novel knowledge is also found in long-lasting and trusted relationships or ‘strong ties’. SMEs can acquire new knowledge from strong ties through the use of ‘bridging capabilities’, by which they pro-actively and systematically explore their collaboration partners’ knowledge base. The study identifies the following bridging capabilities:

1. systematic meetings with customers and/or suppliers to discuss their latest developments;
2. getting reacquainted with customers and/or suppliers beyond their regular business relations;
3. intentionally establishing relationships with customers and/or suppliers on multiple organizational and/or departmental levels;
4. intentionally establishing relationships with organizations to get access to their networks;
5. exchange of personnel.

Through the use of these bridging capabilities, SMEs do not need to develop high ACAP as strong ties are characterized by trust and communication routines that ease knowledge exchange. Further, SMEs can focus on the management of just a few alliances, thereby reducing costs and time spend on alliance management. In sum, developing and deploying bridging capabilities mitigate the liabilities of smallness and newness by reducing the need for high ACAP through exploration and exploitation of existing relationships.

Second, this research shows how SMEs can increase ACAP to acquire novel knowledge for innovation processes. To establish high ACAP a necessary, yet insufficient, condition is that employees have high individual ACAP. This individual ACAP depends on four characteristics:

1. prior knowledge diversity: this is the breadth of knowledge individuals develop as result of age, education and work experience. The more diverse one’s knowledge base, the easier it is to relate new knowledge to what one already knows, which eases recognition of new knowledge and combination with knowledge from others.
2. external network diversity: this is the breadth of personal contacts that individuals maintain with people outside their own organization. The more diverse one’s external network, the more likely individuals meet people with other interests, ideas and new knowledge.
3. bisociative cognitive style: this is a person’s preference to process information and make decisions based on imagination and intuition, and to search for solutions outside disciplinary boundaries. This enables individuals to be creative, think ‘out-of-the-box’ and to come up with novel linkages between existing and new knowledge.

4. organizing capability: this is a person's ability to organize work in such way that there is sufficient 'strategic space' to allow time for ACAP development and to avoid information overload, for instance through time-management and delegation of tasks and responsibilities.

To develop high ACAP SMEs need to establish social integration mechanisms to complement individuals' ACAP. These social integration mechanisms have two functions. The first function is to enable knowledge exchange between organizational levels and units. Doing so, social integration mechanisms operate as the conduits through which knowledge is exchanged among employees, such as participation in decision making, routinization, socialization and coordination through multi-disciplinary teams. The second function is to stimulate employees to share knowledge, for instance through a supportive management style or an integrative culture. The research further shows that there are multiple configurations of social integration mechanisms that, combined with individuals' ACAP, lead to high or low ACAP. This indicates that there is 'no best way' and that managers have alternative ways to develop organizational ACAP.

The research also addresses contingencies that determine ACAP development. While ACAP literature mainly focusses on the knowledge recipient, this research emphasizes the relevance of selecting the right knowledge provider. The innovativeness and ACAP-level of the external partner appears to be a relevant condition for an SME's need to invest in developing its own ACAP. Further, the drivers for fast ACAP development depend on the strategy and growth ambition of the top management team and the SME's life-cycle stage.

Contributions to theory and practice

This research extends and refines ACAP literature in four ways. First, it highlights the relevance of characteristics of external knowledge sources for the development of ACAP. These external sources not only provide knowledge as input for ACAP processes, but also determine the extent to which SMEs need to develop ACAP themselves. Second, this research extends ACAP theory by explicitly introducing individuals' ACAP as a key antecedent for ACAP, through developing a measure for it, and examining its outcome and three of its antecedents. Third, the effects of social integration mechanisms on the dimensions of ACAP are better understood. They complement individuals' ACAP to build organizational ACAP, and need to fulfill two functions simultaneously: to enable and to stimulate knowledge exchange. Furthermore, equifinality in configurations of these social integration mechanisms highlights the causal complexity of micro-foundations which has implications for future conceptual and empirical studies. Fourth, the research emphasizes the relevance

of time as an explaining factor for differences in ACAP between firms. Accounting for the path-dependent and cumulative character of ACAP further increases its causal complexity.

For practitioners, this research provides suggestions on how to benefit from collaborations. Two strategies are suggested. The first strategy concerns the development of bridging capabilities to acquire novel knowledge from existing partners. The second strategy is to develop ACAP in order to absorb novel knowledge from new and more distant partners. SME managers are advised to invest simultaneously in the development of individuals' ACAP and in social integration mechanisms to enable and stimulate knowledge exchange.

SAMENVATTING

Probleemstelling

Innovatie is belangrijk voor middelgrote en kleine bedrijven om hun bestaansrecht op langere termijn te garanderen. Echter, als gevolg van hun beperkte omvang en soms jonge leeftijd krijgen deze bedrijven te maken met bijzondere uitdagingen ten aanzien van innovatie. Deze uitdagingen ontstaan doorgaans door beperkte middelen, capaciteiten en managementaandacht. Een mogelijke oplossing voor deze beperkingen is het aangaan van samenwerkingsrelaties met leveranciers, klanten, universiteiten en concurrenten. Echter, om profijt te hebben van deze samenwerkingsrelaties hebben middelgrote en kleine bedrijven *absorptive capacity* nodig, ofwel kennisabsorberend vermogen. Dit is het vermogen van een organisatie om de waarde van externe kennis te herkennen, om vervolgens deze kennis te assimileren, te transformeren en te gebruiken, om een organisatiecompetentie te ontwikkelen. Dit kennisabsorberend vermogen stelt bedrijven in staat om nieuwe kennis eigen te maken en te gebruiken voor baanbrekende innovaties die bijdragen aan blijvend concurrentievoordeel en het voortbestaan op lange termijn verzekeren.

Echter, bestaande literatuur over kennisabsorberend vermogen veronderstelt juist dat middelgrote en kleine bedrijven een *laag* kennisabsorberend vermogen hebben en problemen hebben om dat vermogen te ontwikkelen, juist als gevolg van hun beperkingen die te maken hebben met hun geringe omvang en jonge leeftijd. Dit zijn dezelfde beperkingen die deze bedrijven het hoofd proberen te bieden door samenwerkingsrelaties aan te gaan en waarvoor ze dat kennisabsorberend vermogen juist nodig hebben. Tegelijkertijd geeft literatuur empirisch bewijs van middelgrote en kleine ondernemingen die succesvolle samenwerkingsrelaties aangaan en die in staat zijn om baanbrekende innovaties in de markt te zetten, wat juist zou duiden op een *hoog* kennisabsorberend vermogen.

Er ontstaan dus paradoxen als bestaande literatuur over kennisabsorberend vermogen wordt toegepast op middelgrote en kleine bedrijven. Het doel van dit onderzoek is om deze paradoxen te verklaren en om aanbevelingen te doen om het kennisabsorberend vermogen van middelgrote en kleine bedrijven te vergroten. De onderzoeksvraag die ten grondslag ligt aan dit onderzoek luidt: Hoe kunnen kleine en middelgrote bedrijven hun kennisabsorberend vermogen ontwikkelen om daarmee hun innovatieprestaties te verbeteren?

Theoretisch perspectief

In dit onderzoek is gekozen voor een theoretisch perspectief dat kennisabsorberend vermogen beschouwt als een *dynamic capability*. De *dynamic capability* literatuur bouwt voort op de *resource based view*, die veronderstelt dat bedrijven blijvend concurrentievoordeel kunnen verkrijgen door het ontwikkelen en inzetten van hun *resources*, ofwel middelen. In de *resource based view* wordt kennis beschouwd als een belangrijke *resource* voor concurrentievoordeel. Echter, het bezitten van deze *resources* alleen is niet voldoende. De *dynamic capability* literatuur veronderstelt dat de prestaties van een bedrijf bepaald worden door het vermogen om deze resources in te zetten om interne en externe competenties te ontwikkelen en te vernieuwen om tijdig in te kunnen spelen op veranderende omstandigheden. Het toepassen van dit *dynamic capability* perspectief op kennisabsorberend vermogen biedt mogelijkheden om de processen en routines van kennisabsorberend vermogen, evenals hun onderliggende factoren, nader te onderzoeken. Deze onderliggende factoren worden ook de *micro-foundations*, ofwel bouwstenen, genoemd en betreffen de individuele en organisatie factoren die de ontwikkeling van routines en competenties van de organisatie bepalen. Onderzoek van deze *micro-foundations* vergroot het inzicht in de aannames die ten grondslag liggen aan de theorie van kennisabsorberend vermogen en draagt daarmee bij aan het beantwoorden van de onderzoeksvraag hoe middelgrote en kleine bedrijven hun kennisabsorberend vermogen kunnen verbeteren.

Onderzoeksmethode

Dit onderzoek bestaat uit een literatuurstudie en drie empirische studies. De literatuurstudie inventariseert de bestaande literatuur over kennisabsorberend vermogen in middelgrote en kleine bedrijven. Daarbij worden vier paradoxen geïdentificeerd, onderzocht en verklaard. Vervolgens worden proposities afgeleid en wordt een onderzoeksagenda gepresenteerd.

De drie empirische studies zijn uitgevoerd in de maakindustrie in Oost-Nederland. Om de *micro-foundations* van kennisabsorberend vermogen te onderzoeken is gekozen voor een kwalitatieve meervoudige casestudie in combinatie met kwantitatieve onderzoeksmethoden. De eerste empirische studie onderzoekt de routines die middelgrote en kleine bedrijven gebruiken om nieuwe kennis van externe partners te herkennen en te verkrijgen. Daartoe zijn twintig interviews afgenomen binnen vier middelgrote en kleine technologie-georiënteerde bedrijven. De interviewdata zijn geanalyseerd middels kwalitatieve methoden waarbij data zijn vergeleken binnen de cases afzonderlijk en tussen de cases onderling.

De tweede empirische studie onderzoekt de antecedenten, de uitkomsten en de dimensies van het kennisabsorberend vermogen van de individuen in de organisatie als een *micro-foundation* van het kennisabsorberend vermogen van de organisatie als

geheel. Hiertoe is een vragenlijst afgenomen onder 147 medewerkers van een Nederlandse keukenfabrikant. De data zijn geanalyseerd middels de statistische techniek *structural equation modeling using Partial Least Squares (PLS)*, die geschikt is als er sprake is van vormende variabelen, een relatief kleine steekproef en een niet-normale verdeling van de data.

Het derde empirische onderzoek exploreert het gezamenlijke effect van individuele en organisatie factoren op het kennisabsorberend vermogen van een organisatie. Hiervoor is een combinatie van kwalitatieve en kwantitatieve onderzoeksmethoden gebruikt. Allereerst is een vragenlijst afgenomen onder 297 medewerkers van vier middelgrote en kleine maakbedrijven om het kennisabsorberend vermogen van 48 afdelingen binnen deze vier bedrijven te bepalen. Vervolgens zijn de gezamenlijke effecten van factoren op individueel en organisatieniveau geanalyseerd. Hierbij is gekeken naar het kennisabsorberend vermogen van medewerkers op individueel niveau en sociale integratiemechanismen op organisatieniveau. Om deze effecten te onderzoeken is gebruik gemaakt van een configuratie-methode genaamd *fuzzy set Qualitative Comparative Analysis (fs/QCA)*, die zeer geschikt is bij een kleine steekproef met een grote mate van causale complexiteit.

Resultaten

Op basis van de literatuurstudie en de drie empirische studies kunnen twee strategieën geïdentificeerd worden voor middelgrote en kleine bedrijven om hun innovatieprestatie te verhogen door samenwerkingsrelaties aan te gaan met externe partners. Ten eerste, in tegenstelling tot de literatuur, laat dit onderzoek zien dat nieuwe kennis niet alleen wordt gevonden door het aangaan van nieuwe en onbekende relaties, zogenoemde *weak ties*, maar dat deze nieuwe kennis ook gevonden wordt in reeds langdurig bestaande en vertrouwde relaties, zogenoemde *strong ties*. Middelgrote en kleine bedrijven kunnen kennis verkrijgen via deze *strong ties* door het gebruik van *bridging capabilities*, die bedrijven in staat stellen om pro-actief en systematisch de kennisbasis van hun samenwerkingspartners te exploreren. Binnen dit onderzoek zijn de volgende *bridging capabilities* geïdentificeerd:

1. het organiseren van reguliere bijeenkomsten met klanten en/of leveranciers om de laatste ontwikkelingen te bespreken;
2. het opnieuw kennismaken met klanten en/of leveranciers in een andere context dan de standaard zakenrelatie;
3. het doelbewust aangaan van relaties met klanten en/of leveranciers op verschillende organisatie- en/of afdelingsniveaus;
4. het doelbewust aangaan van relaties met organisaties om toegang te krijgen tot hun netwerken;
5. het uitwisselen van personeel.

Door het gebruik van deze *bridging capabilities* binnen reeds bestaande relaties hoeven middelgrote en kleine bedrijven minder te investeren in het ontwikkelen van kennisabsorberend vermogen. Omdat *strong ties* gekenmerkt worden door een hoge mate van vertrouwen en doordat onderlinge communicatieroutines al ingebed zijn is kennisuitwisseling in deze gevallen relatief eenvoudig. Tevens reduceert het gebruik van *bridging capabilities* de kosten en tijd die nodig zijn voor het managen van samenwerkingsrelaties, omdat men zich alleen hoeft te richten op een beperkt aantal reeds bestaande relaties. Samengevat blijkt dat het ontwikkelen en toepassen van *bridging capabilities* de beperkingen van middelgrote en kleine bedrijven als gevolg van hun beperkte omvang en soms jonge leeftijd kunnen reduceren door het *verminderen* van de behoefte aan kennisabsorberend vermogen middels het exploreren en exploiteren van bestaande relaties.

Ten tweede laat dit onderzoek zien hoe middelgrote en kleine bedrijven hun kennisabsorberend vermogen kunnen *vergroten* om nieuwe kennis te verkrijgen voor hun innovatieprocessen. Om een hoog kennisabsorberend vermogen te ontwikkelen blijkt een hoog individueel kennisabsorberend vermogen van de medewerkers een noodzakelijke, doch onvoldoende, voorwaarde te zijn. Dit kennisabsorberend vermogen van individuen is afhankelijk van vier factoren:

1. reeds aanwezige kennisdiversiteit: dit is de kennisbreedte van individuen als resultaat van leeftijd, opleiding en werkervaring. Hoe gevarieerder iemands kennisbasis, hoe gemakkelijker het is om nieuwe kennis te relateren aan reeds aanwezige kennis, waardoor het eenvoudiger is om nieuwe kennis te herkennen en om deze te combineren met kennis van anderen;
2. externe kennisdiversiteit: dit is de breedte van persoonlijke contacten die individuen onderhouden met anderen buiten hun eigen organisatie. Hoe gevarieerder iemands externe netwerk, hoe waarschijnlijker deze persoon anderen ontmoet met andere achtergronden, ideeën en kennis;
3. bisociatieve cognitieve stijl: dit is iemands voorkeur om informatie te verwerken en beslissingen te nemen op basis van verbeeldingskracht en intuïtie, en om te zoeken naar oplossingen buiten de geëigende kaders. Deze cognitieve stijl stelt individuen in staat om creatief te zijn, om *out-of-the-box* te denken, en om inventieve verbanden te leggen tussen bestaande en nieuwe kennis;
4. organiserend vermogen: dit is iemands vermogen om het werk zo te organiseren dat er voldoende tijd ontstaat om kennisabsorberend vermogen te ontwikkelen en om informatieoverbelasting te voorkomen, bijvoorbeeld door goed time-management en het delegeren van taken en bevoegdheden.

Om een hoog kennisabsorberend vermogen te ontwikkelen dienen middelgrote en kleine bedrijven naast een hoog kennisabsorberend vermogen van hun medewerkers ook sociale integratiemechanismen te bezitten. Deze sociale integratiemechanismen hebben twee functies. De eerste functie is het mogelijk maken van kennisuitwisseling tussen organisatieniveaus en over afdelingsgrenzen heen. Als zodanig verzorgen de sociale integratiemechanismen de kanalen waarlangs kennisuitwisseling mogelijk wordt gemaakt, zoals door participatie in besluitvorming, werken volgens vaste routines, socialisatie van nieuwe medewerkers en coördinatie middels multifunctionele teams. De tweede functie is het aanmoedigen van medewerkers om kennis te delen, bijvoorbeeld door een stimulerende managementstijl en een kennisintegratie-bevorderende cultuur.

Het onderzoek laat tevens zien dat er verschillende configuraties zijn van sociale integratiemechanismen in combinatie met individueel kennisabsorberend vermogen, die leiden tot een hoog of laag niveau van het kennisabsorberend vermogen van de organisatie. Dit geeft aan dat er niet één beste manier van organiseren is en dat managers over alternatieven beschikken om het kennisabsorberend vermogen van hun organisatie te ontwikkelen.

Het onderzoek geeft ook inzicht in contingentiefactoren die van invloed zijn op de ontwikkeling van kennisabsorberend vermogen. Terwijl literatuur vooral aandacht besteedt aan de kennisontvangende partij, benadrukt dit onderzoek ook het belang van de selectie van de kennisleverende partij. De mate waarin deze kennisleverende partij innovatief is en zelf een hoog kennisabsorberend vermogen heeft blijkt een belangrijke factor voor de noodzaak van middelgrote en kleine bedrijven om zelf te investeren in de ontwikkeling van kennisabsorberend vermogen. Verder blijkt dat een snelle ontwikkeling van kennisabsorberend vermogen afhangt van de gekozen strategie en de groeiambitie van het topmanagement, alsmede van het levenscyclus stadium waarin het bedrijf verkeert.

Bijdragen aan theorie en praktijk

Dit onderzoek verbreedt en verdiept literatuur over kennisabsorberend vermogen op vier manieren. Ten eerste benadrukt dit onderzoek de relevantie van de kenmerken van de externe kennispartner voor de ontwikkeling van kennisabsorberend vermogen. Deze externe kennispartners fungeren niet alleen als leverancier van kennis die als input dient voor kennisabsorberend vermogen, maar bepalen mede de mate waarin middelgrote en kleine bedrijven zelf kennisabsorberend vermogen moeten ontwikkelen. Ten tweede voegt dit onderzoek kennisabsorberend vermogen van individuen expliciet toe als een bepalende voorwaarde voor het kennisabsorberend vermogen van de organisatie. Tijdens dit onderzoek is een meetinstrument ontwikkeld voor individueel kennisabsorberend vermogen en zijn drie antecedenten en de

uitkomst van individueel kennisabsorberend vermogen nader onderzocht. Ten derde leidt dit onderzoek tot een beter begrip van de effecten van sociale integratiemechanismen op de afzonderlijke dimensies van kennisabsorberend vermogen. Deze mechanismen completeren het kennisabsorberend vermogen van de medewerkers en zijn beide nodig om het kennisabsorberend vermogen van de organisatie als geheel te ontwikkelen. De sociale integratiemechanismen hebben twee functies die gelijktijdig moeten worden vervuld, namelijk het mogelijk maken én het stimuleren van kennisuitwisseling. Verder is aangetoond dat er equivalente configuraties van sociale integratiemechanismen zijn die de causale complexiteit van de *micro-foundations* van kennisabsorberend vermogen benadrukken. Deze causale complexiteit heeft consequenties voor toekomstig conceptueel en empirisch onderzoek. Ten vierde benadrukt dit onderzoek het belang van tijd als verklarende factor voor verschillen tussen bedrijven ten aanzien van de ontwikkeling van kennisabsorberend vermogen. Rekening houden met het cumulatieve karakter dat inherent is aan het concept kennisabsorberend vermogen vergroot de causale complexiteit nog verder.

Voor de praktijk bevat dit onderzoek aanbevelingen om meer te profiteren van samenwerkingsrelaties. Hiertoe worden twee strategieën aanbevolen. De eerste strategie is het ontwikkelen van *bridging capabilities* om nieuwe kennis te verkrijgen binnen reeds bestaande relaties. De tweede strategie is om het eigen kennisabsorberend vermogen te ontwikkelen om in staat te zijn nieuwe kennis te absorberen uit verder afgelegen kennisdomeinen. Om dit te bereiken wordt managers van middelgrote en kleine bedrijven geadviseerd om gelijktijdig te investeren in de ontwikkeling van het kennisabsorberend vermogen van hun medewerkers én in sociale integratiemechanismen om kennisuitwisseling te faciliteren en te stimuleren.

APPENDIX A

QUESTIONNAIRE

Dear <FIRM> employee,

Thank you for participating in this study. The aim of this study is to examine <FIRM>' competencies for collaboration and knowledge exchange, to improve its innovative performance. Further, the results are used for academic research on knowledge management and innovation. This study is done by the University of Twente.

What is expected?

This questionnaire consists of two parts. The first part contains personal questions about work experience, your way of collaborating and knowledge sharing, and some personal characteristics. The second part contains questions about your department. These questions relate to the leadership style of your manager/coordinator, culture and organization. If you are a manager/coordinator, you are requested to answer some additional questions on a separate form.

The questionnaire is quite extensive. To enable you to answer the questions carefully, you have about one hour to fill out the questionnaire. Please read the question or proposition carefully and select the answer that comes to your mind first as the most appropriate one. Please answer all questions.

What about confidentiality?

The questionnaires are handed in directly at the researcher of the University of Twente, and are treated confidentially. The final report to <FIRM>' management only contains a summary of results on departmental or organizational level. Data on individual questionnaires are not provided to <FIRM> in any form, nor can reported data be related to individuals' opinions.

Instruction

At the first questions, you are requested to fill in numbers of years or ideas in categories. If a category does not apply, we ask you to leave it blank (instead of '0'). This makes automatic processing of the questionnaires much easier.

A lot of questions in this questionnaire are actually propositions, where you are requested to indicate the extent to which you agree or disagree.

An example

	strongly disagree						strongly agree
I always go to my work by bike	☐	☐	☐	☐	☐	☐	☐

Examples of answers:

- A) You never use your bike as you always come by car. You indicate: *strongly disagree*
- B) You use the bike and car with the same frequency to go to work. You indicate: the *middle option*
- C) You use your bike every day to go to work indeed. You indicate: *strongly agree*

If you encounter any uncertainties or ambiguities, please ask the present researcher for assistance. As the questionnaires are processed automatically, please use the following way to indicate your choice.

Right way	Wrong way	Correcting a wrong choice	
		Wrong choice	New choice
☒	☒	☒	☒

Thank you for your cooperation

Sandor Löwik, researcher University of Twente

Part 1: Questions about yourself

1.A. General

1. How many years have you been working at <FIRM> ?

- ☐ less than 1 year
- ☐ between 1 and 3 years
- ☐ between 3 and 5 years
- ☐ between 5 and 10 years
- ☐ between 10 and 15 years
- ☐ between 15 and 20 years
- ☐ more than 20 years

2. At how many companies have you worked for at least six months, before you started at <FIRM> ?

..... companies

3. Please indicate the highest accomplished level of education

- ☐ primary school
- ☐ lower secondary professional education (in Dutch: VMBO)
- ☐ lower vocational education (in Dutch: LBO, LTS)
- ☐ intermediate vocational education (In Dutch: MBO, MTS, Mavo)
- ☐ pre-university education/pre-higher professional education (In Dutch: Havo, VWO)
- ☐ higher professional education (In Dutch: HBO, HTS)
- ☐ higher education (University)

4. Please indicate your age

- ☐ up to 20 years
- ☐ from 21 till 30 years
- ☐ from 31 till 40 years
- ☐ from 41 till 50 years
- ☐ from 51 till 60 years
- ☐ 61 years and more

5. Please indicate your department

☐ Marketing, Sales & Services Operations ☐ Proces Management ☐ Planning/Werkvoorbereiding ☐ Procurement ☐ Proces Technology ☐ ICT Project Management ☐ Project Management ☐ Project Engineering ☐ Site Management	Engineering ☐ Mechanical engineering ☐ Standards/documentation ☐ Control Production ☐ Logistics ☐ Assembly ☐ Transportation Finance & HRM ☐ Controlling & Treasury ☐ HRM	
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1.B. Your work experience

1. Please indicate the number of years of work experience, including your employment at <FIRM> .

- 0 less than 1 year
- 0 between 1 and 3 years
- 0 between 3 and 5 years
- 0 between 5 and 10 years
- 0 between 10 and 15 years
- 0 between 15 and 20 years
- 0 more than 20 years

2. The next questions concern your total period of work experience, including your employment at <FIRM> . In the table mentioned below, the left column lists functional domains like sales and production. Please indicate in the right column the number of years which you have been active in each functional domain.

When you had combined positions, please indicate the number of years of work experience in proportion. The sum of all numbers should correspond with the total number of years of work experience.

Example: In total your work experience concerns 15 years, of which you worked in operations for 10 years, and in planning for 5 years. In this case you indicate:

Manufacturing or operations	1	0
Planning, quality assurance and/or production engineering		5

Functional domain	Number of years of work experience in this domain	
Sales and/or marketing		
Manufacturing or operations		
Finance and/or accountancy		
Human resources		
Warehousing and/or logistics		
Research & development		
Procurement		
Administrative support		
Planning, quality assurance and/or production engineering		
Supporting services, like ICT, maintenance		
General management		

3. In the table mentioned below, the left column lists types of industries like agriculture, metal and construction. Please indicate in the right column the number of years that you have been working in each industry, including your work at <FIRM>. The sum of all numbers should correspond with the total number of years of work experience.

<FIRM> can be classified as '<INDUSTRY OF FIRM>'.

Industry	Number of years work experience in this industry
Agriculture, forestry, fishery	
Extracting minerals	
Industry - food (food, beverage, tobacco)	
Industry - textile (textile, clothing, shoes)	
Industry - woodwork (no furniture)	
Industry - furniture	
Industry – paper and cardboard	
Industry – printing business	
Industry – chemicals-pharmacy	
Industry – plastics and rubber products	
Industry – ceramic products, mortar, concrete products	
Industry – metal products (no machines)	
Industry - electronics, electronic components and wire	
Industry - machines and appliances	
Industry – transport vehicles	
Public utilities (natural gas, water, electricity)	
Building industry (construction, contractor, installation)	
Wholesale and retail	
Transport and storage	
Hotel and catering industry	
Information and communication (ICT, publisher, radio, television)	
Financial institutions	
Letting and sale of real estate (estate agent, housing association)	
Consultancy/ business services (architects, business consultants, engineering, market research)	
Rental goods and people (lease, employment agency, travel agency, security, call center)	
Government (public service at state, province or municipality)	
Education	
Health care	
Culture, sports and leisure	
Other,	

1.C. Your personal contacts for work

1. Most probably, you discuss work related issues with people from your own company, like colleagues and managers/coordinators. These persons could be colleagues and managers/coordinators from your own department, but also from other departments of <FIRM>.

Please indicate for each department the number of different persons you contacted during the last 12 months to discuss work related issues.

	<u>Number of persons per department</u> with which you had contact to discuss work related issues, during the last 12 months
Marketing, Sales & Services	
Manager Marketing, Sales & Services	
Marketing, Sales & Services	
Operations	
Manager Operations	
Proces Management	
Planning/Werkvoorbereiding	
Procurement	
Proces Technology	
ICT	
Project Management	
Project Management	
Project Engineering	
Site Management	
Engineering	
Mechanical engineering	
Standards/documentation	
Control	
Production	
Logistiek	
Assemblage	
Transport	
Finance & HRM	
Manager Finance & HRM	
Controlling & Treasury	
HRM	

2. Besides colleagues and managers/coordinators of <FIRM> , you can also discuss work related issues with external parties, like family members, customers, suppliers and competitors.

Please indicate the number of different customers, suppliers and other parties which you have contacted during the last 12 months to discuss work related issues.

We ask you to indicate the number of parties (or companies). Example: if you have contact with employees of four suppliers, you indicate '4', regardless how often you had contact.

	<u>Number of parties</u> (customers, suppliers, etc) with which you had contact to discuss work related issues, during the last 12 months
Head office of <FIRM> or sister companies of <FIRM>	
Current customers	
Potential customers	
Current suppliers	
Potential suppliers	
Competitors	
Trade-associations	
Consultants, accountants	
Government agencies (municipalities, provinces, State)	
Research institutes (TNO, Kema, Kiwa)	
Educational establishments	
Family and friends	

1.D. Ideas and suggestions for improvements

This question concerns your own ideas and suggestions for innovation and improvements for your work. These ideas and suggestions could relate to product development, market development, innovation projects, improvements, new working methods, new (production)processes (like new machines, appliances or software), and other changes that are work related.

1. Please indicate the number of suggestions for innovations and improvements that you have done in the last 12 months, concerning:

		Number of suggestions done by me
1	Creating completely new products or services	
2	Improving existing products or services	
3	Entering completely new markets	
4	Extending existing markets	
5	Creating completely new working methods or (production)processes	
6	Improving existing working methods or (production)processes	

2. Please indicate the number of innovation or improvement projects where you have been actively involved in implementation during the last 12 months, concerning:

		Number of projects where I was actively involved in implementation
1	Creating completely new products or services	
2	Improving existing products or services	
3	Entering completely new markets	
4	Extending existing markets	
5	Creating completely new working methods or (production)processes	
6	Improving existing working methods or (production)processes	

1.E Use of knowledge and information

The following propositions concern your use of information and knowledge for your work at <FIRM>. Please indicate the extent of your agreement for each proposition.

Example proposition: I always go to my work by bike

Examples of answers:

A) You never use your bike as you always come by car. You indicate: *strongly disagree*

B) You use the bike and car with the same frequency to go to work. You indicate: the *middle option*

C) You use your bike every day to go to work indeed. You indicate: *strongly agree*

		strongly disagree						strongly agree
1	To search for new information for my job, I regularly read newspapers, magazines and trade publications	☐	☐	☐	☐	☐	☐	☐
2	I always make my knowledge available for others to use internally	☐	☐	☐	☐	☐	☐	☐
3	I often search out new technologies, processes, techniques, and/or product ideas	☐	☐	☐	☐	☐	☐	☐
4	I often apply newly acquired knowledge to my work	☐	☐	☐	☐	☐	☐	☐
5	I often connect new insights to current practices to create new ideas	☐	☐	☐	☐	☐	☐	☐
6	I am always actively looking for new knowledge for my job	☐	☐	☐	☐	☐	☐	☐
7	I use my expertise to improve practices in our company	☐	☐	☐	☐	☐	☐	☐
8	I frequently share my new knowledge with colleagues to establish a common understanding	☐	☐	☐	☐	☐	☐	☐
9	I intentionally search for knowledge in many different areas to look 'outside the box'	☐	☐	☐	☐	☐	☐	☐
10	I am always willing to attend work related trainings and courses after working hours	☐	☐	☐	☐	☐	☐	☐
11	I generate a lot of creative ideas	☐	☐	☐	☐	☐	☐	☐
12	I translate new knowledge in such a way that my colleagues understand what I mean	☐	☐	☐	☐	☐	☐	☐
13	I find it difficult to apply new technologies (like software, machines, products, methods) in my work	☐	☐	☐	☐	☐	☐	☐
14	I communicate newly acquired knowledge that might be of interest for our company	☐	☐	☐	☐	☐	☐	☐
15	I often promote and champion ideas to others	☐	☐	☐	☐	☐	☐	☐

Appendix A: Questionnaire

		strongly disagree						strongly agree
16	I am good at distinguishing between profitable opportunities and not-so-profitable information or business opportunities	☐	☐	☐	☐	☐	☐	☐
17	I often sit together with colleagues to come up with good ideas	☐	☐	☐	☐	☐	☐	☐
18	I <i>never</i> create applications for our company by combining new and existing technologies	☐	☐	☐	☐	☐	☐	☐
19	I exploit new knowledge to create new products, services, or work methods	☐	☐	☐	☐	☐	☐	☐
20	I often investigate and secure funds needed to implement new ideas	☐	☐	☐	☐	☐	☐	☐
21	I often recognize new information that is interesting for my company	☐	☐	☐	☐	☐	☐	☐
22	I only attend trainings after working hours if it is compensated for, by money or spare time	☐	☐	☐	☐	☐	☐	☐
23	I often use new technology for my work (like software, machines, products, methods)	☐	☐	☐	☐	☐	☐	☐
24	I often develop adequate plans and schedules for the implementation of new ideas	☐	☐	☐	☐	☐	☐	☐
25	I keep recordings from my past projects or activities to share with others	☐	☐	☐	☐	☐	☐	☐
26	I attend meetings with people from different departments to come up with new ideas	☐	☐	☐	☐	☐	☐	☐
27	I develop new insights from knowledge that is available within our firm	☐	☐	☐	☐	☐	☐	☐
28	I invest in my work related personal development at own expenses	☐	☐	☐	☐	☐	☐	☐
29	I easily identify what new knowledge is most valuable to us	☐	☐	☐	☐	☐	☐	☐
30	I am very innovative	☐	☐	☐	☐	☐	☐	☐
31	I constantly consider how I can apply new knowledge to improve my work	☐	☐	☐	☐	☐	☐	☐
32	I can turn existing knowledge into new ideas	☐	☐	☐	☐	☐	☐	☐
33	I pass new information to others in our company	☐	☐	☐	☐	☐	☐	☐

1.F. Your way to solve problems

The following propositions concern your personal preferences to solve problems. Please indicate the extent of your agreement for each proposition, according to the example given in section 1.E.

		strongly disagree						strongly agree
1	I enjoy adhering to the commonly established rules of my area	☐	☐	☐	☐	☐	☐	☐
2	I enjoy to be confronted with a maze of ideas which may, or may not, lead me somewhere	☐	☐	☐	☐	☐	☐	☐
3	I enjoy pursuing a problem, particularly if it takes me into areas I don't know much about	☐	☐	☐	☐	☐	☐	☐
4	I enjoy following well-trodden ways and generally accepted methods for solving problems	☐	☐	☐	☐	☐	☐	☐
5	I enjoy being methodical and consistent in the way I tackle problems	☐	☐	☐	☐	☐	☐	☐
6	I enjoy to link ideas which stem from more than one area of investigation	☐	☐	☐	☐	☐	☐	☐
7	I enjoy playing strict regarding to the sequence of steps needed for the completion of a job	☐	☐	☐	☐	☐	☐	☐
8	I enjoy to be fully occupied with what appear to be novel methods of solution	☐	☐	☐	☐	☐	☐	☐
9	I enjoy making unusual connections about ideas even if they are trivial	☐	☐	☐	☐	☐	☐	☐
10	I enjoy adhering to well known techniques, methods and procedures of my area of work	☐	☐	☐	☐	☐	☐	☐
11	I enjoy being strict on the production of results, as and when required	☐	☐	☐	☐	☐	☐	☐
12	I enjoy searching for novel approaches not required at the time	☐	☐	☐	☐	☐	☐	☐
13	I enjoy accepting readily the usual and generally proven methods of solution	☐	☐	☐	☐	☐	☐	☐
14	I enjoy struggling to make connections between apparently unrelated ideas	☐	☐	☐	☐	☐	☐	☐
15	I enjoy spending time tracing relationships between disparate areas of work	☐	☐	☐	☐	☐	☐	☐
16	I enjoy being precise and exact about production of results and reports	☐	☐	☐	☐	☐	☐	☐
17	I enjoy adhering carefully to the standards of my area of work	☐	☐	☐	☐	☐	☐	☐
18	I enjoy being 'caught up' by more than one concept, method or solution	☐	☐	☐	☐	☐	☐	☐
19	I enjoy being fully aware beforehand of the sequence of steps required in solving problems	☐	☐	☐	☐	☐	☐	☐

1.G Your activities

The following propositions concern the kind of activities that you were engaged in during the last 12 months. Please indicate the extent to which you were engaged in work related activities that can be characterized as follows: (scale ranging from 'to a very small extent' to 'to a very large extent').

		To a very small extent						To a very large extent
1	Searching for new possibilities with respect to products/services, processes, or markets	☐	☐	☐	☐	☐	☐	☐
2	Activities of which a lot of experience has been accumulated by yourself	☐	☐	☐	☐	☐	☐	☐
3	Activities which you carry out as if it were routine	☐	☐	☐	☐	☐	☐	☐
4	Evaluating diverse options with respect to products/services, processes, or markets	☐	☐	☐	☐	☐	☐	☐
5	Focusing on strong renewal of products/services or processes	☐	☐	☐	☐	☐	☐	☐
6	Activities which serve existing (internal) customers with existing services/products	☐	☐	☐	☐	☐	☐	☐
7	Activities of which the associated yields or costs are currently unclear	☐	☐	☐	☐	☐	☐	☐
8	Activities of which it is clear to you how to conduct them	☐	☐	☐	☐	☐	☐	☐
9	Activities which clearly fit into existing company policy	☐	☐	☐	☐	☐	☐	☐
10	Activities requiring quite some adaptability of you	☐	☐	☐	☐	☐	☐	☐
11	Activities requiring you to learn new skills or knowledge	☐	☐	☐	☐	☐	☐	☐
12	Activities primarily focused on achieving short-term goals	☐	☐	☐	☐	☐	☐	☐
13	Activities that are not (yet) clearly existing company policy	☐	☐	☐	☐	☐	☐	☐
14	Activities which you can properly conduct by using your present knowledge	☐	☐	☐	☐	☐	☐	☐

Part 2: Your department

2.A Use of knowledge by your department

The following propositions concern your assessment about the ways your department deals with knowledge. Please indicate the extent of your agreement for each proposition, according to the example given in section 1.E.

		strongly disagree						strongly agree
1	Employees of our department regularly visit other firms.	☐	☐	☐	☐	☐	☐	☐
2	It is clearly known how activities within our department should be performed	☐	☐	☐	☐	☐	☐	☐
3	Our department frequently scans the environment for new knowledge	☐	☐	☐	☐	☐	☐	☐
4	Our department thoroughly observes new trends	☐	☐	☐	☐	☐	☐	☐
5	Our department is slow to recognize shifts in our industry (e.g. competition, regulation, technology)	☐	☐	☐	☐	☐	☐	☐
6	Employees of our department <i>hardly</i> visit other firms	☐	☐	☐	☐	☐	☐	☐
7	Our department regularly considers the consequences of changing (market) demands in terms of new products, services or processes	☐	☐	☐	☐	☐	☐	☐
8	In our department new opportunities to serve our (internal) clients are quickly understood	☐	☐	☐	☐	☐	☐	☐
9	(Internal) Client complaints fall on deaf ears in our department	☐	☐	☐	☐	☐	☐	☐
10	Our department observes in detail external sources of new knowledge	☐	☐	☐	☐	☐	☐	☐
11	Our department periodically organizes special meetings with customers or third parties to acquire new knowledge	☐	☐	☐	☐	☐	☐	☐
12	In our department employees record and store newly acquired knowledge for future reference	☐	☐	☐	☐	☐	☐	☐
13	Our department thoroughly collects external knowledge	☐	☐	☐	☐	☐	☐	☐
14	Our department has a clear division of roles and responsibilities	☐	☐	☐	☐	☐	☐	☐
15	Our department quickly analyzes and interpret changing external conditions	☐	☐	☐	☐	☐	☐	☐
16	Employees of our department regularly approach third parties	☐	☐	☐	☐	☐	☐	☐

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		strongly disagree						strongly agree
17	Our department quickly recognizes the usefulness of new external knowledge to existing knowledge	☐	☐	☐	☐	☐	☐	☐
18	In our department employees hardly share practical experiences	☐	☐	☐	☐	☐	☐	☐
19	In our department we have information on the state-of-the-art external developments	☐	☐	☐	☐	☐	☐	☐
20	Our department constantly considers how to better exploit knowledge	☐	☐	☐	☐	☐	☐	☐
21	When our department finds out something important about competitors, it is slow to alert other departments	☐	☐	☐	☐	☐	☐	☐
22	Our department collects industry information through informal means (e.g. talks over lunch or other informal meetings)	☐	☐	☐	☐	☐	☐	☐
23	We laboriously grasp the opportunities for our department from new external knowledge	☐	☐	☐	☐	☐	☐	☐
24	Our department has difficulty implementing new products and services	☐	☐	☐	☐	☐	☐	☐
25	When something important happens to a major customer or market, the whole department knows it in a short period	☐	☐	☐	☐	☐	☐	☐
26	In our department employees have a common language regarding our products, services or processes	☐	☐	☐	☐	☐	☐	☐
27	In our department we meet with (internal) clients at least once a year to find out what products or services they will need in the future	☐	☐	☐	☐	☐	☐	☐
28	Our department periodically meets to discuss consequences of new developments	☐	☐	☐	☐	☐	☐	☐

2.B Manager/coordinator of your department

The next questions concern your assessment about the leadership style of your manager. To assure that we attribute your opinion on leadership style to the correct manager/coordinator, we first ask you to indicate who your manager/coordinator is.

1. My manager/coordinator is:

☐ Manager Marketing, Sales & Services
☐ Manager Operations
☐ Manager Engineering
☐ Manager Control
☐ Coördinator Standards & Documentation
☐ Manager Transport
☐ Coördinator Logistiek
☐ Coördinator Assemblage
☐ Manager Finance & HRM

2. Please indicate the extent of your agreement for each proposition, according to the example given in section 1.E.

		strongly disagree						strongly agree
1	My manager/coordinator encourages us to express ideas/suggestions	☐	☐	☐	☐	☐	☐	☐
2	My manager/coordinator gets the right people involved in innovation and improvement projects	☐	☐	☐	☐	☐	☐	☐
3	My manager/coordinator listens to our ideas and suggestions	☐	☐	☐	☐	☐	☐	☐
4	My manager/coordinator uses our suggestions to make decisions that affect us	☐	☐	☐	☐	☐	☐	☐
5	My manager/coordinator gets key decision makers involved in innovation and improvement projects	☐	☐	☐	☐	☐	☐	☐
6	My manager/coordinator considers our ideas when he/she disagrees with them	☐	☐	☐	☐	☐	☐	☐
7	My manager/coordinator gets problems into the hands of those who can solve them	☐	☐	☐	☐	☐	☐	☐
8	My manager/coordinator makes decisions that are based only on his/her own ideas	☐	☐	☐	☐	☐	☐	☐
9	My manager/coordinator gives all of us a chance to voice their opinions	☐	☐	☐	☐	☐	☐	☐

2.C. Culture of your department

The following propositions concern your assessment about the culture of your department. Please indicate the extent of your agreement for each proposition, according to the example given in section 1.E.

		strongly disagree						strongly agree
1	In our department, employees understand the importance of knowledge to corporate success	☐	☐	☐	☐	☐	☐	☐
2	In our department employees are encouraged to ask others for assistance when needed	☐	☐	☐	☐	☐	☐	☐
3	In our department high levels of participation are expected in capturing and transferring knowledge	☐	☐	☐	☐	☐	☐	☐
4	In our department employees are encouraged to explore and experiment	☐	☐	☐	☐	☐	☐	☐
5	In our department the overall vision is clearly stated	☐	☐	☐	☐	☐	☐	☐
6	In our department on the job training and learning are valued	☐	☐	☐	☐	☐	☐	☐
7	In our department employees are encouraged to interact with other departments	☐	☐	☐	☐	☐	☐	☐
8	In our department employees are valued for their individual expertise	☐	☐	☐	☐	☐	☐	☐
9	In our department employees are encouraged to discuss their work with other departments	☐	☐	☐	☐	☐	☐	☐
10	In our department employees are encouraged to share knowledge with other organizations	☐	☐	☐	☐	☐	☐	☐
11	In our department we believe that the benefits of sharing knowledge outweigh the costs	☐	☐	☐	☐	☐	☐	☐
12	In our department the objectives are clearly stated	☐	☐	☐	☐	☐	☐	☐
13	In our department senior management clearly supports the role of knowledge in our firm's success	☐	☐	☐	☐	☐	☐	☐

2.D. Organizational arrangements of your department

The following propositions concern your assessment about the organizational arrangements of your department. Please indicate the extent of your agreement for each proposition, according to the example given in section 1.E.

		strongly disagree						strongly agree
1	Employees in our department are regularly rotated between different functions	☐	☐	☐	☐	☐	☐	☐
2	Tasks in our department are the same from day-to-day	☐	☐	☐	☐	☐	☐	☐
3	In our department employees participate in the decision to hire new staff	☐	☐	☐	☐	☐	☐	☐
4	Our department often uses liaison personnel to coordinate activities	☐	☐	☐	☐	☐	☐	☐
5	In our department, there is ample opportunity for informal 'hall talk' among employees	☐	☐	☐	☐	☐	☐	☐
6	Whatever situation arises, written procedures are available for dealing with it	☐	☐	☐	☐	☐	☐	☐
7	Experienced colleagues see advising or training newcomers as one of their main job responsibilities	☐	☐	☐	☐	☐	☐	☐
8	In our department employees from different subunits feel comfortable calling each other when the need arises	☐	☐	☐	☐	☐	☐	☐
9	Employees in our department are regularly rotated between different departments	☐	☐	☐	☐	☐	☐	☐
10	Newcomers gain a clear understanding of their roles from observing senior colleagues	☐	☐	☐	☐	☐	☐	☐
11	Our department often uses temporary task forces to coordinate activities	☐	☐	☐	☐	☐	☐	☐
12	Rules and procedures occupy a central place in the department	☐	☐	☐	☐	☐	☐	☐
13	In our department employees participate in decisions on the promotion of any of colleagues	☐	☐	☐	☐	☐	☐	☐
14	The work in our department is routine	☐	☐	☐	☐	☐	☐	☐
15	My manager/coordinator discourages employees discussing work related matters with others than him/her	☐	☐	☐	☐	☐	☐	☐
16	Newcomers receive little guidance from experienced members as to how perform the job	☐	☐	☐	☐	☐	☐	☐
17	In our department employees participate in decisions on adoptions of new policies	☐	☐	☐	☐	☐	☐	☐

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		strongly disagree						strongly agree
18	People in this department do about the same job in a same way most of the time	☐	☐	☐	☐	☐	☐	☐
19	Our department often uses permanent teams to coordinate activities	☐	☐	☐	☐	☐	☐	☐
20	Newcomers are generally left alone to discover what their role in the department should be	☐	☐	☐	☐	☐	☐	☐
21	Written records are kept of everyone's performance within our department	☐	☐	☐	☐	☐	☐	☐
22	In our department employees participate in decisions on adoptions of new work methods/processes	☐	☐	☐	☐	☐	☐	☐
23	Employees are hardly checked for rule violations	☐	☐	☐	☐	☐	☐	☐
24	Basically, people in this department perform repetitive actions in doing their jobs	☐	☐	☐	☐	☐	☐	☐
25	People around here are quite accessible to each other	☐	☐	☐	☐	☐	☐	☐
26	The duties in our department are <i>not</i> repetitious	☐	☐	☐	☐	☐	☐	☐
27	Written job descriptions are formulated for positions at all levels in our department	☐	☐	☐	☐	☐	☐	☐

2E. Human resource policy

The following propositions concern your assessment about the human resource policy of your department. Please indicate the extent of your agreement for each proposition, according to the example given in section 1.E.

		strongly disagree						strongly agree
1	Extensive training programs are provided for our employees in this department	☐	☐	☐	☐	☐	☐	☐
2	In this department qualified employees have the opportunity to be promoted to positions of greater pay and or responsibility	☐	☐	☐	☐	☐	☐	☐
3	In this department we use performance based compensation	☐	☐	☐	☐	☐	☐	☐
4	Employees of this departments normally go through training programs every few years	☐	☐	☐	☐	☐	☐	☐
5	This department places a great deal of importance on merit for promotion decisions	☐	☐	☐	☐	☐	☐	☐
6	When hiring new personnel, we always select candidates from our own industry or business sector	☐	☐	☐	☐	☐	☐	☐
7	In this department compensation is related to the overall performance of the department	☐	☐	☐	☐	☐	☐	☐
8	In this department new personnel is hired based on their distant knowledge in domains beyond our core competences	☐	☐	☐	☐	☐	☐	☐
9	In this department upper-level vacancies are filled from within	☐	☐	☐	☐	☐	☐	☐
10	Formal training programs are offered to employees in this department in order to increase their promotability in this organization	☐	☐	☐	☐	☐	☐	☐
11	For vacancies we externally search for people with a strongly deviating profile from our current employees	☐	☐	☐	☐	☐	☐	☐

2F. Performance of your department

The following propositions concern your assessment about the performance of your department. Please indicate the extent of your agreement for each proposition, according to the example given in section 1.E.

		strongly disagree					strongly agree
1	Our department adequately completes assigned duties	☐	☐	☐	☐	☐	☐
2	Employees of our department often implement new ideas to improve quality of our products and services	☐	☐	☐	☐	☐	☐
3	Employees of our department give little consideration to new and alternative methods and procedures for doing their work	☐	☐	☐	☐	☐	☐
4	Employees of our department fulfil responsibilities specified in job description	☐	☐	☐	☐	☐	☐
5	Employees of our department often produce new services, methods or procedures	☐	☐	☐	☐	☐	☐
6	Employees of our department perform tasks that are expected of him/her	☐	☐	☐	☐	☐	☐
7	Employees of our department meet formal performance requirements of the job	☐	☐	☐	☐	☐	☐
8	This is an innovative department	☐	☐	☐	☐	☐	☐

2G. Confidence

This questionnaire is about collaboration, knowledge exchange and innovation. To assess your confidence with these topics, we want to ask you two final questions.

		To a very small extent					To a very large extent
1	To what extent do you have experience with the topics of this questionnaire?	☐	☐	☐	☐	☐	☐
2	To what extent are you familiar with the wording and definitions that are used in this questionnaire?	☐	☐	☐	☐	☐	☐

2H. Remarks

Here you can list any questions or remarks.

Thank you for your participation.

Attachment for managers/coordinators

1. General

This questionnaire is only intended for managers/coordinators.

1. Please indicate your department

☐ Marketing, Sales & Services ☐ Operations ☐ Proces Management ☐ Planning/Werkvoorbereiding ☐ Procurement ☐ Proces Technology ☐ ICT Project Management ☐ Project Management ☐ Project Engineering ☐ Site Management	Engineering ☐ Mechanical engineering ☐ Standards/documentation ☐ Control Production ☐ Logistiek ☐ Assemblage ☐ Transport ☐ Finance & HRM ☐ Controlling & Treasury ☐ HRM
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2. Innovativeness of employees

A. We are interested in your assessment of your employees' innovativeness. Please indicate the number of employees of your department, who did suggestions for innovations and improvements during the last 12 months, for each category mentioned below.

The same employee can be listed in multiple categories, for instance when he/she did suggestions for creating new products (category 1) as well as for process improvement (category 6).

		Number of employees who did <u>suggestions</u> during the last 12 months:
1	Creating completely new products or services	
2	Improving existing products or services	
3	Entering completely new markets	
4	Extending existing markets	
5	Creating completely new working methods or (production) processes	
6	Improving existing working methods or (production) processes	

B. Please indicate the number of employees of your department, who were actively involved in implementation of innovation and improvement projects (of their own or of others), during the last 12 months, for each category as mentioned below.

The same employee can be listed in multiple categories.

		Number of employees who were actively involved in <u>implementation</u>
1	Creating completely new products or services	
2	Improving existing products or services	
3	Entering completely new markets	
4	Extending existing markets	
5	Creating completely new working methods or (production) processes	
6	Improving existing working methods or (production) processes	

4. Activities of your department

The following propositions concern the kind of activities that are executed by your department. Please indicate the extent of your agreement for each proposition.

		strongly disagree				strongly agree
1	Our department commits to improve quality and lower cost	☐	☐	☐	☐	☐
2	Our department looks for novel ideas by thinking “outside the box”	☐	☐	☐	☐	☐
3	Our department continuously improves the reliability of its products and services	☐	☐	☐	☐	☐
4	Our department bases its success on its ability to explore new techniques and methods	☐	☐	☐	☐	☐
5	Our department creates products or services that are innovative to the firm	☐	☐	☐	☐	☐
6	Our department increases the levels of automation in its operations	☐	☐	☐	☐	☐
7	Our department looks for creative ways to satisfy its internal or external customers’ needs	☐	☐	☐	☐	☐
8	Our department constantly surveys existing internal and external customers’ satisfaction	☐	☐	☐	☐	☐
9	Our department fine-tunes what it offers to keep its current internal or external customers satisfied	☐	☐	☐	☐	☐
10	Our department aggressively ventures into new knowledge domains	☐	☐	☐	☐	☐
11	Our department penetrates more deeply into its existing internal or external customer base	☐	☐	☐	☐	☐
12	Our department actively targets new internal or external customer groups	☐	☐	☐	☐	☐

Thank you for your participation.