# External knowledge absorption in Chinese SMEs

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*To My Mother*

# Preface

This study is inspired by the entrepreneurial stories of many friends and their experiences in managing their enterprises. In the past decades, the world economy has been strongly driven by technological innovation and entrepreneurship. The vital force behind the technology push comes from the almost uncountable number of small and medium-sized enterprises (SMEs). Riding the waves of technological innovation and entrepreneurship, many ambitious individuals try to launch and establish their own business. Many of my friends and former classmates in college and graduate school have become entrepreneurs. They founded their business in different sectors. Their enterprises are mostly small and lack many relevant resources. By talking to them and listening to their stories, I felt that most of them are aware that they need resources beyond the boundaries of their own enterprises. These friends are the primary source of my inspiration. By viewing *knowledge* as the most critical resource, I decided to investigate how SMEs absorb external knowledge. In my Ph.D. study, I was privileged to investigate the knowledge-absorbing processes in SMEs, the challenges in these processes, and how effective the knowledge assimilation mechanisms are.

The results of the investigation are in the thesis. Without any anticipation of the outcome, it is safe to state that External Knowledge Absorption is a fascinating topic for the Leiden University, for the Netherlands, and China, and indeed for all businessmen in the world.

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# List of Abbreviations

The list below contains all abbreviations used in the Ph.D. thesis together with a brief explanation. Standard lexical abbreviations, such as “e.g.” and “etc.”, are not listed. Abbreviations used only in tables or figures are explained in the corresponding table or figure.

| | |
|---|---|
| AC | Absorptive Capacity |
| AI | Artificial Intelligence |
| CEO | Chief Executive Officer |
| CPA | Competing Product Analysis |
| CTO | Chief Technology Officer |
| D-W | Durbin-Watson |
| EKA | External Knowledge Assimilation |
| EKR | External Knowledge Recognition |
| EKU | External Knowledge Utilization |
| EU | European Union |
| HRM | Human Resource Management |
| ICT | Information and Communications Technology |
| IoT | Internet of Things |
| IT | Information Technology |
| KM | Knowledge Management |
| M&A | Mergers and Acquisitions |
| NFBS | Non-financial Business Sector |
| NIH | Not-Invented-Here |
| NiTiM | Network of IT and Innovation Management |
| OECD | Organization for Economic Co-operation and Development |
| PS | Problem Statement |
| RQ | Research Question |
| SMEs | Small and Medium-sized Enterprises |
| SPSS | Statistical Package for Social Science |
| VIF | Variance Inflation Factor |

# List of Definitions

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# 1 Innovation and External Knowledge Absorption

Organizations are nowadays facing an increasingly dynamic environment both within and beyond their organizational boundaries. Companies are forced to try to realize their full potential to meet conflicting demands from different stakeholders (cf. Pache and Santos 2010, Hadi 2017). In the business world, the task of satisfying the needs of end-users has become increasingly urgent as new technologies and innovations continuously emerge and customers become progressively demanding. Even the established big companies cannot merely rely on their own knowledge and capabilities to meet the demand of the end-users. Increasing labor mobility, abundantly available venture capital, and widely dispersed knowledge across multidisciplinary fields motivate organizations to engage with their external environment for knowledge creation and innovation (cf. Chesbrough 2003, van de Vrande, Vareska *et al.* 2009, Dingler and Enkel 2016).

This chapter provides a run-up and an overview of the entire thesis. Section 1.1 provides the broad background of this study. Then, we formulate our Problem Statement (PS) in Section 1.2, followed by three Research Questions (RQs) in Section 1.3. With the PS formulated and the RQs raised, our study's focus, external knowledge absorption in SMEs, is set. The methodology of the study is described in Section 1.4. Finally, we describe the structure of the study in Section 1.5.

## *1.1 Research Backgrounds*

This section deals with the backgrounds of the study. We discuss knowledge and competitive advantages in Subsection 1.1.1. Then we deal with knowledge management (KM) across organizational boundaries in Subsection 1.1.2. Subsection 1.1.3 introduces the concept of absorptive capacity (AC). In Subsection 1.1.4, the importance of SMEs in economies is discussed. Then we link AC and SMEs in Subsection 1.1.5.

### 1.1.1 Knowledge and Competitive Advantages

Knowledge has become the critical driving factor of modern economies (cf. Keep 2000, cf., Andersson *et al.* 2009, Antonelli and Fassio 2016). It is widely recognized by scholars in various scientific fields (e.g., innovation studies, entrepreneurship studies, and science and technology studies) that knowledge lies at the center of building up competitive advantages in organizations and economies (e.g., Grant 1996, 2002, Fagerberg *et al.* 2012, Dima *et al.* 2018).

To handle the concept of knowledge resources, we have to agree on the definition of knowledge. In our study, knowledge (see Definition[1] 1.1) is defined as follows.

**Definition 1.1: Knowledge**

> *Knowledge* is defined as "a fluid mix of framed experience, values, contextual information, and expert insight that provides a framework for evaluating and incorporating new experiences and information" (Davenport and Prusak 1998, p. 5).

Knowledge is often generated and applied in the minds of human beings, persons who know what they are talking about. According to Davenport and Prusak (2000), knowledge is embedded in routines, processes, practices, and norms, as well as in documents and repositories.

In academia, KM (see Definition 1.2) has become a multidisciplinary research subject. KM has been studied by scholars in a variety of fields. Here we mention business management (e.g., Long and Fahey 2000, Hislop *et al.* 2018), innovation management (cf. Stuermer *et al.* 2009, Dahlander and Gann 2010, 2010, Faems *et al.* 2010), information systems (e.g., Schultze and Leidner 2002, Vernadat *et al.* 2018), and information and library science (e.g., Al-Alawi and Chaudhry 2013, Marouf 2017).

[1] All definitions in this dissertation are provided in the context of our research. For understanding the background of the definitions, we provide relevant references. Our study does not aim to launch a discussion on the philosophical aspects of the definitions. Our claim is that they should be "workable" definitions.

Many new corporate strategies and tactics that are developed around the question of how to improve KM capabilities have been advocated by scholars. Many of them turned out to be well received in management practice and have been successfully implemented. Moreover, a large number of companies have invested substantial efforts in building up KM practices to boost knowledge creation and utilization. Usually, the KM practices are embedded in one of the wide concepts of the business structure, e.g., information technology (IT) infrastructure, human resource management (HRM), business networks, and other business practices (cf. Addicott *et al.* 2006, Durst and Runar Edvardsson 2012, Cabrilo and Leung 2019).

**Definition 1.2: Knowledge Management**

*Knowledge management (KM)* is the "deliberate and systematic coordination of an organization's people, technology, processes, and organizational structure in order to add value through reuse and innovation. This coordination is achieved through creating, sharing, and applying knowledge as well as through feeding the valuable lessons learned and best practices into corporate memory in order to foster continued organizational learning" (Dalkir 2017, p. 3).

Already fifty years ago, the resource-based view on firms treated knowledge as one of the crucial resources that would lead to organizational competitive advantage (e.g., Wernerfelt 1984, Barney 2001, Kraaijenbrink *et al.* 2010). The knowledge-based view goes one step further. It recognizes knowledge as the most strategically valuable resource. As knowledge usually is socially complicated and difficult to copy, the knowledge-based view argues that seeking to obtain and master different kinds of knowledge and capabilities is the key to superior organizational performance and competitive advantages (cf. Grant 1996, Darroch 2005, North and Kumta 2018, Bloodgood 2019).

KM researchers have devoted efforts to enhance our understanding of how organizations identify and leverage collective knowledge with the goal to increase innovativeness and responsiveness for competition (e.g., Gupta and Sharma 2004, Girard 2015). For this purpose, Chesbrough advocates an open innovation model. Firms

should purposively use "inflows and outflows of knowledge to accelerate internal innovation, and expand the markets for external use of innovation, respectively" (Chesbrough 2003, p. 2). Many studies have established that firms employing the open innovation strategy tend to have a better performance than those not having an open innovation strategy (e.g., Laursen and Salter 2006b, Du *et al.* 2014, Rauter *et al.* 2019).

A large number of empirical studies indicate that a firm's KM capability increases its dynamic capability. In turn, the dynamic capability enhances the firm's performance and provides competitive advantages (e.g., Tseng and Lee 2014, Lu and Liang 2017, Najmi *et al.* 2018). The concept of dynamic capabilities is defined as follows (Definition 1.3).

**Definition 1.3: Dynamic Capabilities**

*Dynamic capabilities (DC)* are "the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments" (Teece *et al.* 1997, p. 516).

### 1.1.2 Knowledge Management across Organizational Boundaries

Worldwide, many firms invest substantially in collaboration with external partners to tap external sources of knowledge. Large multinational firms such as Cisco, IBM, Intel, Procter & Gamble, DuPont, and Philips have been viewed as their role models. For example, Cisco has already 20 years ago transformed itself successfully into a platform leader in the industry, relying exclusively on external R&D and open standards (see Gawer and Cusumano 2002). Moreover, Japanese firms are also known for their abilities to orchestrate close relations with their suppliers, customers, and even competitors for knowledge sharing and collective innovation (cf. Dyer 1997, Dyer and Nobeoka 2000, Zhu *et al.* 2010, Khojasteh and Abdi 2016).

When we look at governments across the world, then we see that they are also increasingly aware of the value of (1) improving the knowledge circulation in economic activities and (2) devising strategies to encourage a knowledge flow across boundaries of public and private entities. The European Commission, together with a group of national research funders, has launched a plan to open up publicly funded research (see

Thornton 2018). They aim to make it freely and openly accessible to the public from 2020 onwards. In fact, the United States of America has initiated this idea by requiring that federal funding agencies should make federally funded research accessible to the public, industry, and the scientific community in an open and free manner (see Holdren 2013). This being so, we see that more proactive knowledge sharing activities are also going on in the private sector. For instance, Tesla Motors has decided it will share all its patents with anyone who will use them properly, even to competitors (see Ramsey 2014). Following the decision by Tesla, the companies Toyota, LG group, Panasonic Facebook, and Bitstream announced that they would share their technology in all or some specific areas for free. Similarly, Google, DuPont, IBM, GE, and Pfizer have taken the same steps to share their technology with others (see Chien 2015).

The inter-organizational knowledge sharing activities are partially boosted by various new IT infrastructures (see Definition 1.4) and technologies.

**Definition 1.4: Information Technology Infrastructure**

*The information technology (IT)* Infrastructure is defined as a set of IT components that are the foundation of an IT service. Typically they are physical components (e.g., supercomputers, network connection facilities), and various software and network components belong to them (adapted from Wikipedia 2020).

The advancement of the IT infrastructure, e.g., cloud computing, the internet of things (IoT), and artificial intelligence (AI), makes access to various sources of external knowledge much easier, cheaper, and faster. Nowadays, a variety of information and knowledge is stored across different organizations and media. By investing in the KM system and facilities, firms can better leverage knowledge creation, sharing, and utilization within and across organizational boundaries, which in turn increases their innovation capabilities (cf. López-Nicolás and Merono-Cerdán 2011, Santoro *et al.* 2018).

The value of new knowledge can be realized or multiplied if they are shared and utilized in different entities. For instance, a variety of organizations are willing to utilize external knowledge. They are also prepared to share their own knowledge to fully realize its potential. The advancement of the IT infrastructure makes that the knowledge which is traditionally isolated in various organizational boundaries is now much more accessible. It is particularly beneficial to small and medium-sized enterprises (SMEs) (Definition 1.5).

**Definition 1.5: Small and Medium-sized Enterprises**

*Small and medium-sized enterprises (SMEs)* are businesses of which the personnel numbers fall below certain limits. This study refers to SMEs as the firms employing up to 300 workers, with the following breakdown: micro (1 to 10), small (11 to 100), and medium (101-300).

### 1.1.3 Absorptive Capacity

Scholars in the innovation network stream suggest that firms should "seek to create value and extract value from the network" (Dhanaraj and Parkhe 2006, p. 659). Cohen and Levinthal (1989, 1990) advocate that organizations need to develop their own AC in order to better benefit from accessing external knowledge. The definition of AC in this study is defined as follows (see Definition 1.6).

**Definition 1.6: Absorptive Capacity**

*Absorptive capacity (AC)* is defined as various organizational capabilities that allow the organization to quickly "recognize the value of new information, assimilate it, and apply it to commercial ends" (Cohen and Levinthal 1990, p. 128).

Scholars who advocate dynamic capabilities of firms consider the AC as an essential element of dynamic capabilities (e.g., Zahra and George 2002, Adner and Helfat 2003). Many studies have provided evidence that the ability of firms to absorb external knowledge significantly influences their innovative capability and firm performance (e.g., Caloghirou *et al.* 2004, Liao *et al.* 2007, Berchicci 2013, Vrontis *et al.* 2017 etc.).

## Three Essential Processes

According to Cohen and Levinthal (1990), AC is considered to contain three essential processes. The first process is *external knowledge recognition (EKR)* (see Definition 1.7). It involves a variety of activities, including (1) searching for potential external knowledge by scanning the environment to check whether there is new knowledge, (2) evaluating the external knowledge with certain criteria, (3) determining what to assimilate and how to do it based on the evaluation.

**Definition 1.7: External Knowledge Recognition**

*External knowledge recognition (EKR)* is a process of searching for external knowledge candidates and evaluating the potential of specific external knowledge with certain criteria (adapted from Cohen and Levinthal 1990).

The second process is *external knowledge assimilation (EKA)* (see Definition 1.8). It refers to the organizational practice of (1) getting access to the intended external knowledge, (2) acquiring it, and (3) combining it with the existing knowledge base in the firm.

**Definition 1.8: External Knowledge Assimilation**

*External knowledge assimilation (EKA)* is a process of accessing potential external knowledge sources, acquiring the intended knowledge, transforming it if necessary, and combining it with the existing knowledge base (adapted from Cohen and Levinthal 1990).

The third process is *external knowledge utilization (EKU)* (see Definition 1.9). It is the process of realizing the value of the assimilated knowledge by using it to meet a practical or particular purpose, for example, translating it into new or improved products and services, lower costs, or better customer satisfaction.

**Definition 1.9: External Knowledge Utilization**

*External knowledge utilization (EKU)* is a process of realizing the value of the assimilated knowledge by using it to meet a practical or particular purpose (adapted from Cohen and Levinthal 1990).

Since its origin, the AC framework has been applied to analyze how AC behave in the fields of strategic management (e.g., Lenox and King 2004, Lichtenthaler 2016), technology and innovation management (e.g., Stock *et al.* 2001, Zobel 2017), international business (e.g., Lane *et al.* 2001, Peng and Lin 2019), entrepreneurship management (e.g., Gray 2006, Sakhdari and Burgers 2018), information system (e.g., Roberts *et al.* 2012, Cooper and Molla 2017), and organizational economics (e.g., Durham 2004, Kharabsheh *et al.* 2017). Our study see AC as one aspect of DC (see Subsection 2.1.4 Dynamic Capabilities and Fig. 2.2 in Subsection 2.1.5 Embedding AC in Other Theories)

### 1.1.4 SMEs in China

SMEs play essential roles in enhancing social well-being and economic development. SMEs represent 99% of all businesses and generate about 60% of employment in the OECD area (see OECD and Outlook 2019). According to the annual report on European SMEs 2018/2019, SMEs accounted for 99.8% of all enterprises in the EU-28[2] non-financial business sector (NFBS), generating 56.4% of value-added and 66.6% of employment in the NFBS (see Hope *et al.* 2019). According to the World Bank, in emerging markets, most formal jobs are generated by SMEs, which create 7 out of 10 jobs (see World Bank 2020).

SMEs are particularly important in developing countries as developing countries are in great need of eradicating poverty, creating employment, increasing per-capita income in order to realize economic growth and development. Taking China as an example, it has experienced very fast economic growth since its market reform in 1978. SMEs have

[2] The EU-28 is the abbreviation of European Union (EU) which consists a group of 28 countries: https://www.igi-global.com/dictionary/employment-in-innovation-performance/58384

been the primary engine of China's economic development (cf. Cunningham 2011, Deng and Zhang 2018). According to China's Fourth Economic Census (2019), the roles of SMEs in China's economic development and social progress are clearly visible (see Table 1.1) and still growing. China had over 18 million SMEs by the end of 2018, which accounted for 99.8% of all businesses or corporate legal entities. They created more than 233 million jobs, which accounted for nearly 80% of the total corporate employment in China. Most of the SMEs in China are in the non-high-tech sectors such as wholesale and retail, manufacturing, and service industry.

**Table 1.1: SMEs in China's Economy**

| Total number of SMEs | Percentage of SMEs to all corporations | Jobs created by SMEs | Percentage of SME employment to all corporate employment |
|---|---|---|---|
| 18 million | 99.8% | 233 million | 80% |

Source: Fourth Economic Census of China (2019)

China saw that the number of technology-based firms had increased significantly in recent years (see Table 1.2)[3]. In 2018, the number of SMEs in the communication, software, and IT industry was more than three times bigger than it had been in 2013, reaching 0.91 million. Its proportion to the total number of SMEs was doubled. The number of SMEs focusing on scientific research and technology services has increased by 2.5 times since 2013, reaching 1.14 million in 2018. Its proportion to the total number of SMEs in 2018 is about 2.5 times as big as in 2013. The trend indicates that SMEs have played an increasingly important role in the innovation and technological development of China.

**Table 1.2: Trends of Technology-based SMEs in China**

| Technology-based SMEs in Different Industry | Total Number | | Percentage of Total SMEs | |
|---|---|---|---|---|
| | 2013 | 2018 | 2013 | 2018 |
| Communication, software, and IT | 0.22 million | 0.91 million | 2.6% | 5% |
| Scientific research and technology | 0.33 million | 1.14 million | 2.6% | 6.3% |

Source: Fourth Economic Census of China (2019)

[3] We performed this research in the years 2015-2020. Our information gathering has been performed before the outbreak of Covid-19. This implies that we have not taken into account the disruptive break in economic activities. We have included the general trend in our final conclusion.

SMEs are particularly important in developing countries as developing countries are in great need of eradicating poverty, creating employment, increasing per-capita income in order to realize economic growth and development. However, developing countries are usually prone to fragile institutions, harsh business environments, complex economic and social problems compared with developed countries (cf. Sorasalmi and Tuovinen 2015, Bilal *et al.* 2016). For instance, despite significant development, SMEs in China continue to face institution-based barriers such as unfair competition, the weak rule of law, inadequate intellectual property protection, insufficient support system, etc. (cf. Zhu *et al.* 2012, Huang 2017, Jia *et al.* 2020).

Except for formal institutions such as legal and regulatory systems, informal institutions play an essential role in business management in China and other developing countries (cf. Chan *et al.* 2015, Hitt and Xu 2016, Bian 2019). Chinese SMEs operate in the context of Chinese culture (see Wu and Tseng 1985, Yau 1988, Fan 2000) and are governed by its underlying core values that distinguish Chinese society from western societies. For instance, Confucianism is one of the most influential thoughts that form the foundation of the Chinese culture and provides guidelines for social and business behavior (see Bell *et al.* 2003, Yao 2008, Bell 2010). Influenced by the culture, the Chinese exhibit a relatively more calm, silent, and obedient character than their western counterparts. When applied to business management, it shows a paternalistic management style and emphasizes guanxi in the Chinese business community (cf. Li and Moreira 2009, Bian 2019).

### 1.1.5 Absorptive Capacity and SMEs

In innovation studies, SMEs have already been considered, for a long time, as essential players in generating, applying, and disseminating innovations within local economies (cf. Curran and Blackburn 1994, Simmie 2002, Liu *et al.* 2010b). Notably, in the science-driven sectors, such as nanotech and biotech, SMEs have been the primary sources of many radical innovations (cf. Genet *et al.* 2012, Cusmano *et al.* 2018).

Due to a lack of internal resources and competencies when compared to larger companies, it is difficult for SMEs to rely only on internal resources and knowledge to innovate. Thus, SMEs have a strong motivation to absorb external knowledge and adopt more open innovation practices (cf. Sağ *et al.* 2016, Kraus *et al.* 2020). Participation in innovation networks has been offered as a solution for absorbing the needed knowledge and competencies.

As SMEs have to deal with the liability of smallness and the resultant resource shortage, SMEs exhibit different characteristics in how they absorb external knowledge (cf. Gray 2006, Lee *et al.* 2010, Huang *et al.* 2015b). To integrate the new knowledge learned by employees in a strategic alliance into the existing knowledge base, a company must establish certain standards and routines. These specific standards and routines are less likely to exist in SMEs than in big firms. Thus resource constraints incentivize SMEs to rely on less expensive and less risky alternatives than formal in-house R&D (cf. Dahlander and Gann 2010, Spithoven *et al.* 2013). Some researchers (e.g., Huang *et al.* 2015a) have indicated that, if managed well, SMEs may benefit more from external networking than large companies.

However, the specific countries' formal and informal institutions may affect how and how effectively firms can share knowledge between their member employees and learn from other companies in the environment (cf. Weir and Hutchings 2005, Latukha and Veselova 2019). The theoretical foundations of KM and AC studies are mainly based on western experiences. How companies in developing countries absorb external knowledge deserve more attention from scholars. As one of the biggest and most rapidly developing economies, the Chinese case will be more valuable and relevant to other developing countries. Thus, our investigation will be focused on the Chinese experience of SMEs.

## *1.2 Problem Statement*

Knowing how KM works across organizational boundaries (see Section 1.1), we would like to investigate how SMEs absorb knowledge from external sources. In this

regard, scholars are aware of the gain and potential costs of utilizing external knowledge (cf. Dahlander and Gann 2010, Wales *et al.* 2013). Moreover, merely gaining much exposure from external knowledge sources does not suffice for assimilating and utilizing them successfully (cf. Escribano *et al.* 2009, Enkel *et al.* 2017).

Though some specific factors that influence organizational AC and outcomes of organizational AC efforts have been uncovered, and different processes of AC have been distinguished, research has neglected how organizations engage in absorbing new knowledge throughout the phases of the AC process. Our knowledge of what companies do in each phase, what challenges they face, and how effectively they can absorb intended external knowledge remains scant. We lack detailed insights into how companies progress through the processes of identifying valuable knowledge, ensuring its assimilation and acceptance, and, ultimately, ensuring the exploitation of new knowledge. Such a knowledge gap constrains our understanding of how different organizational knowledge-absorption processes emerge, interact, and evolve.

Compounding this issue, the initial theory development of AC has been based mainly on the big firms, which is mostly manifested in the fact that many authors treat AC as a byproduct of R&D activities and use R&D-related indicators to represent AC (cf. Cohen and Levinthal 1990, George *et al.* 2001, Aldieri *et al.* 2018). However, most SMEs are in non-technology industries. And even in the technology-based industries, SMEs tend to lack resources to invest heavily in R&D (cf. Narula 2004, Väyrynen *et al.* 2017). Thus, the conclusions reached from AC studies on big firms may not apply to SMEs.

It is well known that SMEs operate differently from the way that big companies follow. Smaller firms tend to be more flexible, have a short chain of command, operate in a relatively informal way, and are thus more sensitive to market changes. As small firms grow big, they are likely to become more bureaucratic. Big firms tend to have a more complicated structure, formal communication, formal management styles, and a more predefined list of activities and tasks (cf. Hill and Stewart 2000, Lazarević-Moravčević *et al.* 2014, Lai *et al.* 2016). Therefore, the AC of SMEs deserves special

attention from researchers. Hence, more studies should look into how SMEs deal with external knowledge.

In summary, SMEs operate differently as big companies in how they collaborate with external partners for innovation. Our knowledge of how SMEs deal with external knowledge in each of the AC phases is still not sufficient. AC of SMEs deserves special attention. Based on the analysis, we formulate the following PS of the dissertation.

**PS:** *How do SMEs deal with external knowledge in order to improve firm performance?*

There is a variety of directions we can work on in order to enhance our understanding of the stated problem. We take the perspective of AC and its processes in SMEs. Our study is focused on the following three goals: (1) to understand the way how SMEs absorb external knowledge, (2) to identify the potential challenges SMEs face in the knowledge-absorbing processes, and (3) to assess the impacts of different knowledge assimilation mechanisms on the performance.

## *1.3 Research Questions*

By formulating the PS and identifying the three goals of our study, we now formulate three RQs as the target of our investigation.

Our first goal is to understand how SMEs absorb external knowledge. SMEs operate differently from the way that big companies follow, and our understanding of how SMEs absorb external knowledge in each of the AC phases is still not sufficient. The AC of SMEs deserves special attention from scholars. Thus, the first RQ is phrased as follows.

**RQ 1:** *How do SMEs absorb external knowledge?*

The second goal of our study is to identify the specific challenges SMEs may face in their knowledge-absorbing processes. According to the analysis in Section 1.2, SMEs operate differently from large companies and may face unique challenges when dealing with external knowledge. Thus, the second RQ is expressed as follows.

**RQ 2:** *What challenges do SMEs face when absorbing external knowledge?*

Our third goal is to investigate the impact of different knowledge assimilation mechanisms on the performance of SMEs. By answering RQ 1, it is expected that crucial mechanisms that SMEs utilize to assimilate external knowledge can be identified. Then, our investigation proceeds to test which knowledge assimilation mechanisms may have a positive impact on organizational performance. Hence, we phrase the third RQ as follows.

**RQ 3:** *Which knowledge assimilation mechanisms do have an impact on the performance of SMEs?*

## *1.4 Research Methodology*

According to the different nature of the three RQs, we utilize different methodologies to address them.

The examination of RQ 1 regarding how SMEs absorb external knowledge is described in Chapter 3. The goal of the examination is to generate insights into what SMEs do in each of the essential phases of their knowledge-absorbing processes. It has an exploratory and qualitative nature. We designed a semi-structured interview scheme that covers questions related to RQ 1 and conducted in-depth interviews with 16 SMEs in China. All the interviews were recorded and transcribed into text. The content of the text was analyzed systematically using qualitative research techniques, including grounded theory and content analysis. The text notes were analyzed with professional qualitative data analysis software MAXQDA[4].

The investigation of RQ 2 is described in Chapter 4 and regards what challenges SMEs may face in their knowledge-absorbing processes. Here we adopted the same method and processes as in the examination of RQ 1. Semi-structured questions on the perceived challenges of SMEs are added to the 16 interviews mentioned above. The data collection and analysis processes are similar to the ones described above.

[4] MAXQDA is a software program designed for computer-assisted qualitative and mixed methods data, text and multimedia analysis in academic, scientific, and business institutions. See further information at https://www.maxqda.com/.

To answer RQ 3, we tested if the different knowledge assimilation mechanisms identified by the qualitative study (described in Chapter 5) may have an impact on the performance of SMEs. We designed a survey to measure the intensity of each of the knowledge assimilation mechanisms in the SMEs and their respective performances. Their relations are tested with linear regression analysis with the Statistical Package for Social Science (SPSS). The data was based on 221 Chinese SMEs in various industries and areas of China.

## *1.5 Structure of the Dissertation*

Chapter 1 introduces the background of this study and embeds the research topic in the AC field. The PS is formulated, and three RQs are raised accordingly. The research methods used to address each RQs are introduced. The overall structure of this dissertation is presented at the end of the chapter.

Chapter 2 presents an extensive literature review to position the AC study in related theories. We review four theories that underpin the theoretical origin of the AC study. The relations between these fields and AC are discussed. Then it provides a review of major topics within the existing AC literature and the AC studies that are focused on SMEs.

Chapter 3 presents our examination on RQ 1 regarding how SMEs absorb external knowledge in terms of its recognition, assimilation, and utilization. Accordingly, the investigation is divided into examining three sub-RQs regarding (1) How do SMEs recognize external knowledge? (2) How do SMEs assimilate external knowledge, and (3) How is external knowledge utilized in SMEs? Specifically, it examines the criteria that SMEs use to evaluate external knowledge, the mechanisms they use to assimilate external knowledge, and their purposes of utilizing external knowledge.

Chapter 4 provides an examination of RQ 2: What challenges do SMEs face when absorbing external knowledge? It attempts to reveal the frictions or barriers that SMEs face in their knowledge absorbing absorptive processes, which include factors that

hinder the processes of absorbing external knowledge or making the processes more difficult or costlier.

Chapter 5 proceeds to investigate the performance implications of the way that how SMEs assimilate external knowledge (RQ 3). In Chapter 3, we are able to identify five external knowledge assimilation (EKA) mechanisms that SMEs often use. Based on the findings, we proceed to explore whether these EKA mechanisms can affect the performance of SMEs with a quantitative approach.

In Chapter 6, the conclusion of the study is provided. Based on the findings of previous chapters, it summarizes and provides answers to the three RQs and PS. The theoretical and managerial implications of the study are discussed. Contributions and potential limitations and constraints of our study are pointed out. Finally, the chapter provides three possible avenues for future studies.

# 2 Absorptive Capacity Literature Review

This research is dedicated to improving our understandings of three important issues regarding absorptive capacity (AC) of SMEs, which are formulated in three RQs. In summary, they deal with (1) how do SMEs absorb external knowledge in terms of its recognition, assimilation, and utilization? (2) what challenges may they face in the processes? Moreover, (3) which external knowledge assimilation (EKA) mechanisms do have an impact on the performance of SMEs? To investigate the RQs, we introduce the concept of AC as the key theoretic perspective.

This chapter serves two purposes. First, it underpins the AC study by a broader theoretical basis. Second, the chapter is aimed to demonstrate the necessity of investigating the RQs phrased in the introduction chapter. To these purposes, Section 2.1 reviews four theories that we believe underpin the theoretical origin of AC. Moreover, the relationship between AC and the four theories is elaborated upon. Then, Section 2.2 provides a review of essential topics within the existing AC literature. Based on the review, potential knowledge gaps are explored and identified in Section 2.3. The necessity of conducting this study is described accordingly.

## *2.1 Underpinning the AC Studies*

Since its introduction by Cohen and Levinthal (1989, 1990), the concept of AC has become a popular research topic. A simple search of "Absorptive Capacity" in Google Scholar (excluding citations and patents) for the AC studies in the last three decades (1989-2020) returns more than 67 thousand results. About half of them were conducted in the last ten years (from 2010 to 2020).

The AC concept has roots in several well-established concepts and theories, and the concept has been enhanced through re-conceptualizations and extended by various studies. This section introduces the most relevant theoretic perspectives that are distinct yet closely related to AC literature. Subsection 2.1.1 is focused on the resource-based view of the firms. Subsection 2.1.2 reviews the knowledge-based view of the firms. The theory of organizational learning is reviewed in Subsection 2.1.3, followed by

Subsection 2.1.4 that is focused on dynamic capabilities. Subsection 2.1.5 specifies the relationship between these research streams and AC.

### 2.1.1 Resource-based View

Penrose (1959) is one of the earliest scholars to conceptualize firms as consisting of a collection of resources. He recognizes that internal resources could contribute to a firm's competitive advantages when appropriately used and translated into demanded products and services. Wernerfelt (1984), who explicitly argues that internal resources and product outputs are two sides of a coin, stresses that internal resources at the firm level are the main determinants of sustainable competitive advantages. He suggests that a firm can earn above-normal profits by recognizing, attaining, and developing critical resources. An adequate strategy for a large firm involves achieving a balance between the exploitation of existing resources and the exploration of new ones.

The resource-based view of the firm has earned considerable attention among scholars as a framework for explaining the conditions under which a firm may gain a sustained competitive advantage. In the early strategic management literature, authors generally had given the equal emphasis on internal strengths and weaknesses within a firm versus the opportunities and threats in the external environment (e.g., Priem and Butler 2001). Other scholars have investigated how or why resources contribute to the advantage of one firm over another. For example, Barney (1991) and Barney *et al.* (2001) further articulates that the resource-based view is based on the assumption that endowments and capabilities of different companies are unevenly distributed, and the market is imperfect for resources and capabilities to be freely transferred. Only resources that own specific characteristics are critical to a firm's sustained competitive advantages. These resources must be valuable, rare, inimitable, and no-substitutable. Such resources include a combination of a firm's tangible and intangible assets, such as management scheme, knowledge, capabilities, and organizational procedure.

However, some scholars have pointed out that merely owning specific resources is not enough and critiqued the static nature of the resource-based view (cf. Priem and

Butler 2001, Newbert 2007). These authors advocated that the possession of resources will not bring competitive advantages automatically unless a firm owns competencies to alter and utilize the resources effectively, particularly when the environment is changing. Hence, firms need to develop distinctive capabilities to alter or reconfigure their internal resources, knowledge, and capabilities timely.

So, according to Barney (1991), the resource-based view has two sides. On the one hand, it stresses that knowledge and capabilities are critical organizational resources leading to strategic advantages. On the other hand, it calls for firms to develop unique capabilities to reconfigure their resources purposefully. Thus, the resource-based view of firms is seen by this study as having laid the fundamentals for many new research streams such as knowledge-based view of firms, organizational learning, and dynamic capabilities. These streams, in turn, have influenced the generation of the theory of organizational AC.

From the resource-based view, knowledge is one of the strategic resources (cf. Probst *et al.* 1998, Hult *et al.* 2006, Pee and Kankanhalli 2016). It can be either generated internally or obtained externally. Hence, the AC research coincides with the facet of the resource-based view that deals with how to obtain knowledge that is positioned as a strategic resource externally.

### 2.1.2 Knowledge-based View

The knowledge-based view of the firm is built upon the resource-based view of the firm by considering knowledge as the most crucial resource. In that regard, the knowledge-based view clearly differs from the resource-based view. Moreover, the knowledge-based view considers knowledge as the primary determinant of competitive advantage (cf. Kogut and Zander 1992, Spender and Grant 1996, Eisenhardt and Santos 2002, Caputo *et al.* 2019).

The understanding of knowledge is often made clear by relating it to data and information. Data is a fact or content that can be directly observed and verified. It is comprised of basic, unrefined, and generally unfiltered information. Information is

regarded as data that is given meanings. It contains meaning and is thereby useful. Knowledge, in turn, can be seen as information put in the context of human cognition, action, and experience. It involves the beliefs of humans and is intimately connected to action. Knowledge stems from information as information stems from data. Knowledge is more valuable than data and information as it is closer than them to human action (cf. Davenport and Prusak 1998, Dixon 2000, Bellinger *et al.* 2004, Liew 2007, van den Herik 2016, Dalkir 2017).

In companies, knowledge is often embedded in documents, rules, organizational routines, processes, practices, and also individuals (cf. Davenport and Prusak 1998, Tsoukas and Vladimirou 2001). Knowledge resides in humans, or human minds are described as tacit knowledge as a contrast to explicit knowledge. Explicit knowledge is often stored in a tangible form such as words, recordings, or pictures. In contrast, tacit knowledge is disembodied knowledge that is hard to be codified. Learning tacit knowledge is via an unstructured or semi-structured manner, such as experiencing and learning by doing.

The tacit nature of knowledge makes it difficult to be transferred and acquired (cf. Jeremy 1996, Cavusgil *et al.* 2003, Tsoukas 2005, Dalkir 2017). To make knowledge useful to others, the expression of knowledge must be interpretable (cf. Alavi and Leidner 2001, van den Herik 2016). Information is of little value unless it is processed through reflection, enlightenment, or learning. From the knowledge-based perspective, competitive firms are those that can better manage their knowledge (cf. Argote and Ingram 2000, Chuang 2004, Wang 2014). Especially, tacit knowledge has been argued to be in a central place in developing competitive advantages as it is difficult to substitute and transfer, and, on top of it, it is scarce (cf. Ambrosini and Bowman 2001, Pereira *et al.* 2012, Muthuveloo *et al.* 2017).

Davenport and Prusak (1998) suggest that the goals of KM in organizations should include: (1) making knowledge visible and show the role of knowledge in an organization, (2) developing a knowledge-intensive culture and purposely seeking and

sharing knowledge, (3) building a knowledge infrastructure to improve connections among people and encourage them to interact and collaborate for new knowledge. KM practices vary in different organizations and may include different processes (cf. Alavi and Leidner 2001, Rubenstein-Montano *et al.* 2001, Heisig 2009, Becerra-Fernandez and Sabherwal 2014). For instance, Alavi and Leidner (2001) consider KM as including four basic processes of knowledge creation, knowledge storage/retrieval, knowledge transfer, and knowledge application.

The knowledge-based view has strongly impacted the relevance of the concept of AC because AC is vital to developing, updating, and increasing a firm's knowledge base (cf. Cohen and Levinthal 1989, 1990). Hence, this study considers the knowledge-based view as a broader theoretic background against which the AC concept emerges.

### 2.1.3 Organizational Learning

Learning is "a purposive quest to retain and improve competitiveness, productivity, and innovativeness in uncertain technological and market circumstances" (Dodgson 1993, p. 378). Knowledge and organizational learning are major causes of organizational competitiveness and innovation (cf. Jiménez-Jiménez and Sanz-Valle 2011). The study of organizational learning centers on how organizations develop knowledge through the collective experiences of individuals in the organization in order to enhance organizational capabilities (cf. Fiol and Lyles 1985, Huber 1991, Slater and Narver 1995, Easterby‐Smith *et al.* 2000, Argote 2011).

Organizational learning research relates to AC in a few ways. Some fields of organizational learning overlap with AC research. For instance, organizational learning deals with learning at different levels of organizational communities. According to Tucker et al. (2007), organizational learning deals with learning at four levels: (1) individual, (2) group, (3) organization, and (4) inter-organization. Organizational learning involves various processes at different levels. For instance, Crossan *et al.* (1999) divide organizational learning into four processes: (1) intuiting, (2) interpreting, (3) integrating, and (4) institutionalizing. The intuiting and interpreting processes are

believed to occur mainly at the individual level. Integrating happens at the group level and institutionalizing at the organizational level.

Among the four levels, studies on inter-organizational learning are focused on how different organizations cooperate, share knowledge, and learn from one another (see Tucker *et al.* 2007). In comparison, AC studies focus on how organizations absorb external knowledge through recognition, assimilation, and utilization (see Cohen and Levinthal 1990). The external knowledge in AC studies is always created by other organizations and must cross organizational boundaries to be absorbed. Hence, AC studies can be viewed as coinciding with organizational learning at the inter-organizational level.

Furthermore, from the process perspective, Argote (2011, 2012) conceives organizational learning as including three sub-processes: (1) knowledge creation, (2) knowledge retention, and (3) knowledge transfer. The third sub-process, i.e., knowledge transfer, refers to knowledge sharing within and between organizations. Through knowledge transfer, an organization can learn and benefit from the knowledge spillovers from other organizations. So, studies of knowledge transfer in organizational learning overlap largely with AC studies as well. Here, the focus is on how an organization could improve its ability to quickly recognize, assimilate, and utilize external knowledge.

Therefore, we see organizational learning as representing a broader research area than AC. In this study, AC research is viewed as a branch of the organizational learning theory that focuses on knowledge transfer at the inter-organizational level (cf. Huber 1991, Beeby and Booth 2000, Argote 2011, Eiriz *et al.* 2017).

### 2.1.4 Dynamic Capabilities

Teece et al. (1997, p. 516) define dynamic capabilities as "the firm's ability to integrate, build, and reconfigure internal and external competencies to address rapidly changing environments". Eisenhardt and Martin (2000) consider dynamic capabilities as a firm's routines that utilize resources to match and even produce market change, specifically the processes to obtain, integrate, recombine, and release resources. The

resource-based view of the firm emphasizes the role of valuable, rare, inimitable, and no-substitutable resources on sustainable competitive advantage (see Barney 1991). The theory of dynamic capabilities extends the resource-based view to the dynamic markets. It focuses more on the role of a firm's capacity to promptly reconfiguring internal resources and capabilities in a rapidly changing environment (see Teece *et al.* 1997). Amit and Schoemaker (1993, p. 35) state that capabilities "refer to a firm's capacity to deploy resources, usually in combination, using organizational processes, to effect a desired end". From a routine-based perspective, dynamic capabilities are formed from various well-known processes such as alliancing, product development, and strategic decision making (cf. Eisenhardt and Martin 2000, Pavlou and El Sawy 2011, Teece 2018).

Some authors such as Vogel and Güttel (2013) labeled the core cluster of the literature of dynamic capabilities as "strategic learning and change" as it focuses on learning capabilities and relates them to company performance. They pay more attention to knowledge resources than their predecessors. This school of authors advocates that knowledge resources can be translated into human capital and firm capabilities through learning mechanisms at different levels. For instance, Zahra and George (2002, p. 185) treat AC as a "dynamic capability pertaining to knowledge creation and utilization". Hence, our study sees AC as one aspect of organizational dynamic capabilities.

### 2.1.5 Embedding AC in other Theories

Whatever the case, we consider the AC literature as being built upon a few related research streams. The resource-based view on companies is seen as a more fundamental theory underlying the knowledge-based view and theory of dynamic capabilities. Knowledge is a valuable resource. To obtain external knowledge is one aspect of managing all resource assets. Organizational learning is taken as arising from the knowledge-based view of firms. The study of AC overlaps with some sub-areas of organizational learning and dynamic capabilities. We view AC studies as overlapping with knowledge transfer studies of organizational learning at the inter-organizational level. AC is regarded by Zahra and George (2002) as one of the dynamic organizational

capabilities that deal mainly with how organizations accumulate and utilize knowledge from their environment (cf. Huber 1991, Zahra and George 2002, Argote 2011, Ince *et al.* 2016).

The underpinning of AC in this study is illustrated in Figure 2.1.

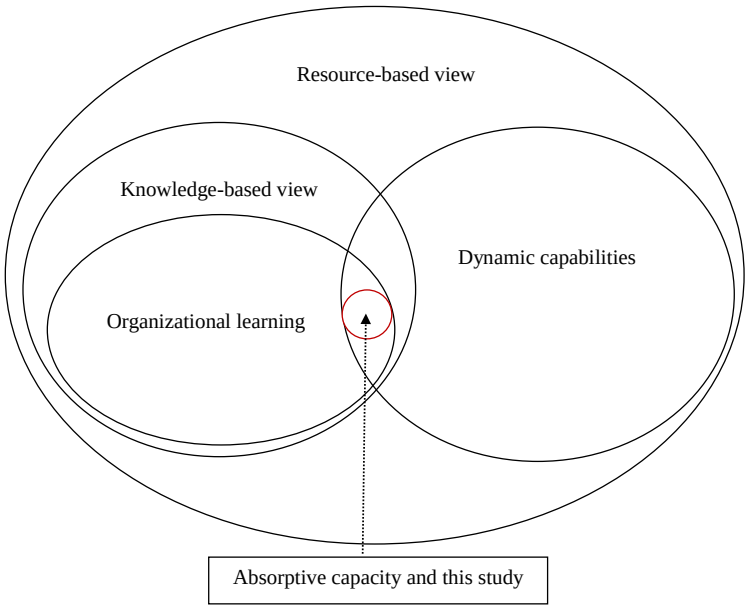


**Figure 2.1: Theoretical Underpinnings of AC**

## *2.2 AC Literature*

AC has been a hot topic for three decades. Many works were devoted to reflecting, summarizing, and advancing the theoretical development of the concept. A few prominent examples are papers written by Cohen and Levinthal (1989, 1990), Zahra and George (2002), Lane *et al.* (2006), Todorova and Durisin (2007), Volberda *et al.* (2010), Lewin *et al.* (2011), Duchek (2013), Marabelli and Newell (2014), Senivongse *et al.* (2015), and Apriliyanti and Alon (2017). These studies not only build the theory of AC but also outline the main research streams of existing AC studies. Based on these work, the current section focuses on five aspects of existing AC studies: conceptualization of AC (Subsection 2.2.1), consequences of AC (Subsection 2.2.2), sources of AC (Subsection 2.2.3), measurement of AC (Subsection 2.2.4), and AC studies focused on SMEs (Subsection 2.2.5).

### 2.2.1 Conceptualization of AC

Cohen and Levinthal (1989, 1990) laid the theoretical fundament of the AC concept. They advocate that a firm's R&D is not only a direct source of new knowledge but also produces an ability which decides how much a firm can benefit from external knowledge spillovers. Knowledge spillover is defined in our study as follows (Definition 2.1).

**Definition 2.1: Knowledge Spillover**

> *Knowledge spillover* is the technical and organizational knowledge that is transferred among different agents such as another associate, competitor, supplier firm, or any other agent that they interact with. Both formal arrangements (e.g., licensing) and informal mechanisms (e.g., learning from social networks) can be involved (adapted from Dutrénit and Vera-Cruz 2003).

Cohen and Levinthal (1989, 1990) consider AC as a byproduct of in-house R&D. Both in-house R&D and acquisition of external knowledge contribute directly to a firm's accumulated knowledge base. In their conceptualization, in-house R&D is not only a direct source of a firm's knowledge base but also enables a firm to better benefit from external knowledge by enhancing its learning capabilities or AC. The exploitation of external knowledge is realized through the *interaction* of a firm's AC with external knowledge spillover. AC can be viewed as a *moderator* between the external knowledge spillovers and the ultimate benefit the firm can realize from the knowledge spillovers. With a strong AC, a firm may better recognize, assimilate, and utilize the external knowledge spillovers to improve its competitiveness. With a weak AC, a firm may not effectively absorb external knowledge for its benefits, even though there are many potential knowledge spillovers outside.

The interaction signifies that a firm cannot absorb externally available knowledge passively. To utilize the external knowledge effectively, the firm has to build its AC by investing in in-house R&D.

The relations between a firm's in-house R&D, AC, external knowledge spillover, and accumulated knowledge base are illustrated in Figure 2.2.

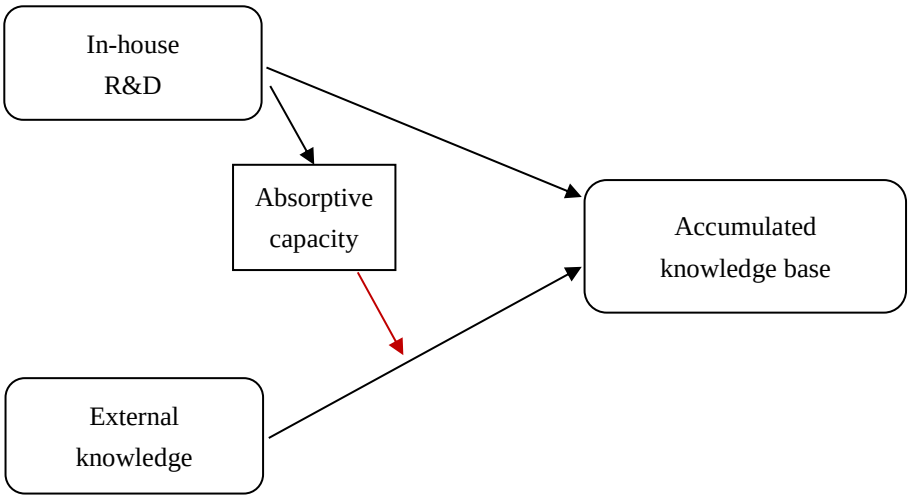


**Figure 2.2: Relations between In-house R&D, AC, and External Knowledge**

Source: Cohen and Levinthal (1990)

AC is of particular importance in adopting innovation in areas that require complementary internal efforts and pre-existing related knowledge (cf. Cohen and Levinthal 1989, 1990). Since Cohen and Levinthal's (1989, 1990) seminal work, many authors cited the concept and added their understanding to define them. Generally, most authors agree that AC is a series of capabilities needed to learn from others and obtain external knowledge. For instance, Mowery and Oxley (1995) treat AC as a set of organizational capabilities needed to handle the tacit aspects of inwardly transferred knowledge and the ability to apply a foreign-sourced innovation for domestic scenarios. Kim (1998) sees AC as organizational capabilities to assimilate external knowledge for imitation and problem-solving skills to generate new knowledge for innovation.

Lane and Lubatkin (1998) invented the term "relative AC" to describe the phenomenon that a firm's AC is relative, and firms have various levels of AC when absorbing knowledge from different external organizations. They argue that a firm's capacity to learn from other organizations depends on the similarity between them. The more similarity the student and teacher firms have, the easier the student firm can recognize, assimilate, and utilize knowledge originating from the teacher firm. Except for the similarity in prior knowledge bases, they suggest that similarity in organizational structures, compensation policies, and dominant logics also contribute to enhancing a

firm's AC. The relationship between the performance of inter-organizational learning and the degree of similarity may not be linear. Too much similarity may reduce the potential of inter-organizational learning, as there is not much to learn from each other.

Thus, the challenge is to decide an optimal level of similarity so that there is sufficient dissimilarity to learn something new, but not so different as to preclude mutual understanding and productive knowledge exchange (see Nooteboom *et al.* 2007). Their point of view adds to Cohen and Levinthal's suggestion that diversity help individuals think innovatively and make novel linkages by stressing that a certain degree of similarity between different organizations can increase efficiency in communication and inter-organizational learning.

In Cohen and Levinthal's (1989, 1990) original conceptualization, AC is divided into three processes: (1) external knowledge recognition (EKR) (see Definition 1.7), (2) external knowledge assimilation (EKA) (see Definition 1.8), and (3) external knowledge utilization (EKU) (see Definition 1.9). Some other authors extend the concept by treating AC as a four-dimension concept, including (1) external knowledge acquisition by (a) identifying and (b) acquiring the new knowledge, (2) external knowledge assimilation based on current knowledge base, (3) transformation of the knowledge by expanding the firm's existing knowledge base, and (4) exploitation of this knowledge by delivering high-value knowledge and products and services (see Zahra and George 2002).

Both the three-dimensional conceptualization and the four-dimensional conceptualization cover the complete knowledge absorbing process. However, Cohen and Levinthal (1989, 1990) phrased the first process of AC as knowledge recognition through identifying or evaluating the potential external knowledge. Zahra and George (2002) expressed the first step as knowledge acquisition by (a) identifying external knowledge and (b) then acquiring it. Hence, the knowledge identification activity is similar to the knowledge recognition process in Cohen and Levinthal's (1989, 1990) conceptualization. Though Cohen and Levinthal (1989, 1990) do not phrase knowledge acquisition and transformation as individual processes, the knowledge assimilation process in their definition can be regarded as relating to the acquiring activity,

knowledge assimilation, and knowledge transformation process contained in the conceptualization by Zahra and George (2002). The knowledge acquiring activity in the knowledge acquisition process and the knowledge transformation process of the conceptualization by Zahra and George (2002) can be incorporated in the knowledge assimilation process because knowledge assimilation can only occur after the intended knowledge is acquired, and the necessary transformation is completed (see Todorova and Durisin 2007). Hence, the knowledge assimilation process in Cohen and Levinthal's (1989, 1990) definition can be regarded as corresponding to the knowledge acquiring activity, the knowledge assimilation process, and the knowledge transformation process in the definition of Zahra and George (2002). The knowledge utilization process in Cohen and Levinthal's (1989, 1990) conceptualization coincides with the knowledge exploitation process in Zahra and George's (2002) conceptualization in a way that both emphasize realizing the value of the external knowledge assimilated.

Zahra and George (2002) further define the first two dimensions in their definition as the potential AC and the latter two dimensions as the realized AC. Potential AC represents a firm's receptivity to acquiring and assimilating new knowledge. Realized AC is a firm's ability to transform and exploit acquired knowledge, which represents a firm's capacity to leverage and profit from the absorbed knowledge (see Zahra and George 2002). Zahra and George further argue that potential AC and realized AC could be distributed unevenly within the same firm as "…firms can acquire and assimilate knowledge but might not have the capability to transform and exploit the knowledge for profit generation" (Zahra and George 2002, p. 191).

In their conceptualization, Lewin *et al.* (2011) decompose the construct of AC into two components: internal AC and external AC. Internal AC is a firm's ability to manage the processes of internal variation, selection, and replication of new knowledge and best practices. External AC is defined as the exploration of new knowledge in the external environment and the assimilation process.

More recently, Song *et al.* (2018) identified three dimensions of AC, including (1) absorptive knowledge base, (2) absorptive effort, and (3) absorptive process. The absorptive knowledge base is the existing knowledge stock of a company. Absorptive effort refers to the investments committed by a firm for building up knowledge. The absorptive process includes a firm's internal procedures and practices connected to knowledge diffusion.

Different conceptualizations of AC may have consequences in determining how it is operationalized, particularly when we decide what and how many processes AC may contain. It also influences how AC is measured in quantitative studies, as many non-R&D measurements gauge AC by directly measuring each of its dimensions or processes (see Subsection 2.2.4).

Table 2.1 shows the five most cited AC conceptualizations identified by this study.

### 2.2.2 Consequences of AC

Cohen and Levinthal (1990) suggest that AC influences expectation formation and the aspiration level of the firm. It allows the firm to foresee more accurately the nature and commercial value of new technology. Hence, a higher level of AC will lead to a firm's proactiveness in exploiting new external opportunities (cf. Cohen and Levinthal 1990). Scholars have since cited AC to explain variances between firms in competitive advantages and organizational performance. Most existing studies have supported that AC has a significant positive effect on firm performance (e.g., Song *et al.* 2018).

**Table 2.1: Important AC Conceptualizations**

| Key conceptualization | Contributions to the conceptualization of AC | Source |
|---|---|---|
| Three-dimensional conceptualization: AC is a set of organizational capabilities to (1) recognize, (2) assimilate, and (3) utilize external knowledge. | Laying the groundwork by conceptualizing AC and highlighting the role of it in accumulating knowledge and innovation | Cohen and Levinthal (1990) |
| Relative AC: A firm's AC is relative, and firms have various levels of AC when absorbing knowledge from different external organizations. | AC is not solely determined by internal factors but also by relations with external sources, such as the similarity between the two | Lane and Lubatkin (1998) |
| AC is divided into (A) potential AC and (B) realized AC. Potential AC represents a firm's receptivity to (1) acquiring, and (2) assimilating new knowledge. Realized AC is a firm's ability to (3) transform, and (4) exploit acquired knowledge, which represents a firm's capacity to leverage and profit from the absorbed knowledge. | Extending the AC concept to four dimensions, and further highlighting that potential AC and realized AC are two different aspects of AC, and they can be distributed unevenly within the same firm | Zahra and George (2002) |
| AC is divided into (1) Internal AC as internal variation, selection, and replication of new knowledge and best practices, and (2) external AC as the exploration for new knowledge in the external environment and the assimilation process. | Underlying that both internal and external processes are essential in absorbing external knowledge | Lewin *et al.* (2011) |
| Three dimensions are divided: (1) absorptive knowledge base, (2) absorptive effort, and (3) absorptive process. | Identifying three groups of sources of AC, and incorporating the sources into its conceptualization | Song *et al.* (2018) |

According to Zahra and George (2002), firms with a higher potential AC, higher capabilities of knowledge acquisition and assimilation, are more capable of updating their knowledge base and other capabilities needed for competing in a changing environment. AC directly enhances organizational performance indirectly through mediators. For instance, Zahra and George (2002) suggest that a well-developed realized AC can achieve a competitive advantage through more successful innovation and product development. Chang *et al.* (2013) find that realized AC and potential AC are positively associated with market responsiveness and firm innovativeness, which are important aspects of firm performance. Through a meta-analysis of 241 studies, Zou *et*

*al.* (2018) find that the effect of AC effects on firms' financial performance is fully mediated innovation and knowledge transfer.

However, firms may also be worse off to have too much AC. According to Cohen and Levinthal (1989), an existing knowledge base in combination with an AC may have both positive and negative influences on knowledge absorption processes in companies. On the one hand, existing knowledge defines the locus of knowledge search. It makes the knowledge absorbing process more effective when the intended knowledge is connected to the existing knowledge base. On the other hand, prior experience and knowledge may limit a firm's search scope only to areas that are proximate and familiar to the existing knowledge. Hence, AC has a path-dependent or accumulative nature in its conceptualization.

Some authors caution that firms need to have a balance between their potential AC and realized AC. They argue that, if too many resources were concentrated on acquiring and assimilating external knowledge, firms might suffer from high costs incurred in the acquisition and assimilation processes without being able to exploit the potential value of the acquired knowledge (e.g., Zahra and George 2002, Lichtenthaler 2009).

Hence, the relationship between AC and organizational performance is more likely to be curvilinear instead of linear. Based on data from 285 technology-based small and medium enterprises, Wales *et al.* (2013) suggest an inverted-U shaped relationship between AC and financial firm performance. When the measures exceed the optimal level, AC even has a negative effect on performance and becomes harmful to firms.

The review above shows that the current way of measuring the impact that AC may have on the firms is still not conclusive. More studies are needed to uncover (1) the mechanisms through which AC may have an impact and (2) the specific conditions surrounding the measuring procedure.

### 2.2.3 Sources of AC

This subsection deals with sources of AC. We distinguish two distinct lines: (A) organizational factors that influence of AC, and (B) environmental factors that influence AC.

#### A: Organizational Factors that Influence AC

To fully exploit the AC concept and explore future fruitful extensions of the concept, we need to understand what organizational factors may help build up AC (cf. Volberda *et al.* 2010). Drawing from the cognitive basis for an individual's learning ability, Cohen and Levinthal (1990) see prior knowledge and diverse expertise as the most direct sources of organizational AC. Hence, measures that contribute to knowledge creation and accumulation in certain areas, such as R&D investment, manufacturing activities, and external collaboration, can help enhance a firm's AC. Among these measures, R&D investment is considered the most important source of AC. Some researchers advocate that AC research should be extended to non-R&D contexts in order to capture the complexity of its various dimensions because AC is not a static resource but a process or ability (e.g., Lane *et al.* 2006).

Some authors have emphasized four organizational factors that are essential to enhance the AC of a firm: (1) prior relevant knowledge, (2) effective communication network, (3) appropriate communication climate, and (4) effective knowledge scanning (e.g., Tu *et al.* 2006, Ali *et al.* 2013). Employee ability and motivation are also principal sources of the firm's AC (e.g., Martinkenaite and Breunig 2016, Elbaz *et al.* 2018). That is consistent with Cohen and Levinthal's (1990) argument that AC resides in individual employees who work in the firm. Particularly, a firm's AC depends on the key individuals who are responsible for interacting with external knowledge sources and communicating between different subunits in the firm. Knowledge workers' cognitive process of perspective-taking and their creative behavior are important micro-foundations of AC (cf. Volberda *et al.* 2010, Distel 2019).

The study by Duchek (2015) showed that a firm's AC not only depends on the basic organizational form but also on complementary structures. R&D centrality, gatekeeper

positions, and interface positions matter when transferring knowledge across different organizations and business units. For instance, a centralized R&D unit can broaden the search scope and enhance the efficiency of the knowledge absorption process. Gatekeeper positions help acquire external knowledge and disseminate internal knowledge across the organization, and interface positions facilitate better integration and application of the acquired knowledge.

AC was first seen as one of a firm's capabilities. Grant (1991) argues that capability is essentially a routine or some interacting routines. Organizational Routines (Definition 2.2) in this study are defined as follows.

**Definition 2.2: Organizational Routines**

*Organizational routines* are defined in this study as distinct behavioral patterns that involve both formal and informal processes and sophisticated social practices in organizations (Adapted from Dosi *et al.* 2001, Nicolini *et al.* 2003).

Seeing AC as comprising various routines, Vinding (2004) stresses that HRM practices such as formal education, work experience, the organizational set-up, and a closer relationship between different actors, all contribute to enhancing a firm's AC. In a more recent study, Zhou *et al.* (2020) find that different dimensions of AC can be developed by specific HRM practices. For example, better internal communication can facilitate knowledge acquisition capability. Internal training has a positive impact on knowledge assimilation capability, and greater use of performance appraisal systems can positively influence the knowledge exploitation capabilities of the companies.

Some authors have investigated the role of some other specific organizational practices on absorbing external knowledge. Such organizational practices include the participation of academic and industrial conferences (e.g., Spencer 2003), technological alliances with external partners (e.g., Anand *et al.* 2010, Love *et al.* 2016), collaboration with universities and research institutes (e.g., Bishop *et al.* 2011, Rajalo and Vadi 2017), utilization of online database and open-source resources (e.g., Vujovic and Parm Ulhøi

2008, Hossain *et al.* 2018), provider and user involvement (e.g., Möller *et al.* 2008, McQueen 2019). The knowledge-building investments made by a firm, the current knowledge stock of a firm, and a firm's internal procedures and practices related to knowledge diffusion are also seen as primary sources of organizational AC by Song *et al.* (2018).

Table 2.2 lists some of the essential organizational factors of AC identified by this study.

**Table 2.2: Organizational Factors that Influence AC**

| Important Factors that Influence AC | Examples of Related Authors |
|---|---|
| Prior knowledge and diverse expertise: R&D investment, manufacturing activities, and external collaboration | e.g., Cohen & Levinthal (1989; 1990) |
| Diverse and complementary sources of external knowledge and experience | e.g., Zahra and George (2002) |
| Prior relevant knowledge, communications network, communications climate, and knowledge scanning mechanisms. | e.g., Tu *et al.* (2006); Ali *et al.* (2013) |
| Employees' ability and motivation | e.g., Martinkenaite and Breunig (2016); Elbaz *et al.* (2018) |
| Knowledge-building investments made by a firm, current knowledge stock of a firm, and a firm's internal procedures and practices related to knowledge diffusion | e.g., Song *et al.* (2018) |
| HRM practices, such as formal education, work experience, the organizational set-up, a closer relationship between different actors, internal communication and training, and performance appraisal systems | e.g., Lund Vinding (2004); Zhou *et al.* (2020) |

### B: Environmental Factors that Influence AC

Some scholars have emphasized environmental factors that affect knowledge-absorbing processes and the outcomes in organizations (see Table 2.3). One frequently mentioned environmental factor by many authors is the *regime of appropriability* (e.g., Cohen and Levinthal 1990, Zahra and George 2002, Volberda *et al.* 2010, Crowley and Jordan 2018). The regime of appropriability refers to the institutional and industry

dynamics that affect a firm's ability to take advantage of new technology and innovation (cf. Hurmelinna *et al.* 2007, Hurmelinna‐Laukkanen *et al.* 2008).

**Table 2.3: Environmental Factors of AC**

| Environmental factors that affect AC | Authors |
|---|---|
| The regime of appropriability | e.g., Cohen and Levinthal (1989, 1990) |
| The regime of appropriability, activation triggers, social integration mechanisms | e.g., Zahra and George (2002) |
| Power relations | e.g., Todorova and Durisin (2007) |
| The intensity of competitiveness, dynamism, knowledge characteristics, and the regime of appropriability | e.g., Volberda *et al.* (2010); Wang *et al.* (2015) |
| Knowledge type ("what"), governance mode used for approaching external knowledge ("how"), and source of external knowledge ("from whom") | e.g., Song *et al.* (2018) |
| Organizational culture | e.g., Zerwas (2014); Limaj and Bernroider (2019) |

Traditionally, it was believed that a firm's incentive to invest in internal R&D decreases under weak regimes as it is hard for companies to appropriate the outcomes of their R&D investment. The investment might be uneconomic because competitors can easily copy or imitate the outcomes (cf. Boisot and Griffiths 1999, Crowley and Jordan 2018). When the appropriability is low, it is easy to copy from other companies. That may increase the opportunity to absorb their knowledge. In such cases, plenty of external spillovers may encourage internal R&D investment because firms need to build a high level of AC through R&D investment in order to better benefit from external knowledge. According to Cohen and Levinthal (1990), the positive absorption incentive associated with spillovers may be strong enough in some cases to offset the negative appropriability incentive.

Except for the regime of appropriability, factors such as activation triggers and social integration mechanisms may also moderate a firm's ability to translate external knowledge into its competitive advantages (see Zahra and George 2002). Todorova and Durisin (2007) see power relations, and Volberda *et al.* (2010) consider the intensity of competitiveness, dynamism, and knowledge characteristics as environmental factors

that may affect an organizational AC. Song *et al.* (2018) discern knowledge type ("what"), ways of governance for approaching external knowledge ("how"), and source of external knowledge ("from whom") as three important contingency factors that influence outcomes of absorbing external knowledge. A more open and balanced organizational culture can also affect a firm's ability to benefit from new knowledge absorbed from external sources (cf. Harrington and Guimaraes 2005, Zerwas 2014, Limaj and Bernroider 2019).

The existence of various factors that can affect AC, particularly the environmental factors, indicates that it is not an easy task to build up AC and to determine how AC may affect the organizations. It is decided by the specific characteristics of the organization and the circumstances surrounding it. Hence, it is beneficial in the future AC studies to specify the circumstances surrounding them and extend the investigations to different scenarios.

### 2.2.4 Measurement of AC

In order to better understand how AC interacts with other factors such as organizational performance, many empirical studies focused on AC emerge, and a variety of measures of AC have been developed. In general, there are two primary ways of measuring AC in existing studies: (A) R&D-related measures and (B) Non-R&D measures.

#### A: R&D-related measures

The majority of empirical studies on AC uses R&D-related indicators to measure the construct rather than measure it directly. Both input and output related indicators are used as proxies for AC. Frequently used R&D-related input indicators for AC include R&D intensity measured by R&D spending as a percentage of company sales (e.g., Cohen and Levinthal 1990, Stock *et al.* 2001), or the size of R&D personnel (e.g., Gao *et al.* 2008, Huang *et al.* 2015c). Output-oriented indicators of AC include the number of patents and patent citations (e.g., Mowery *et al.* 1996, George *et al.* 2001), or the number of R&D publications and their cross-citation rate (e.g., Deeds 2001). Some

authors measure AC by combining different output indicators such as R&D intensity and the number of patent citations (e.g., Kostopoulos *et al.* 2011, Aldieri *et al.* 2018).

However, some scholars have expressed concerns and critics on the use of R&D-related proxies to measure AC. A few even provide empirical evidence about the relatively low explanatory power of R&D spending in comparison to the explanatory power of multiple dimensions of AC (e.g., Lane and Lubatkin 1998, Lichtenthaler 2009). Organizational AC consists of various organizational practices that are beyond R&D-related activities.

Though Cohen and Levinthal (1989, 1990) initially consider the AC as a byproduct of in-house R&D, the role of non-R&D activities, such as manufacturing and HRM, in building up firm AC are also recognized. Duchek (2013) argues that using only R&D-related proxies to measure AC fails to capture the multidimensional and structural nature of AC. Most of these R&D-related measures are particularly inadequate for SMEs. Because SMEs do not always have a specific R&D department, and many SMEs consider the patent process to be too expensive and time-consuming. Furthermore, the absence of an R&D department or a patent registration policy in most SMEs does not represent that they do not absorb external knowledge (cf. Hervas-Oliver *et al.* 2012, Chauvet 2014).

### B: Non-R&D measures

Many other studies have used non-R&D proxies for AC. These non-R&D measures often correspond to different AC conceptualizations. The focus is on accurately identifying the processes firms adopt in absorbing external knowledge, linking them to separate components or dimensions of AC, and then adequately measuring them by using surveys or questionnaires (cf. Cadiz *et al.* 2009, Jiménez-Barrionuevo *et al.* 2011, Harris and Yan 2019).

Some researchers treat AC as a one-dimensional concept and have developed single questions or a set of questions to measure the overall AC. For example, Szulanski (1996) and Su *et al.* (2013) treated AC as a one-dimensional construct. They measured it with

designed items to capture the overall ability of firms to identify, assimilate, and apply external knowledge.

Due to the multi-dimensional nature of AC, it is believed that a single one-dimensional measure is not appropriate to measure AC. In a study focused on the relationship between HRM practices, AC, and knowledge transfer in multinational corporations, Minbaeva *et al.* (2003) conceptualize AC as comprising employees' ability and motivation. They develop three items to indicate ability and five items to indicate motivation as a measurement of AC. Some recognize the multi-dimensional nature of AC and developed measures for the three processes of knowledge recognition, assimilation, and utilization (e.g., Lane *et al.* 2001, Cadiz *et al.* 2009, Zobel 2017). Nieto and Quevedo (2005) use four groups of non-R&D factors as the proxy indicators in their questionnaire to measure a firm's AC, including (1) external communication, (2) intensity of internal know-how and experience, (3) knowledge breadth and overlaps in the knowledge structure, and (4) strategic positioning.

Tu *et al.* (2006) and Ali *et al.* (2013) consider AC as a second-order construct comprised of four first-order sub-constructs: (1) prior relevant knowledge, (2) communication network, (3) communication climate, and (4) knowledge scanning. They measure AC by developing items to measure each of the four sub-constructs. Some others treat AC as a four-dimensional concept that includes acquisition, assimilation, transformation, and exploitation and develop scales of them to measure AC quantitively (e.g., Jansen *et al.* 2005, Chauvet 2014). Jiménez-Barrionuevo *et al.* (2011) and Flatten *et al.* (2011a) differentiate between acquisition, assimilation, transformation, and exploitation and develop a measurement for each of the dimensions with questionnaires.

The significant difference between the one-dimensional measurement and multidimensional measurement is that the latter allows researchers to single out a specific individual dimension for analysis as different components of AC are measured and distinguished. Though the one-dimensional measure of AC may adopt multiple items or indicators, the measures are down to a scale of the concept as a whole. Duchek

(2013) argues that these non-R&D measures can provide more useful information about the degree of AC than the R&D-related indicators, as the former identifies the process of knowledge absorption.

Table 2.4 shows an overview of different measurement methods over AC.

**Table 2.4: Different Measurement of AC**

| Categories of measurement | | Authors |
|---|---|---|
| R&D-related measures | Input indicators | e.g., Cohen and Levinthal (1990); Stock *et al.* (2001); Gao *et al.* (2008); Huang *et al.* (2015c) |
| | Output indicators | e.g., Mowery *et al.* (1996); George *et al.* (2001); Deeds (2001) |
| | Integrating both input and output indicators | e.g., Kostopoulos *et al.* (2011); Aldieri *et al.* (2018) |
| Non-R&D measures | One-dimensional measures | e.g., Szulanski (1996); Su *et al.* (2013) |
| | Multi-dimensional measures | e.g., Minbaeva *et al.* (2003); Nieto and Quevedo (2005); Ali *et al.* (2013); Zobel (2017) |

Based on the previous discussion, we may conclude that multidimensional non-R&D measures seem to be better indicators of AC in quantitative studies.

### 2.2.5 AC Studies on SMEs

Smaller companies typically suffer from scarce resources comparing to big firms (cf. Carson *et al.* 1995, Gruber 2003). Except for the lack of tangible resources, SMEs tend to lack specific competencies and knowledge comparing to big firms. Freel (1999) identified technical skills in the workforce, managerial competency, and poor marketing skills as primary skills that small firms may lack compared to more prominent companies. Gray (2006) suggests that the knowledge base in smaller companies, micro-firms in particular, is weak compared with larger firms.

Many authors have applied the concept of AC to examine how SMEs collaborate with external sources for new knowledge and innovation and the impact of absorptive on SMEs. For instance, Liao *et al.* (2003) examined the relationship between different dimensions of AC and organizational responsiveness in the context of 284 growth-oriented SMEs. Organizational responsiveness refers to the action organizations take in

response to the new information acquired and disseminated. It is related to organizational performance and reflects how fast and how well coordination with which actions are implemented and periodically reviewed. The study operationalizes AC into two dimensions: external knowledge acquisition and intra-firm knowledge dissemination. They designed measures of each dimension and organizational responsiveness. The results of the quantitative study indicate that both dimensions of the AC of SMEs have positive effects on their organizational responsiveness.

In a study testing potential mediating effect of strategic alliances between AC and the performance of SMEs, Flatten *et al.* (2011b) suggest that AC has a positive effect on SME performance. Strategic alliances partially mediate the relationship between AC and firm performance. In other words, AC impacts organizational performance, both directly and indirectly. The indirect impact of AC on firm performance is exerted through influencing strategic alliances, and strategic alliances, in turn, have a positive impact on the performance of SMEs.

From a practice-based perspective, Duchek (2015) investigated what organizational structure may determine the AC of SMEs with a qualitative approach. With case studies of two innovative medium-sized firms in the German engineering industry, the study suggests that division form, the centrality of R&D, gatekeeper positions, and interface positions are essential determinants of AC.

More recently, Aboelmaged and Hashem (2019) examined the relationships between AC, sustainable capabilities, and green innovation adoption in the SME context. The result of the study shows that AC positively influences sustainable capabilities and green technology adoption in SMEs. Further, the findings indicate that sustainable orientation and collaboration capabilities mediate the effect of AC on green innovation adoption.

Most of the existing AC studies, particularly quantitative ones, cite the concept of AC without providing its definition. AC is treated in the studies like a black box without clarification of what operational processes it may contain. Therefore, some researchers have called for more empirical studies focusing on the inherent processes of knowledge

absorption (e.g., Lewin *et al.* 2011, Marabelli and Newell 2014, Duchek 2015). Consequently, the outcomes of current studies lack valid operational suggestions that can direct management practices in SMEs.

Whatever the case, the majority of the theory development of AC has been based on big firms. It is evidenced by many authors treating AC as a byproduct of R&D activities and uses R&D-related indicators to represent AC (cf. Cohen and Levinthal 1990, George *et al.* 2001, Aldieri *et al.* 2018). However, most SMEs are in non-technology industries. Moreover, even in technology-based industries, SMEs tend to be lacking the resources to invest heavily in R&D (cf. Narula 2004, Väyrynen *et al.* 2017). Thus, the current conclusions reached from AC studies on big firms may not apply to SMEs. Therefore, separating SMEs from large firms in studies on AC processes is necessary and deserves more special attention.

## *2.3 Chapter Conclusion*

In this chapter, we reviewed literature related to the concept of AC and specified relations between AC and four theories. By doing so, we positioned AC and our study in a broad and sound theoretic base. The four theories investigated include the resource-based view, the knowledge-based view, organizational learning, and dynamic capabilities. They are reviewed in relation to each other. Then, this chapter took a close look at the existing studies that are focused on AC. Several vital topics discussed in previous AC studies, including its conceptualization, sources of AC, measurement of AC, and AC studies and SMEs, are highlighted and discussed in the chapter.

Based on our analysis, we may conclude that we need to (1) improve our understanding of the knowledge-absorbing processes in SMEs and (2) formulate more operational suggestions on how SMEs should absorb external knowledge. Our study will adopt both qualitative and quantitative methods to investigate (1) how SMEs absorb external knowledge, (2) what challenges they face in the AC processes, and (3) whether different knowledge assimilation mechanisms have an impact on firm performance.

In the next chapter, we use in-depth interviews to investigate specific processes of SMEs to absorb external knowledge. With the interviews, we attempt to address the issues of how SMEs absorb external knowledge from a process view.

# 3 External Knowledge Absorption in SMEs

This chapter[5] addresses RQ 1: How do SMEs absorb external knowledge? We will explore the underlying routines and practices in the knowledge-absorbing processes of SMEs. Section 3.1 of this chapter introduces the knowledge-absorbing processes, and Section 3.2 divides RQ 1 into three sub-RQs. Then, Section 3.3 describes how the study is conducted by introducing the research method, the data collection, and the analysis processes. Following that, Section 3.4 provides answers to each of the sub-RQs and combines them with discussions. Section 3.5 concludes the chapter with a summary.

## *3.1 External Knowledge-Absorbing Processes*

Knowledge has become the critical factor of the societal development on which modern economies are based. It is widely recognized that knowledge is of utmost importance in building up organizational competitive advantages (cf. Davenport and Prusak 1998, McEvily and Chakravarthy 2002, Andersson *et al.* 2009, Antonelli and Fassio 2016). Scholars in the innovation network streams suggest that firms should "seek to create value and extract value from the network" (Dhanaraj and Parkhe 2006, p. 659). Chesbrough (2003) advocates that companies should purposively use inflows and outflows of knowledge and resources to facilitate internal innovation and expand the markets for external utilization of innovation. Knowledge management (KM) researchers have devoted efforts to enhance our understanding of how organizations identify and leverage collective knowledge to increase innovativeness and responsiveness for competition (cf. Gupta and Sharma 2004, Girard 2015).

To be able to benefit from external resources and knowledge, Cohen and Levinthal (1990) argue that organizations need to develop absorptive capacity (AC) to quickly recognize the value of new external knowledge, assimilate it, and utilize it to create commercial value. Since its origination, the concept of AC has attracted much attention

[5] Chapter 3 and 4 are based on the publication with permission of the authors: Pi L., Paetzold, K., Ortt, J.R., "How SMEs Absorb External knowledge: Interviews on Chinese Entrepreneurs", 24th International Conference on Engineering, Technology and Innovation, 2018, Stuttgart, Germany, © 2018 IEEE.

from scholars. Many authors have devoted efforts to developing the concept and apply it to the analysis of different phenomena in various fields. Most of the studies consider AC as a concept consisting of different processes regarding how to deal with external knowledge.

In the conceptualization by Cohen and Levinthal (1990), AC consists of three essential processes: (1) external knowledge recognition (EKR), (2) external knowledge assimilation (EKA), and (3) external knowledge utilization (EKU). In contrast, some authors see AC as including four processes (e.g., Mowery and Oxley 1995, Veugelers 1997, Mangematin and Nesta 1999, Zahra and George 2002) that includes (1) knowledge acquisition, (2) knowledge assimilation, (3) knowledge transformation, and (4) knowledge exploitation. As the two most cited conceptualizations, the three-process and the four-process are also related in our thesis. They have been compared in Subsection 2.2.1 in our literature review (see, in particular, table 2.1).

Nevertheless, some authors are cautious about the four-dimensional conceptualization of AC and its measurement. For example, Todorova and Durisin (2007) reject the idea that transformation follows assimilation. Instead, they see the transformation as an alternative to assimilation, which takes place only when the new knowledge does not fit with existing cognitive structures. After close inspection of these arguments, we decided to return to the original definition of AC by Cohen and Levinthal (1990) by treating the concept as containing three processes.

## *3.2 Partitioning the Research Question*

Though existing studies on AC have divided AC into different processes (see e.g., Cohen and Levinthal 1990, Zahra and George 2002), the description of these processes is not specific. While specific sources and outcomes of organizational AC have been uncovered in the literature (see Section 2.2), we still know little about what organizations do when absorbing new knowledge in the identified processes of AC.

We consider AC as including three different processes: EKR (see Definition 1.7), EKA (see Definition 1.8), and EKU (see Definition 1.9). Hence, the investigation of RQ 1 regarding how SMEs absorb external knowledge is partitioned into three sub-RQs accordingly (see Figure 3.1).

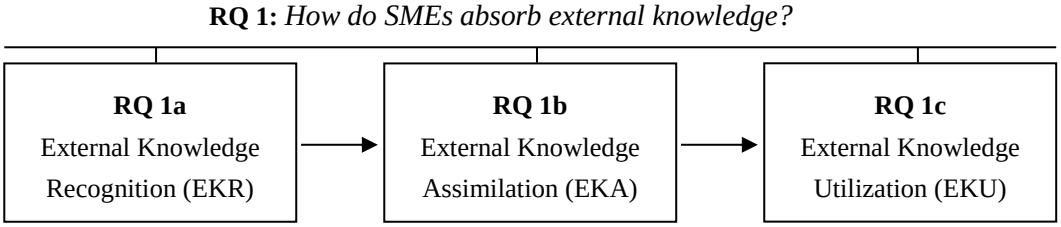


**Figure 3.1 Partitioning Research Question 1**

The three sub-RQs are formulated as follows.

**RQ 1a:** *How do SMEs recognize external knowledge?*

**RQ 1b:** *How do SMEs assimilate external knowledge?*

**RQ 1c:** *How do SMEs utilize external knowledge?*

As illustrated in Figure 3.1, we treat the three AC processes as three sequential activities for easier understanding. However, some authors have suggested that different AC processes may be interrelated and iterative (e.g., Todorova and Durisin 2007, Camisón and Forés 2010). There is still a knowledge gap in how different AC processes emerge, *interact*, and evolve. By looking into the three AC processes, this chapter may shed some light on the potentially interactive and iterative relationship between the three AC processes.

## *3.3 Research Design*

In the section, we describe how the research is designed and conducted. Subsection 3.3.1 describes the overall methodology, i.e., the interview design. The data collection processes and an overview of the interviewees are provided in Subsection 3.3.2. Subsection 3.3.3 describes the data analysis process.

### 3.3.1 Research Method

The investigation aims to generate insights into how companies progress through the AC process and what they do in each phase. The investigation is designed to be exploratory and tentative. So, we adopted a qualitative research approach and used the in-depth semi-structured interview as the primary data collection method. Interviews are particularly useful for getting the story behind the participants' experiences so that we can obtain in-depth information around the topic (cf. McNamara 1999, Hollway and Jefferson 2000, Kallio *et al.* 2016).

We prepared a *general interview guide* to ensure that the same general areas of information are collected from each interviewee. The guide contains a list of questions centered on (1) how external knowledge is absorbed in the firms and (2) what will be their perceived challenges in the processes. All the questions are intended to be open-ended to allow us both to focus on the relatively new, complex topic and keep the possibility of developing new theoretical insights. In order to obtain possible uncovered but meaningful information, the interviewees were asked to express their opinions and add topics that they believe are relevant but not included in the interview guide.

In advance of the actual interviews, three pilot interviews by phone were conducted with three potential interviewees. These pilot interviews were meant to check whether the questions can be easily interpreted. After the three pilot interviews, the questions were adjusted according to their feedbacks. For example, the initially designed questions asked the interviewees directly on the three knowledge-absorbing processes. However, the interviewees in the pilot interviews reported difficulties in understanding the three processes and the essence of the questions. One reason is that they considered the phrasing of the questions as too academic and too hard to be understood from an operational perspective. A second reason is probably that the word "assimilate" and "absorb" are almost identical in Chinese (i.e., "吸收") when Cohen and Levinthal's (1990) definition was translated. To make it easier for the interviewees, we changed the phrasing and wording of some of the questions. For instance, we formulated the question

of "How does your company approach those sources for useful knowledge?" instead of directly asking, "How does your company assimilate external knowledge?"

The overall structure of the interview comprises of three parts: (1) introduction of the research purpose, (2) background questions on the interviewees and the firm they work for, and (3) questions on different AC processes in the SMEs and the potential challenges they face. An overview of the structure of the interview can be found in Table 3.1.

**Table 3.1: Interview Structure**

| **Interview Structure** | **Part 1: Introduction** | **Part 2: Interviewee Backgrounds** | **Part 3: AC Processes and Challenges** |
|---|---|---|---|
| Content | Statements on the purpose of the study | Five questions on the interviewees and the SMEs | 11 questions on the AC processes and one on the challenges |

The first part of the interview, the introduction, is to provide the interviewees with a broad background of the study and our purposes. We explained the concept of AC with plain words so that the interviewee may understand the concept better and provide more relevant information. The second part, the background questions, is designed to understand the profiles of the interviewees and their companies. They were asked to provide information on the position they hold in the company, the company size, and its core business, etc. After introducing the interview and obtaining the backgrounds of the interviewees and their companies, the third part focuses on how they conduct AC practices in their daily operations and their perceived challenges[6] in the AC processes.

Further detailed information on the interview questions can be found in Appendix 1.

### 3.3.2 Data Collection

Prior studies indicate that the owner-managers of the SMEs play a crucial role in the growth and performance of the company (cf. Brunetto and Farr‐Wharton 2007, Sarwoko and Frisdiantara 2016). A firm's AC is a joint outcome of the actions and developments by owner-managers and employees in the knowledge environment. Hence, qualified interviewees in our study are those who oversee the daily operations of their companies and have in-depth knowledge of how they absorb external knowledge.

[6] The findings of the perceived challenges are discussed in chapter 4.

Most of the interviewees in our sample are the principal founders or owners of SMEs. They usually hold an executive position, such as the Chief Executive Officer (CEO) or Chief Technology Officer (CTO) of the SMEs. All the interviewees take part in the all-around operation of the companies and are supposed to have in-depth knowledge of how external knowledge is absorbed in their firms.

We conducted sixteen interviews with owner-managers of SMEs from August 12th to September 9th in 2016 in three different cities of China: Beijing, Shanghai, and Shenzhen. The sample of the interviewees was selected from the author's alumni networks of Peking University and Xiamen University in China. Thirteen of them are network friends and acquaintances of the author. The other three are referred to and connected by the members of the two alumni networks indirectly.

Choosing the alumni networks as the main sources of the research subjects may bring a selection bias to the research as some of the interviewees share similar educational backgrounds, and most of them held a bachelor's or master's degree from the two universities. Such shared characteristics among them may reduce the representativeness of our research findings by under-representing the SMEs of which the owner-managers did not receive higher education. Existing studies have shown that a manager's educational background may influence how they make decisions (e.g., Gröschl and Barrows 2003, Bhagat *et al.* 2010, Loi *et al.* 2019). For instance, a manager with a master's or doctoral degree may already have some connections with universities and research institutes. Those managers are also more familiar with the operations of potential academic partners. Such previous knowledge of and familiarity with academic institutes may stimulate them to be more willing to contact academic partners for external knowledge than the managers who did not attend higher education.

However, selecting samples from the alumni networks allows us to have more open and in-depth communication with the interviewees because of the trust and confidence having been built up by the previous interactions in the networks. The interviewees are

more willing to reveal their thoughts to someone they already know and trust (cf. Hiller and DiLuzio 2004, Jacob and Furgerson 2012, Alshenqeeti 2014).

Ten of the 16 interviewees work in technology-based SMEs from different industries, such as software and IT service. The other six work in SMEs that do not focus on technology but use technology in their core business, such as e-commerce and online education. The SMEs in our sample are relatively small in size. Most of them have less than 100 employees, and five of them employ fewer than ten employees. The age of the firms ranges from less than one year to about ten years.

Table 3.2 shows a cursory profile of the interviewees. A more detailed description can be seen in Appendix 2.

**Table 3.2: Profile of the Interviewees**

| **Contents** | **Gender** | | **Firms size** | | | **Industry** | | **Firm Location** | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Categories | Female | Male | Micro | Small | Medium | Tech-based | Tech-user | Beijing | Shanghai | Shenzhen |
| Frequencies | 1 | 15 | 5 | 10 | 1 | 10 | 6 | 7 | 2 | 7 |

All the interviews were conducted informally. The interviews mostly took place at the interviewees' offices or in coffee shops to suit their convenience. The questions were asked and answered in Chinese. All the interviews were recorded in audio format with the permission of the interviewees. We also took notes of the critical points of what the interviewees answered during the interview processes. Twelve interviews were transcribed into text by professional audio-to-text transcription-service agents, and the texts were then translated from Chinese to English for analysis. The remaining four interviews were not transcribed due to poor audio quality. The text of the notes of these four interviews is analyzed together with the text of the twelve interviews.

### 3.3.3 Data Analysis

All the audio recordings, transcriptions, and text notes were reviewed and analyzed with professional qualitative data analysis software MAXQDA. As the interview is semi-structured, part of the text from each interview has a pre-defined structure following the RQs. They are treated as categories used to group the analysis units in the content analysis. Accordingly, the analysis of this study contains pre-defined categories

as EKR, EKA, and EKU. The semi-structured nature of the interview also allows the interviewees to express their understanding of the theme next to giving answers to the predefined questions.

Our data analysis approach follows the instructions by Graneheim and Lundman (2004) on how to use content analysis in nursing research. We first read and coded the interview texts by providing a label or code to the words or sentences which we consider to have a meaning that is relevant to the sub-RQs. All the codes were then assigned to one of the pre-defined categories. Though we used frequency counts of each code, the final codes from which we formulated the answer were not determined by the frequency of the counts. Many codes formulated in the first round have been re-coded and integrated into new higher-level codes that constitute the research findings. Codes within each category are compared and reviewed to decide their relevance and significance to the RQs. The codes that are considered to be directly relevant to the answers are kept as part of the answers. Some others were reorganized and integrated into new codes to formulate the answers. The remaining codes that were considered irrelevant were excluded and deleted. Potential links and some common patterns that emerged from the codes of different categories are generalized as themes and discussed in the finding sections.

We tried to adopt measures to minimize the subjectivity in the study. For example, in order to improve the validity of the coding scheme, two researchers coded the same three interview texts independently in the first round. The two code systems were then compared and discussed until a certain degree of agreement was reached. The agreed code system was applied as the framework to analyze all the interview text.

Here we add that we used the same approach for answering RQ 2. The findings are described in chapter 4.

## *3.4 Findings and Discussions*

The goal of the qualitative research is to address how Chinese SMEs absorb external knowledge in terms of its (1) recognition, (2) assimilation, and (3) utilization. Accordingly, findings with respect to RQ 1a, RQ 1b, and RQ 1c are presented and discussed as follows. Subsection 3.4.1 provides the answers to RQ 1a. Subsection 3.4.2 describes our findings on RQ 1b. The answers to RQ 1c are expressed in Subsection 3.4.3.

### 3.4.1 External Knowledge Recognition Criteria

Cohen and Levinthal (1990) define AC as organizational learning processes in which knowledge recognition is the first sub-process before knowledge assimilation and utilization. They formulate knowledge recognition as a process of recognizing the value of new information. So, we view EKR as an evaluation process. This chapter is focused on examining what specific *EKR criteria* (see Definition 3.1) SMEs often use to make the evaluation.

**Definition 3.1: External Knowledge Recognition Criteria**

*External knowledge recognition (EKR) Criteria* are defined in our study as principles or standards by which external knowledge is judged in order to decide its value.

The intangibility nature of knowledge makes its evaluation complicated (cf. Xu *et al.* 2014). The valuation of knowledge is often biased and subjective (cf. Menon and Pfeffer 2003). Most interviewed SMEs use qualitative benefit-cost analysis to evaluate external knowledge before making decisions on whether to absorb external knowledge and how to do it.

As one of the interviewees stated: *"However, that solution does not fit us because its costs is too high……It is all about what resources you could afford and whether the resources you look for match the needs"* (coded as "financial costs" that later merged into the higher-level code "expected costs").

A second interviewee mentioned: *"If we want to develop some similar functions to their API, we have to spend half a year, one year…You can manage to develop it yourself if you want. But it takes a lot of time costs…After two months, the product which requires the function is already obsolete"* (first coded as "time costs" then merged into the higher-level code "expected costs").

The interviews indicate that SMEs in China often consider three *criteria* when valuing specific potential knowledge or technology. They are discussed below as: (A) the potential of external knowledge to meet internal needs, (B) expected costs associated with knowledge-absorbing processes, and (C) accessibility of the knowledge sources. The first criterion represents perceived benefits, and the other two perceived costs. The most valuable knowledge item is the one that is accessible and can meet internal needs at affordable costs.

### A: Potential of the External Knowledge to Meet Internal Needs

SMEs emphasize the strategic value of the knowledge needed. Therefore, they consider whether it has the potential to meet internal needs as the most critical criterion to recognize its value. Firms are willing to invest more money (or efforts) to obtain knowledge that is expected to deliver strategic value. Knowledge could be defined as an entity to attain specific goals. Comparing its potential performance and functionality with other knowledge candidates is an important means to determine its value (cf. Reich 1995, Bontis 2001, Xu and Bernard 2010, Andrey *et al.* 2020). At the very beginning of the knowledge absorbing process, SMEs mainly consider what technology or knowledge can help solve their problems or bring extra value. This initial stage of knowledge evaluation is highly ambiguous and subjective, particularly when the knowledge involved is implicit. The evaluation process often depends on the experience and accumulated knowledge of the owner-managers or internal experts. When asked about what methods or processes they use to make the evaluation, most of the interviewees replied that they do not have explicit or defined processes.

### B: Expected Costs for the Knowledge Absorption

In the decision-making process of valuing external knowledge, the management team of the SMEs is highly cost-sensitive. They look at time and money. The perceived value of potential external knowledge is negatively impacted by the expected costs in the knowledge-absorbing processes. The higher the estimated financial costs and time costs associated with external knowledge absorption, the lower its perceived value, and the lower the probability that it will be chosen. The SMEs aim to value and foresee how much cost it will incur in the knowledge absorption process, particularly the costs in the assimilation and utilization phases.

Financial costs and time costs are the most apparent costs. Not surprisingly, these costs are among what SMEs concern mostly. When the external knowledge is seen as too costly, firms will choose not to absorb it by either finding a less costly option or turning to internal R&D. The reason is straightforward. Extra financial resources will allow a firm more room to maneuver. For SMEs, speed is important. Therefore, it is essential to keep in mind that, in a highly dynamic environment, fierce competition forces companies to deliver fast. Hence, SMEs emphasize strongly how fast specific knowledge can be absorbed and how much time it costs to deliver what they need. When SMEs have several potential solution candidates and need to compare them, time is a crucial aspect to consider. How much time it may take to absorb the intended knowledge has to do with the nature of the knowledge and how they would like to absorb it (cf. Haldin-Herrgard 2000, Buckley *et al.* 2009, Sousa and Rocha 2019). In the fast-paced, high-tech industry, a timely absorption of new knowledge is more critical to a firm's success than in traditional industries (cf. Narasimhan *et al.* 2006, Alblas and Notten 2020).

### C: Accessibility of the Knowledge Sources

SMEs in our interviews also stress the accessibility of external knowledge when evaluating it. Strong and broad strategic partnerships are often built on organizational social resources, such as reputation, status, internal resources, and expertise (cf. Eisenhardt and Schoonhoven 1996, Jamali *et al.* 2011, Mtega and Ngoepe 2019). While

big firms could take advantage of knowledge sources in the network such as universities, research centers, and R&D alliances, SMEs often find it hard to build official relations with significant institutions and get access to their knowledge pools (cf. Purcell and McGrath 2013, Cuervo-Cazurra and Rui 2017). Even though some knowledge or technology seems valuable, SMEs must consider whether and to what extent they can access it for assimilation and utilization. SMEs often report that they know what they need and where to find it, but they cannot get access to it because the knowledge might be protected by intellectual property laws, or the knowledge owner is not willing to share it.

Difficulties in getting access to external knowledge represent unobvious costs that SMEs may have to deal with. When the accessibility of specific knowledge is low, the costs associated with the following absorbing process would be high, which in turn reduces the perceived net value of it.

### 3.4.2 External Knowledge Assimilation Mechanisms

By looking at both organizational and individual-level activities, our interviews search for different *EKA mechanisms* (see Definition 3.2) that SMEs utilize to assimilate external knowledge.

**Definition 3.2: External Knowledge Assimilation Mechanisms**

*External knowledge assimilation (EKA) mechanisms* are different methods that firms utilize to assimilate external knowledge.

We asked the interviewees questions regarding how their firms assimilate external knowledge. Two examples of the many relevant answers we received are as follows.

One answered: *"We determine to enter this market and are preparing by cultivating relevant technical knowledge. Earlier this year, we hired a few new employees with relevant experience on it. Skilled employees are a warrant of satisfying products at customer sites"* (coded as "assimilation through hiring new employees").

The other one replied: *"In the beginning, we try to 'copy' what the big firms produced. It was very common in the past, particularly with many firms in small cities"* (first coded as "copy directly" and then merged into a higher-level code "benchmarking and then learning by doing" and in the end "referring to free sources").

Based on the interviews, we distinguished five *EKA mechanisms*. They include (A) consulting personal networks, (B) purchasing products or services, (C) referring to free sources, (D) recruiting new talents, and (E) collaborating with value-chain partners such as suppliers and customers. We discuss them below.

### A: Consulting Personal Networks

The interviews suggest that Chinese SMEs see their personal networks as relevant knowledge sources and frequently consult their personal networks for useful knowledge and problem-solving. Formal classmates, alumni networks, friends, relatives, and former colleagues of owner-managers and internal employees constitute the main body of personal networks. The interaction is based on the reciprocal nature of the personal relationship, which helps SMEs circumvent organizational barriers to gaining knowledge from official channels (cf. Xin and Pearce 1996, Chen and Chen 2004, Burt and Burzynska 2017). The knowledge-sharing activities between personal networks are relatively informal and happen mainly at the individual level.

Personal consulting is a usual practice to transfer knowledge from social networks to SMEs (cf. Huang *et al.* 2011, Azagra-Caro *et al.* 2017). Dialogue, in particular, is a vital process of combining different pieces of knowledge (cf. Hedlund 1994, Kasperek *et al.* 2014, Al Saifi *et al.* 2016). The consulting process may take place at various sites and take different forms. For example, doing business and sharing knowledge during dinners is very common in Chinese business culture. Many SMEs report that they often invite individuals who can provide them useful information to have dinner together. Informal meetings around dining tables help build amicability and avoid communication barriers existing on non-personal occasions. In some cases, SMEs also invite relevant individuals to their workplace to give direct instruction in the knowledge assimilation process.

However, such activities may impair the interests of organizations that the donating individuals work for by leaking their intellectual property they would like to protect.

B: Purchasing Products or Services

When there is a need for external knowledge, SMEs sometimes opt to purchase it in the form of products or services to minimize costs spent in the assimilation process, such as understanding and modifying it. A product or service is purchased as a supply that is used in a system. Knowledge embedded in purchased products and services can be seen as enclosed in a "black box". Firms can utilize it and combine it with existing internal knowledge without fully understanding it. A product or service can also be purchased to study the solutions and understand its inside principles. That is viewed as a different process by this study.

Knowledge assimilation in the form of purchasing products and services is influenced by the extent of how much the products or services can be modularized. Modularity is an attribute of a complex system that emphasizes designing structures based on minimizing interdependence between modules and maximizing interdependence within them. Various modules can be mixed and matched in order to obtain new configurations without loss of the system's functionality and performance (cf. Baldwin and Clark 2006, Eidelwein *et al.* 2018). External knowledge assimilated in the form of products and services connects internal knowledge through pre-designed interfaces. A well-designed interface can significantly reduce or preempt the need to alter internal or external structures in the assimilation process (cf. Langlois 1992, Bennett and Flach 2011, Blandi 2018).

According to the interviews, SMEs that emphasize internal knowledge and internal R&D tend to purchase knowledge in the form of products and services in their non-core business or complementary components of their products. From the knowledge-based view, firms are competing for obtaining and sustaining valuable knowledge. Firms do not need to own full knowledge of every component. In an ideal market, they can buy some components in the form of products or services while focusing on developing

cutting-edge knowledge on the core parts of the final product. By doing so, they may improve their specialization or save time for developing the final product.

### C: Referring to Free Sources

It is of great importance for companies to have an open eye for market changes and new technologies and adopt the best practices within and across the industry. Referring to various free sources is a useful process to learn as much new knowledge as possible without any costs. SMEs, especially those with limited official channels, rely heavily on online resources that have free access and open channels without paywalls for external knowledge. In the knowledge assimilation process, there is little interaction between SMEs and the knowledge sources at both the organizational and individual levels. The knowledge in these sources is often free of charge and non-exclusive.

For instance, in the software industry, there are plenty of open-source websites that provide functional codes for free (cf. Sowe *et al.* 2008, Naidu *et al.* 2017, Marsan *et al.* 2020). By using existing online codes, developers in SMEs can save much time and financial costs when developing new products or solve internal problems. Many interviewed SMEs conduct Competing Product Analysis (CPA) frequently to analyze and learn directly from the product-and-service design of their competitors or even the pioneers within the industry. The knowledge of the products can be found in the advertisement on the websites and in technical documents at exhibitions.

In such learning processes, SMEs mainly depend on internal employees searching free sources for the needed information and then developing new knowledge based on their interpretation. However, referring to free sources is an EKA mechanism that mainly applies to the knowledge that is explicit and easy to be assimilated. Assimilating sophisticated implicit knowledge often requires SMEs to have in-depth interactions with the knowledge sources and to invest more time and money, which are something that SMEs are unable or unwilling to offer.

D: Recruiting New Talents

Many interviewees in our interviews consider hiring external experts as the most effective mechanism for assimilating external knowledge. Human resources have been seen as one of the most crucial resources in companies. Knowledge can take different forms and can be embedded in different types of entities. People are an essential form of knowledge holders (cf. Jain 2011, Davenport 2016, Holford 2019). Organizational competitiveness, to the greatest extent, depends on the skills and knowledge held by their employees (cf. Hamel and Breen 2007, Papa *et al.* 2018). To hire new talents with needed expertise and knowledge is considered the most effective and quickest means to absorb external knowledge by many SMEs owner-managers.

However, costs associated with recruiting new talents may be relatively higher for SMEs than big firms. Some SMEs express that they cannot pay the market-level wage to attract highly skilled employees. It is only an option when the knowledge is in urgent need and necessary financial resources are available. SMEs sometimes choose to hire external expertise temporarily to solve the most critical and urgent problems to save costs, other than to provide them permanent positions inside. For instance, some interviewed SMEs in the software industry often search and hire individual experts with specific technical expertise to work for them only at weekends or in off-work time to solve challenging technical issues. Those external experts either hold a position in other organizations as their main job or work as freelancers in specific technical fields. Their work is compensated according to the nature of the project and the amount of work involved.

E: Collaborating with Value-chain Partners

Owner-managers of SMEs in the interview rarely report collaboration with other big firms, research institutes, or universities for knowledge-absorbing purposes. However, collaborations with value-chain partners such as suppliers and customers occur frequently in SMEs.

When one problem pops up and requires external collaboration, SMEs could quickly get help from their suppliers and customers. One interviewee told us that their suppliers

share R&D facilities, human capital, and other intellectual resources with them. Knowledge-sharing activities among business partners are supported by long-term business interaction and shared interests and goals (cf. Chow and Chan 2008, Lim *et al.* 2017).

Many SMEs have built mature communication channels with their suppliers and customers both at the organizational and individual levels. With organizational level support, both explicit knowledge, such as knowledge in technical documents and implicit knowledge, such as knowledge carried by an internal expert, can be openly shared and transferred. The employees of the two sides interact with each other, and the links built by previous interaction makes them familiar with each other's need and work convention. Such familiarity would facilitate knowledge transfer across value-chain partners (cf. Kotabe *et al.* 2003, Wu 2017).

### 3.4.3 External Knowledge Utilization Purposes

In existing research, the utilization of external knowledge is the least investigated part of the three AC processes. One reason may stem from the unclear definition of "utilization". Many researchers take the term "utilization" for granted without providing details of what dimensions the concept comprises or what topics it should include. Most previous research defines utilization as a process to "use" or "implement" assimilated knowledge to create value or performance effects. According to the Oxford Dictionary, "implement" means "to make something that has been officially decided to start happening or to be used". The word "utilize" is defined as "to use something, especially for a practical purpose". The word "use" has the meaning that "to do something with a machine, a method, an object, etc. for a particular purpose". So, the words "use," "implement," and "utilize" are often associated with a purpose. Hence, our investigation of how SMEs utilize external knowledge will be focused on what the purposes SMEs may have when utilizing external knowledge. We express these purposes as *EKU purposes* (see Definition 3.3).

**Definition 3.3: External Knowledge Utilization Purposes**

*External knowledge utilization (EKU) purposes* are the intentions of utilizing external knowledge instead of internal knowledge in SMEs. The purposes represent what SMEs intend to achieve when utilizing certain external knowledge.

When asked about why they would like to utilize external knowledge, one interviewee mentioned: *"The need for the outside solution is not necessarily crucial because we have the capacity to develop it too. But the outside solution did help us lower the costs and shorten the development time. This is the case that we utilize the final product of others. You just buy it"* (coded as "to reduce costs").

Another interviewee replied: *"We are not a manufacturing firm. We do not do everything ourselves, which is normal for any medical equipment producer"*(coded as "to concentrate on core business").

Based on all the answers in the interviews, we identify five primary *purposes* of utilizing external knowledge in the SMEs: (A) improving existing products or services, (B) solving urgent problems, (C) reducing time costs, (D) reducing financial costs, and (E) concentrating internal resources and expertise in the core business.

A: Improving existing products or services

Most interviewees expressed that the direct purpose of seeking external knowledge is to improve existing products or services. Firms often face challenges in adding new features or functions to their existing products and services or developing next-generation ones. To have new features or functions in the existing products or services may require SMEs to extend their current knowledge bases by adding new knowledge. When internal expertise is insufficient for needed improvement, firms are motivated to seek new knowledge from external sources. This finding is consistent with the conclusions of the previous study that SMEs pursue open innovation primarily for market-related motives such as meeting customer demands or keeping up with competitors (e.g., van de Vrande, Vareska *et al.* 2009, Oduro 2019).

### B: Solving Urgent Problems

The interviewees often report that they resort to external sources for new knowledge when severe problems pop up suddenly. New problems expose knowledge gaps existing inside an organization and force decision-makers to seek external knowledge to fill in the gap. Three typical urgent problems are: (1) a customer requiring adding new features to the current products that are unknown or completely new to internal employees, (2) unexpected technical problems in information system due to a sudden growth of customer number, and (3) the unexpected leaving of key employees who are the only ones with the knowledge of the core business. In these scenarios, SMEs experience the difficulty of relying purely on internal human power or resources to solve problems. Hence, they will search for external resources.

### C: Reducing Time Costs

Many SMEs in our interviews cited shortening the time in product development and problem-solving as one of the primary purposes of utilizing external knowledge. First or early mover advantages and fierce competition force firms to compete for the fastest development and delivery of new technologies and products. It is particularly the case in an industry with a short product lifecycle. To rely only on internal human resources and the internal knowledge base to develop new technology or problem-solving may take a longer time. Companies may accelerate the development process by utilizing external knowledge.

Absorbing external knowledge provides more optional extras for faster development and delivery. Nonetheless, knowledge absorption processes also take time. It has been found that different means of knowledge assimilation may differ significantly in length (see Fletcher and Prashantham 2011). Firms should choose proper means of knowledge absorption mechanisms according to the peculiar circumstances and time constraints they face. For example, assimilation by purchasing or buying may take much less time than learning by doing. When the time pressure is very high, firms are more likely to buy specific “knowledge” in the form of products or services instead of learning by doing.

D: Reducing Financial Costs

In our interviews, SMEs have been acutely aware of the role of utilizing external knowledge in reducing development costs. Performing R&D internally for new technology and knowledge will incur costs in buying necessary equipment or in training employees. While absorbing new knowledge from others also incur costs. These costs can be significantly lower if proper mechanisms and suppliers are selected. This advantage is even more evident when a firm's business involves many different components, and many providers of these components exist in the market. To trade with external business partners can help improve specialization and reduce costs.

Moreover, firms may purchase needed knowledge from the market as products or services at a lower cost than developing them themselves. For instance, in the software industry, many technology firms have developed software tools in the form of a Plugin. A Plugin is a software component that adds a specific feature to existing software to implement a specific function. Knowledge embedded in Plugins can be utilized immediately after purchasing them. The cost of buying such a Plugin is often much lower than developing it in-house.

E: Concentrating Internal Resources and Expertise in Core Business

In the interviews, owner-managers express that utilizing external knowledge in unnecessary or complementary parts of their product could help them concentrate limited resources and expertise on their core business. This holds in particular for the most value-adding aspects where they have comparative advantages. Products and services are often systems that consist of many components. Firms collaborate with their suppliers and other network partners to deliver final products to end-users. The competitiveness of a firm is based on its relative advantage in building a few components or the ability to combine various parts innovatively. While SMEs face many challenges in competition with big firms, they can improve their competitiveness by focusing on a specific market, customer group, expertise, or technology so that they can specialize and accumulate in-depth knowledge in limited fields (cf. Chesbrough 2010, Koo and Lee

2019). Focusing on too many areas will risk dispersing the limited resources that a firm possesses (cf. Nath *et al.* 2010, McDowell *et al.* 2016).

## *3.5 Chapter Conclusion*

In this chapter, we described our exploratory research on how SMEs absorb knowledge in terms of (1) EKR, (2) EKA, and (3) EKU. We conducted 16 in-depth interviews with owner-managers of Chinese SMEs in three Chinese cities, Beijing, Shanghai, and Shenzhen.

Regarding EKR, this study arrived at the findings that SMEs evaluate potential knowledge with three criteria: (A) the potential of external knowledge to meet internal needs, (B) expected costs involved in the knowledge absorption processes, and (C) accessibility to the knowledge sources. Once the external knowledge is deemed to be valuable, SMEs usually utilize different mechanisms to assimilate it.

Regarding EKA, our study identified five EKA mechanisms used frequently by SMEs, including (A) consulting personal networks, (B) purchasing products or services, (C) referring to free sources, (D) recruiting new talents, and (E) collaborating with value-chain partners such as suppliers and customers.

Regarding EKU, our findings show that SMEs mainly use external knowledge for the purposes of (A) improving an existing product or service, (B) solving urgent problems that existing internal knowledge cannot solve, (C) reducing internal time costs, (D) reducing internal financial costs, and (E) concentrating internal resources and expertise as much as possible in core business areas.

The findings of this chapter (see Table 3.3) bring our attention to the cost-related issues associated with AC processes. It is shown in our interviews that SMEs are highly cost-sensitive when making decisions regarding absorbing external knowledge, particularly in the EKR and EKU processes. For instance, the expected costs are identified by our study as an important criterion to evaluate potential external knowledge in the EKR phase. Different EKA mechanisms are associated with different costs (see

discussions in Sub-section 3.4.2). Reducing time and financial costs are two of the five primary purposes of EKU in SMEs.

**Table 3.3: Summary of the Chapter Findings**

| Research Questions | Findings | |
|---|---|---|
| 1. How do SMEs recognize external knowledge? | EKR Criteria | A: Potential of external knowledge to meet internal needs<br>B: Expected costs for knowledge absorption<br>C: Accessibility to the knowledge sources |
| 2. How do SMEs assimilate knowledge? | EKA Mechanisms | A: Consulting personal networks<br>B: Purchasing products or services<br>C: Referring to free sources<br>D: Recruiting new talents<br>E: Collaborating with value-chain partners |
| 3. How is external knowledge utilized in SMEs? | EKU Purposes | A: Improving existing products or services<br>B: Solving urgent problems<br>C: Reducing time costs<br>D: Reducing financial costs<br>E: Concentrating internal resources and expertise |

The fact that cost issues influence all the three AC processes indicates that different AC processes are related. For instance, an SME that is with limited resources may have to evaluate external knowledge candidates with an emphasis on the potential costs when absorbing them. They are more likely to choose the EKA mechanisms that are more economical, such as referring to free sources or consulting personal networks. The purpose of utilizing external knowledge is more likely to reduce costs. Such a connection between different AC processes suggests that they are interrelated with each other.

Moreover, though different AC processes can be distinguished conceptually and are treated largely as a series of sequential activities, our observation suggests that the three AC processes interact and provide feedback to each other. The whole knowledge-absorbing process is iterative in nature. To be specific, the EKR process entails anticipating the costs involved in the EKA and EKU processes because the EKR and EKU processes may take a big chunk of time and financial costs of the knowledge absorbing process. The evaluation process cannot be complete until the firm assimilates and utilizes the intended knowledge. The EKA and EKU processes provide necessary information on the real value of the intended knowledge to the firm. The EKA and EKU

processes may overlap as the assimilation processes involve utilization. Especially for tacit knowledge, a firm can only fully assimilate it when the knowledge candidates are successfully utilized and its value is realized. Tacit knowledge requires a certain extent of learning by experiencing or learning by doing (cf. Lam 2000, McLeod *et al*. 2006, cf. Agyemang and Boateng 2019). These different AC processes could go back and forth several times until the intended knowledge is appropriately valued, assimilated, and utilized.

Based on the analysis, the interrelated and iterative relationship between the three AC processes can be illustrated in Figure 3.2.

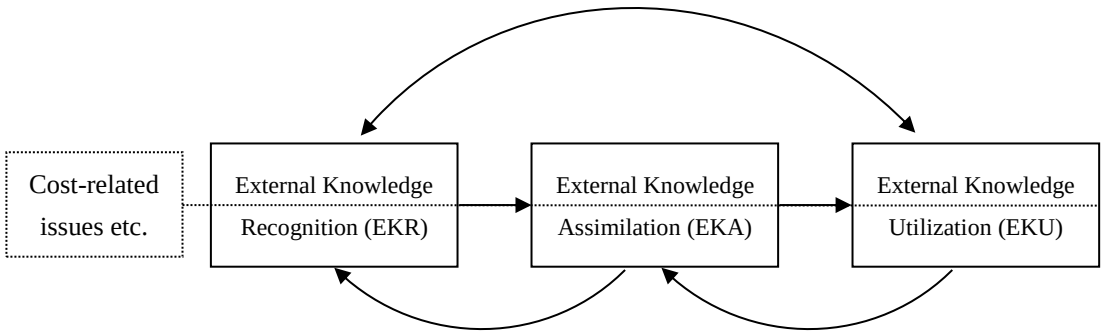


**Figure 3.2 Interrelated and Iterative Relationship between AC Processes**

The highlighted cost-related issues in the knowledge-absorbing processes of SMEs may reflect the fact that SMEs have to face the challenge of having limited resources. Nevertheless, SMEs may face more challenges in their knowledge-absorbing practices because of their smaller sizes, particularly compared to large firms. Towards this direction, we will investigate what particular challenges SMEs may face in their knowledge-absorbing processes in the next chapter.

# 4 Challenges in Absorbing External Knowledge

This chapter deals with RQ 2: What challenges do SMEs face when absorbing external knowledge? So far, the challenges which SMEs may face in the knowledge-absorbing processes have not been thoroughly investigated. Previous studies mentioned that, due to their small size and limited resources, SMEs tend to face unique challenges and difficulties that are different from the ones big companies are facing (cf. Anggadwita and Mustafid 2014, Widdup 2018). Our research tries to shed light on what challenges SMEs may face when absorbing external knowledge by interviewing the owner-managers of Chinese SMEs. The structure of this chapter is as follows. Section 4.1 provides the background of the investigation. Section 4.2 describes the research design. The findings and discussions are presented in Section 4.3. Section 4.4 concludes the chapter and leads to the investigation of the next chapter.

## *4.1 Our Search for Challenges of AC*

SMEs play essential roles in the economic and technological development of societies. When compared to larger companies, we see that SMEs, due to a lack of internal resources and competencies, have a stronger motivation to absorb external knowledge and to adopt more open innovation practices. Open innovation involves purposively using knowledge inflows and outflows to boost internal innovation (see Chesbrough 2003). SMEs should open up their boundaries for new knowledge and innovation by collaborating with other organizations (cf. Sağ *et al.* 2016, Kraus *et al.* 2020).

Existing studies have suggested that various factors may impact the external knowledge absorbing process and its outcomes. For instance, Volberda *et al.* (2010) consider the intensity of competitiveness, dynamism, and knowledge characteristics as environmental factors that may affect an organizational AC. Some other authors suggest that organizational culture is another important factor that influences a firm's AC (e.g., Harrington and Guimaraes 2005, Zerwas 2014, Limaj and Bernroider 2019). These identified factors may either facilitate or hinder the AC processes in organizations. For

instance, an open and balanced organizational culture may facilitate absorbing external knowledge processes in firms. A lack of openness and balance in organizational culture may hinder absorbing external knowledge.

So far, the challenges in the AC processes (see Definition 4.1) have attracted limited attention. There is one study conducted by Cuervo-Cazurra and Rui (2017) that focuses on AC challenges in multinational corporates. They identified various (1) internal and (2) external challenges that will hinder big firms that want to absorb external knowledge (see Table 4.1). The identified internal challenges are (A) *managerial biases* and (B) *weak social integration mechanisms*. The external challenges include (A) *muted activation triggers*, (B) *conflicting source relationships*, and (C) *feeble appropriability regimes*.

**Definition 4.1: Challenges in the AC Processes**

*Challenges in the AC processes* are defined as obstacles that require firms to invest extra efforts to address them in order to absorb intended external knowledge. In practice, they act as constraining forces that make the AC process more difficult and thus costlier.

**Table 4.1: AC Challenges in Multinational Corporates**

| Categories | Description of the Challenges |
|---|---|
| 1. Internal challenges | A. *Managerial biases* are the prejudices that managers have for or against sources of knowledge. |
| | B. *Weak social integration mechanisms* are the limitations of the processes and procedures within the firm that enable the coordination of actions and activities among employees. |
| 2. External challenges | A. *Muted activation* triggers are limitations in external clues that limit the incentives of managers and employees to seek external knowledge. |
| | B. *Conflicting source relationships* are disagreements between the source of external knowledge and the firm in the access and use of knowledge. |
| | C. *Feeble appropriability regimes* are the underdevelopment in the development and application of rules and regulations that protect intellectual property rights. |

Source:Cuervo-Cazurra and Rui (2017)

Nevertheless, the challenges big corporates face when absorbing external knowledge may not be the same as those in SMEs. SMEs exhibit different characteristics in the way how they absorb external knowledge (cf. Liao *et al.* 2003, Gray 2006, Lee *et al.* 2010, Huang *et al.* 2015b). Moreover, SMEs have to deal with the liability of smallness and the resultant shortage of resources. For instance, resource constraints may incentivize SMEs to rely on less expensive and less risky alternatives than formal in-house R&D to acquire new knowledge (cf. Dahlander and Gann 2010, Spithoven *et al.* 2013). So, we postulate that the lack of resources would be one of the most prominent challenges SMEs may face when absorbing external knowledge. However, this is not the case for big corporates, according to Cuervo-Cazurra and Rui (2017). They do not identify any challenges that relate to resource constrictions in the study on multinational corporates.

The rest of this chapter will be focused on examining the challenges that SMEs face in their knowledge-absorbing processes.

## *4.2 Research Design*

The research design for the investigation of the challenges is the same as the research design described in chapter 3. The investigations for RQ 1 and RQ 2 are conducted at the same time with the same interviews. A detailed description of the research design for RQ 1 can be found in Section 3.2. Below we describe our qualitative research for RQ 2.

We adopted a qualitative research approach and used in-depth semi-structured interviews as the primary data collection method. The sixteen interviews on SMEs were conducted from August 12th to September 9th in 2016 in three different cities of China: Beijing, Shanghai, and Shenzhen. All the audio recordings, transcriptions, and text notes were reviewed and analyzed with professional qualitative data analysis software MAXQDA. Admittedly, it is a subjective task. Therefore, the findings of the study were based on our best knowledge and experience in the qualitative research method, but they are inevitably subject to bias and limitations.

## 4.3 Challenges in the AC Processes

Analyzing the answers from all the interviewees, we found seven challenges that SMEs may face in their AC processes. Depending on where the challenges stem from, they are categorized into two groups: (1) internal challenges (see Subsection 4.3.1) that stem from within the firm, and (2) external challenges (see Subsection 4.3.2) that come from the environment in which the company operates.

Below we provide two examples of interview excerpts that indicate an internal challenge (*lack of business reputation*) and an external challenge (*weak appropriability regime*).

One interviewee answered: *"Sometimes you meet people who look down on you if you are from small firms. They may despise you for not being able to solve 'small' problems"* (coded as lack of business reputation).

The second interviewee commented: *"For marketing things, we are not willing to communicate (with others) because any unique ideas may easily get copied. It happens very fast that your idea is copied. In the current business environment of China, it is hard to protect intellectual property rights. If you tell it to others, they just copy it. For instance, if you have an idea having not been fully implemented and you tell it to another company, they may think it is a good idea as well and implement it faster than you, especially when the firm is big and with more resources"* (coded as weak appropriability regime).

### 4.3.1 Internal Challenges

The owner-managers of Chinese SMEs perceive the following five obstacles as significant internal challenges when they try to absorb external knowledge. They include (A) lack of resources, (B) limited internal expertise and competencies, (C) lack of social capital, (D) lack of business reputation, (E) negative attitudes towards external knowledge.

A: Lack of Resources

SMEs in our interview series often express that having limited resources is a significant challenge that they face when absorbing external knowledge. Absorbing external knowledge is associated with costs, and thus firms need to invest in resources. Lack of relevant resources will limit the ability of firms to absorb external knowledge effectively. For instance, some authors suggest that firms with a relative abundance of resources can experiment and engage in riskier innovation projects and indulge the need for exploration (cf. Laursen and Salter 2006a, Wiklund *et al.* 2009, Sisodiya *et al.* 2013, Sok and O'Cass 2015). With limited resources, SMEs have to rely on less risky and less expensive mechanisms to absorb external knowledge (cf. Dahlander and Gann 2010, Spithoven *et al.* 2013). Consequently, it may limit a firm's searching scope for external knowledge and the options of specific EKA mechanisms that are effective but involve relatively higher costs.

In our interviews, owner-managers of SMEs often opt against knowledge absorbing mechanisms that involve higher costs and managerial complexity. Let us consider the consequences. Some interviewees explicitly stated that purchasing products or services and hire new talents as EKA mechanisms for new knowledge are too expensive. Therefore, to save costs, they tend to choose free sources and personal networks as the primary sources of external knowledge. Indeed, limited options of EKA mechanisms may restrain their ability to get the most valuable knowledge. For example, as we discussed in Subsection 3.4.2, referring to free sources may help SMEs obtain explicit knowledge quickly with minimum costs. Nevertheless, the knowledge stored in online media is often accessible to the public. The explicit and public nature of the knowledge may make it less valuable as it can be exploited by everyone. The validity of the information in the free sources might not be checked and hence dubious.

B: Limited internal Expertise and Competencies

Even though smaller firms could be quicker in noticing new market changes and new opportunities, they may not be able to capitalize on the new opportunities due to a lack of relevant expertise and knowledge (cf. Bougrain and Haudeville 2002, Gilmore *et al.*

2013, Bigliardi and Galati 2016). Indeed, many surveyed SMEs list a lack of internal expertise and relevant knowledge as a challenge to learning from others. Previous AC research has agreed that knowledge absorption requires the recipient to own specific relevant knowledge. The proximity of the internal and external knowledge base may significantly impact the effectiveness of knowledge absorption (cf. Cohen and Levinthal 1990, Mattes 2012, Rafique *et al.* 2019).

It is particularly pressing when a firm intends to go for some new business, and the required knowledge is different from its current knowledge base. Though SMEs may be able to accumulate in-depth knowledge in specific and narrow domains, they often lack heterogeneous expertise and competencies across different disciplines. Lack of knowledge breadth will limit an SME's ability to evaluate and assimilate knowledge in new areas, which will negatively impact their ability to innovate (cf. Cohen and Levinthal 1990, Leiponen and Helfat 2010, Zhou and Li 2012, Xu and Cavusgil 2019).

C: Lack of Social Capital

Social capital (see Definition 4.2) is a multi-dimensional concept related to different entities networking and connecting with each other to facilitate specific actions based on trust, reciprocity, and cooperation to facilitate specific actions. It is a unique relational resource derived from social networks and used to create benefits for different actors (cf. Adler and Kwon 2002, McElroy *et al.* 2006, Dubos 2017). Social capital can either be a substitute for or a complement of other resources.

**Definition 4.2: Social Capital**

*Social capital* is defined in this study as the goodwill available to individuals or groups. Its source lies in the structure and content of the actor's social relations. Its effects flow from the information, influence, and solidarity it makes available to the actor (Adler and Kwon 2002, p. 23)

Social capital acts as a facilitator to knowledge creation and has a positive impact on knowledge transfer (cf. Adler and Kwon 2002, Gooderham *et al.* 2011, Ortiz *et al.* 2017).

Network ties, shared language and codes, trust, and obligations are essential aspects of a firm's social capital (cf. Nahapiet and Ghoshal 2000, Dubos 2017).

The interviews indicated that SMEs' lack of social capital hinders their ability to absorb external knowledge. Though they interact with the environment for various resources, the ties and relations with external sources often lack formality and strong obligation to each other. As knowledge assimilation entails interactions between two sides, complex and tacit knowledge assimilation requires a certain level of mutual trust and cooperation to support the process (cf. Bosch-Sijtsema and Postma 2010, Ko 2014, Hasnain 2017). Most SMEs in the interview mentioned that weak ties with external sources make it unable for them to access a range of important knowledge sources and reduce the effectiveness of transferring external knowledge into them. They often report that (1) lack of external acquaintances in potential knowledge sources limits their access to the sources, and (2) lack of commitment and trust between them and the knowledge sources hinder their ability to assimilate and exploit the intended knowledge.

D: Lack of Business Reputation

Lack of business reputation (Definition 4.3) is also frequently expressed by SMEs as a challenge to absorbing external knowledge. A firm's reputation is considered a valuable intangible asset that can be leveraged via social capital for strategic consequences.

**Definition 4.3: Business Reputation**

*Business reputation* is defined in this study as "a collective assessment of a company's attractiveness to a specific group of stakeholders relative to a reference group of companies with which the company competes for resources" (Fombrun 2012, p. 100).

Business reputation is a general organizational attribute that reflects the extent to which external stakeholders see the company as "good" or "bad" (cf. Roberts and Dowling 2002, Horn *et al.* 2015, Gonz ález-Rodr íguez *et al.* 2019). A positive reputation allows firms to form more social capital, while at the same time, social capital may

enable the firm to establish a good reputation (cf. Carroll 2013, Vig *et al.* 2017). Reputation can be based on owning cutting-edge knowledge in specific fields or owning star managers or employees known in the industry. A good reputation is seen as a signal by potential partners that the firm has the capabilities to provide reciprocity and hence improve the probability of a firm gaining external resources and new knowledge. Strong positive reputations may help firms to attract better employees and partners, which are important sources of new knowledge.

Compared to big firms, SMEs are in a disadvantageous position to win cooperation from other companies for absorbing their knowledge because of a lack of business reputation. According to our interviews, even SMEs with a relative abundance of the resource reported that lack of reputation constrains their potential to collaborate with others for the exploration of new knowledge. When firms choose partners, reputation is an important factor to consider. It may help to send a positive signal to external sources that the firm can be trusted according to its reputation and channel the intended external knowledge into the firm (cf. Lucas 2005, Salvato and Melin 2008, Liu *et al.* 2019).

E: Negative Attitudes towards External Knowledge

Except for some "explicit" challenges such as lack of resources and social capital, there are also "latent" challenges existing in SMEs when absorbing external knowledge, of which the owner-managers or employees may not be aware. Our interviews showed that different interviewees exhibit a different level of openness toward external knowledge and its usefulness. While some owner-managers may hold the attitude that external knowledge is important to internal innovation and business success, others believe that external knowledge only has trivial value and emphasize internal knowledge and expertise as the only critical source. Such a negative attitude is recognized as Not-Invented-Here (NIH) syndrome (see Definition 4.4).

Previously, authors tended to believe that NIH syndrome occurs in the teams of big companies. As they think that they are already in a cutting-edge position in terms of technology or knowledge in their domains, they are reluctant to communicate with

external sources for new knowledge. Such a negative attitude may impair a firm's ability to benefit from external knowledge and harm its performance in the long run (cf. Katz and Allen 1982, Antons and Piller 2015). However, our interviews indicate that the NIH syndrome can also occur in SMEs. Many surveyed SMEs hold the belief that the competitiveness built on an open approach towards innovation is unsustainable. In their perception, too much reliance on external sources instead of internal R&D for innovation may risk losing internal core capabilities and being subject to external influences. Such an attitude drives the owner-managers of SMEs away from collaborating with external partners for new knowledge and innovation and makes them emphasize internal R&D and self-independent innovation overly.

**Definition 4.4: The Not-Invented-Here Syndrome**

*The Not-Invented-Here (NIH) syndrome* is defined as the negative attitudes of managers and employees towards external knowledge and their reluctance to learn from external sources (adapted from Katz and Allen 1982, Wastyn and Hussinger 2011).

### 4.3.2 External Challenges

The second set of challenges is external to the firm, in the sense that they depend on factors outside a firm. Two external challenges are listed as (A) issues with contracts and (B) weak appropriability regime.

#### A: Issues with Contracts

External knowledge absorption concerns interaction and commitment between two parties. Two essential control mechanisms for managing the relationship between the two sides are contracts and trust (cf. Jap and Ganesan 2000, Aalbers 2010, Zhang *et al.* 2018). Most formal mechanisms, such as outsourcing or purchase, involve signing a contract with the partner. Issues entailed in the contract management processes such as ill fulfillment, weak law enforcement, and high costs for a lawsuit are perceived as a big challenge by SMEs when absorbing external knowledge (cf. Lu and Tao 2010, Qian *et al.* 2016). For instance, in the IT industry, the tasks being outsourced are often non-

standard and hard to be defined. Such tasks involve a high degree of complexity when negotiating and managing the contract. Even if the two sides can agree on a contract, it is difficult to ensure that due care and diligence is exercised by the partner in the performance of the SMEs.

Most surveyed SMEs have expressed that contract issues often happen, and managing these issues is a big challenge to them. This is particularly the case when high-risk, complex tasks are being outsourced. If these issues occur, it is almost impossible for them to claim compensation through lawsuits as the legal approaches are perceived to be costly. SMEs often lack the respective resources and capabilities to manage issues. Such anticipation reduces their motivation to absorb external knowledge by establishing a formal contract. Consequently, they have to either turn to internal R&D or informal mechanisms such as referring to personal networks to absorb new knowledge, in which signing a contract is not necessary.

B: Weak Appropriability Regime

The regime of appropriability is an important environmental factor that may impact a firm's knowledge-absorbing activities (cf. Cohen and Levinthal 1990, Zahra and George 2002, Volberda *et al.* 2010, Crowley and Jordan 2018). The regime of appropriability is the extent to which knowledge and innovations can be protected from imitators and generate profits for the companies that own the knowledge and innovations. It depends on the nature of the core knowledge (e.g., tacit vs. codified knowledge) in innovation and the efficacy of legal protection for intellectual assets (cf. Teece and Pisano 1994, Hurmelinna‐Laukkanen *et al.* 2008, Ritala and Hurmelinna‐Laukkanen 2013). Many owner-managers of SMEs have significant concerns about leaking business or technology secrets and being unable to protect their intellectual property when exchanging information with external partners.

Absorbing external knowledge involves companies opening their doors and interacting with external players. Such communication across organizational boundaries may pose threats of secrets leaking to other firms (cf. Dahlander and Gann 2010, Faems

*et al.* 2010, Freel and Robson 2017). Firms open to the external environment will have to frequently disclose information and knowledge to external parties and hence are subjected to potential leaks of valuable IP. The risk of leaking business secrets is not only a concern on the donor's side but also a worry on the recipient's side because knowledge absorption requires both sides to disclose a certain amount of information in the communication processes. When the appropriability regime is weak in society, protecting internal IP could be difficult. It will reduce the willingness of a firm to interact with external partners for information sharing and knowledge absorption.

## *4.4 Chapter Conclusion*

This chapter explored what challenges SMEs face in the knowledge-absorbing processes. We conducted 16 in-depth interviews with owner-managers of Chinese SMEs in different industries. The study identifies seven main challenges SMEs may face when absorbing external knowledge (see Table 4.2).

**Table 4.2: Summary of the Chapter Findings**

| **Research Question** | **Findings** | |
|---|---|---|
| What challenges may SMEs face in the processes of absorbing external knowledge? | 1. Internal challenges | A. Lack of resources |
| | | B. Limited internal expertise and competencies |
| | | C. Lack of social capital |
| | | D. Lack of business reputation |
| | | E. Negative attitudes towards external knowledge |
| | 2. External challenges | A. Issues with contracts |
| | | B. Weak appropriability regime |

We categorize them into two groups: (1) internal challenges and (2) external challenges. Five internal challenges are listed as (A) lack of resources, (B) limited internal expertise and competencies, (C) lack of social capital, (D) lack of business reputation, (E) negative attitudes towards external knowledge. Two external challenges are identified as (A) issues with contracts and (B) weak appropriability regime.

According to our study, (1A) lack of resources and (1B) limited internal expertise and competencies are the most mentioned challenges for Chinese SMEs. It is in line with our presumption that SMEs may face unique challenges when dealing with external

knowledge due to their smallness and lack of resources. In contrast, in the study by Cuervo-Cazurra and Rui (2017) (see Table 4.1 in Section 4.1), lack of resources and competencies are not identified as challenges of multinational corporates as big companies usually own more resources and competencies needed for absorbing external knowledge than SMEs. Whereas both big and smaller firms may face some other similar challenges. For instance, we have identified (1C) the lack of social capital and (1E) negative attitudes of the owner-managers towards external knowledge as internal challenges of SMEs when absorbing external knowledge. Similarly, Cuervo-Cazurra and Rui (2017) recognize the lack of social integration mechanisms and managerial bias as obstacles to AC of multinational corporates. In both studies, a weak appropriability regime is believed to impose similar constraints on both big and small firms when they try to absorb external knowledge.

The findings of our interviews reveal the challenges that SMEs may face when absorbing external knowledge. Firms, particularly SMEs with limited resources, need to carefully deploy their knowledge-absorbing strategies with external partners, as different strategies will entail different costs and challenges. Therefore, they may have different impacts on firm performance (cf. Lin and Wu 2010, Kang and Kang 2014). The next chapter of the study will focus on testing the performance implications of different EKA mechanisms identified by our study in Subsection 3.4.2.

# 5 Effects of Different External Knowledge Assimilation Mechanisms

This chapter is dedicated to answering RQ 3: Which external knowledge assimilation (EKA) mechanisms do have an impact on the performance of SMEs? We have identified five EKA mechanisms that Chinese SMEs often adopt to assimilate new knowledge in Chapter 3. Based on the findings, we proceed to explore whether these EKA mechanisms have a positive impact on the organizational performance of SMEs. We designed a survey (see Appendix 3) to measure the intensity of each of the five knowledge assimilation mechanisms in the context of 221 Chinese SMEs and their firm performance. We tested the relationship between (a) the intensity of each of the five knowledge assimilation mechanisms and (b) the firm performance with linear regression analysis using the statistical package for social science (SPSS).

Section 5.1 introduces how AC may affect firm performance. Section 5.2 describes the five EKA mechanisms and links each mechanism with the relevant literature. Then, we formulate our hypotheses. In Section 5.3, we describe our research methodology, and finally, Section 5.4 discusses the results of this study and its implications.

## 5.1 AC and Firm Performance

In the highly dynamic business environment today, scholars have advocated that firms should purposely adapt their resource base and update internal capabilities to address the external changes (e.g., Teece *et al.* 1997, Chesbrough 2003, Warner and Wäger 2019, Randhawa *et al.* 2020). Knowledge is considered one of the most critical resources, and knowledge management (KM) plays a vital role in facilitating internal innovation and enhancing firm performance (cf. Darroch 2005, Du Plessis 2007, Inkinen 2016, Bashir and Farooq 2019). An increasing number of companies today are breaking their traditional boundaries and are utilizing both internal and external knowledge to generate innovation (cf. Chesbrough 2003, Soto-Acosta *et al.* 2017, Yun *et al.* 2020).

Assimilating external knowledge and learning from others can be costly. Such costs include financial costs, time costs due to coordination and integration, and risk of

knowledge leakage (cf. Helfat and Eisenhardt 2004, Roest *et al.* 2018). Therefore, the extent of interaction with external networks generates both opportunities and constraints and can lead to unpredictable economic outcomes for firms. Some authors even indicate that relying too much on external knowledge may result in worsening a firm's performance (e.g., Enkel *et al.* 2009, Wales *et al.* 2013, Asimakopoulos *et al.* 2020).

Firms tend to use various external knowledge sourcing modes simultaneously. Different EKA mechanisms entail different costs and challenges. Existing studies suggest that various mechanisms of acquiring external knowledge may have different impacts on performance (e.g., Kang and Kang 2009, Lin and Wu 2010, Kang and Kang 2014, Santoro *et al.* 2017). However, these studies on EKA mechanisms either focus on large firms or fail to differentiate SMEs from big firms. In Subsection 3.4.2, we identified five EKA mechanisms that SMEs often use. The findings make it possible to investigate specifically the effects of different EKA mechanisms on the performance of SMEs.

Moreover, organizational performance is multidimensional. Prior studies have focused on the links between the EKA mechanisms and different dimensions of performance. *Financial performance* and *growth performance* are two dimensions of performance that are often emphasized. For instance, Lin and Wu (2010) distinguish growth performance (measured by sales growth) and financial performance (measured by returns on assets) in their study on the effects of different knowledge sourcing strategies on firm performance. They find that both technical acquisitions and R&D alliances have a positive impact on a firm's growth performance but have no effects on financial performance.

To distinguish growth performance from financial performance is particularly relevant for SMEs. Growth potentiality is an important indicator of SME business performance. Firms, particularly SMEs, may prefer growth to financial performance at a certain stage (cf. Lu and Beamish 2006, Banerjee 2014, Larsson and Möller 2020). For instance, companies may want to offer a relatively low price to stimulate demand and

increase market share when they enter a new market. Companies may have fewer profits at an early stage, but the growth in market share and customer size may help them gain more profits in the long run. Besides, growth as a measure of non-financial performance is also more accurate and accessible than archival measures of financial performance for SMEs (cf. Wiklund and Shepherd 2005, Helm *et al.* 2017).

## 5.2 Propositions

We have identified five EKA mechanisms that SMEs often use to assimilate external knowledge (see Subsection 3.4.2). They are (1) consulting personal networks, (2) purchasing products or services, (3) recruiting new talents, (4) referring to free sources, and (5) collaborating with value-chain partners. In this section, we detail each of the five EKA mechanisms and formulate our hypotheses on their relations with the firm performance.

### 5.2.1 Consulting Personal Networks

Personal networks have long been recognized as one of the most strategically important resources of entrepreneurs and owner-managers (cf. Assimakopoulos and Yan 2006, Fayolle *et al.* 2011, Hernández-Carrión *et al.* 2020). Many owner-managers in our interview perceive personal sources of information to be more important than impersonal ones. Prior schoolmates, alumni, former colleagues, friends, relatives, and other acquaintances of the owners or other employees of SMEs are important sources of new knowledge.

Trust, which is often developed through prior interactions, makes personal networks a reliable and effective communication channel for knowledge sharing. It is particularly important in the Chinese business context, which emphasizes Guanxi or personal relationships when conducting formal business (cf. Chen and Chen 2004, Burt and Burzynska 2017, Bian 2019). Guanxi serves as a substitute for official institutional support, especially for private and small companies. By consulting personal networks for knowledge, SMEs can get access to knowledge beyond their direct business contacts. The contacted individuals serve both as a communication channel to the firms and as a direct knowledge source.

Personal networks facilitate the knowledge absorbing process involving knowledge evaluation, assimilation, and utilization. When owner-managers are not sure where to find a technology or what the actual value of a technology is, they often first refer to their personal networks. Unlike formal business networks, personal networks emphasize personal reciprocity. The owner-managers do not necessarily pay for knowledge-sharing activities among personal network members but are personally obliged to share their knowledge when required. Strong personal involvement allows the transfer of tacit knowledge through personal networks. By choosing appropriate communication mechanisms, such as face-to-face meetings or telephone calls, assimilating external knowledge from personal networks could be very fast and cheap for SMEs. Hence, we hypothesize that contacting former classmates, colleagues, friends, relatives, or other members within our personal networks for new knowledge positively affects the organizational performance of SMEs.

**Hypothesis 1a**: *Assimilating external knowledge through personal networks has a positive influence on the financial performance of SMEs.*

**Hypothesis 1b**: *Assimilating external knowledge through personal networks has a positive influence on the growth performance of SMEs.*

### 5.2.2 Purchasing Products or Services

Assimilating external knowledge through purchase refers to getting access to specific technology or knowledge through contracts and market arrangements. It often involves activities such as purchasing a product or outsourcing research and development (R&D) services in which the required knowledge is embedded. Although it involves direct financial costs, purchasing it directly can help firms gain specific knowledge quickly. In fast-changing environments, firms become increasingly more specialized and complex. Their core resources and expertise should focus on their knowledge niche. When external complementary technology is available at an acceptable cost, firms often decide to purchase the technology from external sources so that they can focus on internal

resources and expertise in developing core competencies (cf. Milberg and Winkler 2013, Kim *et al.* 2019).

Knowledge embedded in purchased products and services can be seen as enclosed in a "black box". Firms can utilize it and combine it with existing internal knowledge without fully understanding it. Knowledge assimilation in the form of products and services is influenced by the extent of how much the products or services can be modularized. External knowledge assimilated in the form of products and services connect internal knowledge through pre-designed interfaces. A well-designed interface can significantly reduce or preempt the needs to alter both internal or external structures in the assimilation process (cf. Langlois 1992, Bennett and Flach 2011, Ezzat *et al.* 2019)

Purchasing is different from collaborating with existing suppliers for knowledge sharing. Gaining access to new knowledge through purchase is based on market arrangement and payment. Compared to collaborating with existing suppliers and customers, "purchase" is a one-time transaction and builds new provider-customer relationships. Some studies suggest that well-managed knowledge purchasing activities will lead to positive firm performance (e.g., Luzzini *et al.* 2015, Schütz *et al.* 2020). Therefore, we predict that assimilating purchasing a product or outsourcing R&D services positively affects the organizational performance of SMEs.

**Hypothesis 2a**: *Assimilating external knowledge through products or services has a positive effect on the financial performance of SMEs.*

**Hypothesis 2b**: *Assimilating external knowledge through products or services has a positive effect on the growth performance of SMEs.*

### 5.2.3 Referring to Free Sources

Owners-managers or employees of SMEs often search free sources to acquire various new knowledge. Online sources such as search engines, open-source websites, internet technical forums, conferences, and exhibitions are among the frequently used free sources. Knowledge sharing online has become a trend since the internet boom in the

early 2000s. Individuals and organizations are willing to share knowledge in various free and open forms, which were previously considered proprietary. For instance, Tesla Motors announced that it would share all its patents with anyone who would use them properly (see Ramsey 2014). Knowledge can achieve a higher overall value if it is freely available to everyone, and the contributor can benefit from peer recognition and enhanced business reputation. Such benefits can translate into financial returns in the long run. Riding such waves, SMEs can find valuable knowledge from many open sources. Utilizing free open source software and sharing knowledge online is popular in the IT and software industry (cf. Lerner and Tirole 2001, Sowe *et al.* 2008, Hwang *et al.* 2015, Kalyvas *et al.* 2017).

Free sources are particularly important for SMEs because they often lack the resources and relations to get access to other sources. For instance, collaborating with suppliers and customers involves management attention and is time-consuming. Purchasing knowledge and recruiting new talents for new knowledge involve relatively high costs. With new technology available, individuals and organizations can access knowledge residing in open sources quickly and free of charge. We predict that relying on free sources such as search engines, open sources, online technical forums, conferences, and exhibitions positively affects the organizational performance of SMEs.

**Hypothesis 3a**: *Assimilating external knowledge through referring to free sources has a positive effect on the financial performance of SMEs.*

**Hypothesis 3b**: *Assimilating external knowledge through referring to free sources has a positive effect on the growth performance of SMEs.*

### 5.2.4 Recruiting New Talents

Existing studies on knowledge assimilation mechanisms rarely consider recruiting new talents as a means of assimilating external knowledge. However, in practice, both big and small firms emphasize that recruiting new human capital is an important means of KM (cf. Rappaport *et al.* 2003, Al-Laham *et al.* 2011, Gope *et al.* 2018). In the

previous interviews, many SMEs express that they perceive recruiting new employees as the most effective way to transfer knowledge from the outside. Big firms sometimes acquire a team of experts to build competencies in certain areas. Compared to assimilating external knowledge through Mergers and Acquisitions (M&A), seeking new knowledge through recruiting individuals is more affordable and faster for SMEs. M&A activities are not common to SMEs as they do not have the required financial resources. Particularly when SMEs plan to open new business areas and need new knowledge, recruiting new talents is an effective strategy. Newly recruited members could bring their expertise immediately to SMEs, and help interpret, assimilate, and utilize relevant new knowledge according to what they already know.

However, comparing to collaboration with suppliers and customers or learning from free open sources, developing new capabilities and knowledge through recruiting new talents involves relatively more costs. SMEs with limited resources and business reputations may find it challenging to attract, motivate, and retain new employees with needed expertise (cf. Baublyte 2010, Krishnan and Scullion 2017, Cui *et al.* 2018). Hence, the overall impact of utilizing recruiting new employees as a knowledge assimilation mechanism on SMEs' performance may not be guaranteed. To test it, we hypothesize that hiring external expertise or recruiting new employees to assimilate external knowledge positively affects the organizational performance of SMEs.

**Hypothesis 4a**: *Assimilating external knowledge through the recruitment of new talents has a positive effect on the financial performance of SMEs.*

**Hypothesis 4b**: *Assimilating external knowledge through the recruitment of new talents has a positive effect on the growth performance of SMEs.*

### 5.2.5 Collaborating with Value-chain Partners

The role of collaboration with value-chain partners, such as suppliers and customers, in innovation and knowledge transfer has been confirmed by many researchers (cf. Kaufman *et al.* 2000, Brettel and Cleven 2011, Fossas-Olalla *et al.* 2015). Transferring valuable knowledge between supplier and buyer has become a key competitive

advantage for a vertical relationship (cf. Paton and McLaughlin 2008, Liu *et al.* 2017, Whitehead *et al.* 2019). As they are relatively small and often lack resources, SMEs often find it challenging to collaborate with other organizations without a direct business connection. Our prior study shows that SMEs in China rarely collaborate with big firms, research institutes, or universities for knowledge assimilating purposes. However, collaboration with suppliers and customers for new knowledge is frequent in SMEs. With existing business relations and shared interests between SMEs and their customers and suppliers, it is easier for SMEs to exchange knowledge and resources with direct suppliers and customers. A stable, high-trust customer-supplier relationship facilitates the creation and transfer of organizational knowledge, particularly tacit knowledge (cf. Lincoln *et al.* 1998, Holste and Fields 2010, Saini *et al.* 2019).

Due to the shared interests of creating value for end-users, knowledge absorption from supplier-customer relationships can get strong organizational support from both sides. Such support is important for both organizational and individual level learning. SMEs can get easier access to R&D facilities, human capital, technical document, and other intellectual property of their suppliers and customers. The existing transactional and relational connection enables a faster and more effective transfer of knowledge compared to other channels (cf. Cavusgil *et al.* 2003, Liu *et al.* 2017). Hence, we predict that collaborating value-chain partners for new knowledge positively affects the organizational performance of SMEs.

**Hypothesis 5a:** *Assimilating external knowledge through collaborating with value-chain partners, such as suppliers and customers, has a positive effect on the financial performance of SMEs.*

**Hypothesis 5b:** *Assimilating external knowledge through collaborating with value-chain partners, such as suppliers and customers, has a positive effect on the growth performance of SMEs.*

Figure 5.1 illustrates the overall theoretic framework of this chapter.

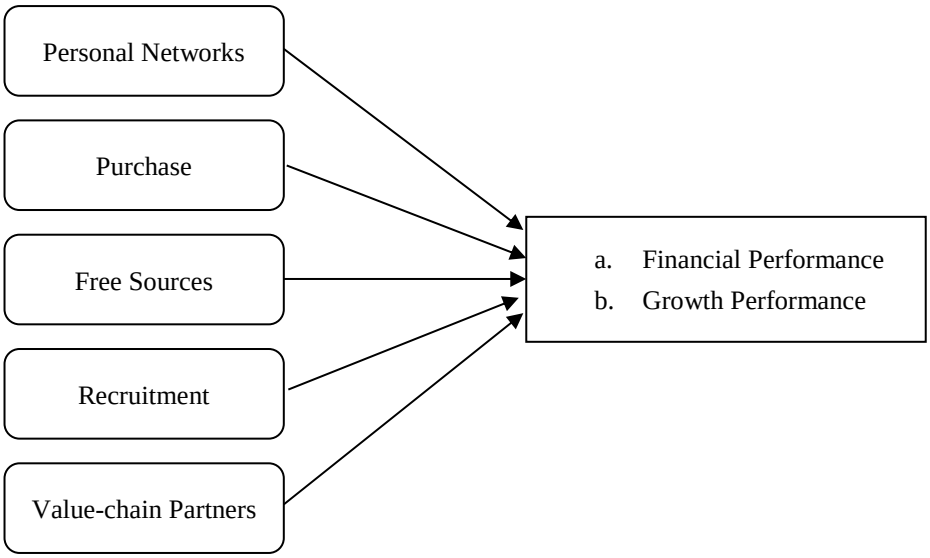


**Figure 5.1: Hypothesis between EKA Mechanisms and Performance**

## 5.3 Research Methodology

In the section, we present how the study is designed and conducted. We use the survey and questionnaire as the research method for data collection and analysis. Subsection 5.3.1 describes how the questionnaire of the survey is designed and the data collection process. Subsection 5.3.2 describes how different variables in our theoretical model are measured. In Subsection 5.3.3, the descriptive statistics of the collected data are provided. Subsection 5.3.4 describes the data analysis process.

### 5.3.1 Questionnaire Design and Data Collection

We used a questionnaire to measure the variables in the theoretical model. The questions regarding each of the variables were decided according to existing literature or theory (see Subsection 5.3.2). We first designed a pilot questionnaire and sent it to four managers. They were asked to check whether the questions in the survey were clear and understandable. Changes were made to the texts according to their feedback. The survey was then sent randomly through a professional data collection website. A total of 109 completed questionnaires were returned. Ninety-three questionnaires were valid and were used to test the reliability of the combined variables and distribution of all the variables. Based on the preliminary analysis, we improved our measurement of some of the variables. A detailed description of the survey questions and measurements can be found in Appendix 3.

We used the professional data collection service from a survey company to send questionnaires electronically. Qualified respondents were above 25 years old, had held a managerial role in an SME for the last two years, and were the general manager or had an executive-level role in the company. These top managers are often SME owners. They are believed to be directly involved in the overall operation of their business and have comprehensive knowledge about business performance and many other aspects. We refer to SMEs as the firms employing up to 300 workers, with the following breakdown: micro (1 to 10), small (11 to 100), and medium (101-300).

**Table 5.1: Questionnaire Screening Process**

| **Questionnaire screening processes** | **Phase 1:** Receiving completed cases | **Phase 2:** Deleting unqualified cases | **Phase 3:** Deleting inconsistent cases |
|---|---|---|---|
| Number of the kept cases after each phase | 314 | 228 | **221** |

Finally, 314 completed questionnaires were returned. We exclude questionnaires from firms that employ more than 300 employees (86 cases) as our study is focused on SMEs. A trap question was designed to control the quality of the answers. Respondents are asked to rate the importance of the growth in the number of employees for firm performance twice in different sections of the questionnaire. The two answers were compared, and seven cases with a different score of two or more were considered inconsistent and deleted. For those with a discrepancy score of one, we averaged the two as the final score of the indicator and used the average for the calculations. Finally, 221 observations from firms that employ fewer than 300 employees were used for the analysis.

### 5.3.2 Measures

This section presents how the variables were measured concerning (A) EKA mechanisms, (B) performance, and (C) control variables.

In a similar study, Lin and Wu (2010) measured two external knowledge assimilating mechanisms, external acquisition, and R&D alliance, with firms' archival data in which the two formal external sourcing strategies usually are documented. However, other EKA mechanisms, particularly informal ones in small firms, are usually not recorded. Some authors measure the extent of applying specific knowledge assimilating mechanisms by the perceived importance of each source (e.g., Escribano *et al.* 2009, Kang and Kang 2009, 2014). They consider different sources and ask respondents to rate the relative importance of each source. The total or average scores of each source are then used to indicate the intensity of respective knowledge sourcing strategies in the firm. As the authors have admitted, such measures may not fit the purpose of studying the effects of different knowledge assimilations as their data are second-hand and are not explicitly designed for this purpose (see Kang and Kang 2009).

Our research is based on two fully different assumptions. The first assumption is that the higher the top managers' (a) intention toward a specific EKA mechanism and (b) their belief that it is effective, the more intensively they may use that mechanism in their daily operation. The intention and belief are measured by five-point Likert scales. According to Ajzen's (1991) Theory of Planned Behavior, people's behavior can be predicted by their intentions towards their behavior and their perceived confidence in how effectively they can execute the behavior. We extend the theory to an organizational context by assuming that the extent of a firm's utilization of specific EKA mechanisms can be predicted by top managers' intentions towards applying each of the mechanisms and their perceived effectiveness of them. The two measures are multiplied to indicate the intensity of each EKA mechanism in firms.

The second important assumption of this study is that the preferences or intentions of SME owner-managers regarding EKA mechanisms are stable over time. Different EKA mechanisms may have different influences on performance. Existing studies have shown the stability of cognitive preference over time-related learning studies (e.g., Barbosa *et al.* 2007, Reynaud and Couture 2012, Schildberg-Hörisch 2018). Based on this

assumption, this study does not consider the potential time-lag effects between the EKA mechanisms and firm performance. It allows us to use cross-sectional data to measure the intensity of assimilation mechanisms and firm performance and circumvent the fact that SMEs often lack accurate records on performance and data on how they assimilate external knowledge.

B: Performance

Business performance is usually measured in one or a combination of the following three ways: subjective financial, subjective non-financial, and archival financial (cf. Rauch *et al.* 2009, Taticchi *et al.* 2010, Samaeemofrad and van den Herik 2018). However, many SMEs do not have archival performance data, and SME owners may not be willing to reveal real archival performance data to researchers (cf. Bamford *et al.* 2000, Chung-Wen 2008). Hence, we use subjective measures of performance. Although subjective measures of performance of SMEs can be disadvantageous in that they rely on the owners' ability to rate the performance of their firm accurately, many studies have suggested that these subjective measures may have equal accuracy and reliability as archival indicators (cf. Wall *et al.* 2004, Zulkiffli and Perera 2011).

This study distinguishes financial performance and growth performance. The measurement of SME performance is adapted from Kraus *et al.* (2012) and Zahra *et al.* (2017). We measured financial performance by four indicators, including (1) cash flow, (2) profitability ratios, (3) gross margin, and (4) return on assets. SMEs' growth performance was measured by three indicators: (1) sales growth, (2) market share growth, and (3) growth in the number of employees (cf. Kraus *et al.* 2012, Zahra *et al.* 2017). We asked the owner-managers to rate the relative importance of each item on 5-point Likert-type scales to the overall firm performance and their satisfaction with their firm's achievement regarding each indicator. We then multiplied the relative importance of each item and the owner-managers' satisfaction score. The financial performance was calculated by adding the scores of the four financial indicators, and the growth performance by adding the scores of the three growth indicators.

C: Control Variable

The number of employees, firm age, and annual sales are used as control variables. Firm age influences performance in many studies (cf. Majumdar 1997, Loderer and Waelchli 2010, Coad *et al.* 2018). Organizational performance may benefit from economies of scale (cf. Lambrecht 2004, Wells 2016) and economies of scope (cf. Helfat and Eisenhardt 2004, Roest *et al.* 2018). Hence, the number of employees and annual sales are frequently used as control variables. A description of the control variables and their coded value are shown in Table 5.2.

**Table 5.2: Description of the Samples**

| Variable | Category | Coded Value | Frequency | Percent |
|---|---|---|---|---|
| Number of Employees | Micro firms | 1 | 4 | 1.8% |
| | Small firms | 2 | 120 | 54.3% |
| | Medium-sized | 3 | 97 | 43.9% |
| Firm Age | <5 years | 1 | 16 | 7.2% |
| | 6～10 | 2 | 88 | 39.8% |
| | 11～15 | 3 | 77 | 34.8% |
| | 16～20 | 4 | 27 | 12.2% |
| | 21～25 | 5 | 11 | 5.0% |
| | 26～30 | 6 | 1 | 0.5% |
| | >30 years | 7 | 1 | 0.5% |
| Annual Sales in Yuan[7] | <5 million | 1 | 50 | 22.6% |
| | 5～10 | 2 | 34 | 15.4% |
| | 10～15 | 3 | 19 | 8.6% |
| | 15～20 | 4 | 30 | 13.6% |
| | 20～25 | 5 | 22 | 10.0% |
| | 25～30 | 6 | 24 | 10.9% |
| | >30 million | 7 | 42 | 19.0% |

### 5.3.3 Descriptive Statistics of Measured Variables

This study focuses on Chinese SMEs. We include a total of 221 observations from 25 provincial administrative regions of China. Guangdong, Jiangsu, Shanghai, Zhejiang, and Beijing together contribute more than 50% of the total sample. More than half of

[7] 1 Chinese Yuan≈0.144 US Dollar when (2018.11) the analysis was conducted

the surveyed firms have fewer than 100 employees and 80% fewer than 200. About 81% of the firms have annual sales of less than 30 million Chinese yuan (equal to about 4.2 million US dollars). These firms are from 23 industries. The top five are mechanical equipment, light industry, electrical equipment, computer, and electronics. Together, these five industries account for about 50% of all the companies. Table 5.3 presents the descriptive statistics of all the variables included in the analysis.

**Table 5.3: Descriptive Statistics of the Samples**

| Variable | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Financial Performance | 221 | 28 | 91 | 61.42 | 12.11 |
| Growth Performance | 221 | 13 | 68 | 37.94 | 11.60 |
| Employee number | 221 | 1 | 3 | 0.02 | 0.13 |
| Firm Age | 221 | 1 | 7 | 2.71 | 1.02 |
| Annual Sales | 221 | 1 | 7 | 3.81 | 2.23 |
| Personal Networks | 221 | 1 | 25 | 9.34 | 5.57 |
| Purchase | 221 | 2 | 25 | 14.00 | 6.06 |
| Free Sources | 221 | 2 | 25 | 14.32 | 5.87 |
| Recruiting | 221 | 2 | 25 | 16.80 | 6.07 |
| Value-chain Partners | 221 | 1 | 25 | 12.09 | 5.98 |

Table 5.4 shows the result of the Spearman correlation (rank-order correlation) analysis between all the variables. To better understand the correlations between the dependent and independent variables, we also run the partial correlation analysis in which the effect of each independent variable on the dependent variable is assessed while the effects of the other independent variables are controlled.

Table 5.5 shows the result of partial correlations analysis. It indicates that both EKA 3 and EKA 4 positively correlate with both of the two aspects of SME performance. The correlations between the other three EKA mechanisms and SME performance are not significant. Based on the results, we proceed to test their relations with linear regression analyses.

**Table 5.4: Correlations (Spearman) between Measured Variables**

| Variable | 1 | 2 | 3 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|
| 1.Financial Performance | 1 | | | | | | | | | |
| 2.Growth Performance | 0.402** | 1 | | | | | | | | |
| 3.Employee Number | 0.047 | 0.139* | 1 | | | | | | | |
| 5.Firm Age | 0.140* | 0.111 | 0.247** | 1 | | | | | | |
| 6.Annual Sales | 0.126 | 0.065 | 0.390** | 0.293** | 1 | | | | | |
| 7.Personal Networks | 0.012 | -0.105 | 0.039 | -0.007 | -0.13 | 1 | | | | |
| 8.Purchase | 0.017 | 0.04 | -0.017 | -0.042 | 0.077 | 0.048 | 1 | | | |
| 9.Free Sources | 0.276** | 0.143* | -0.04 | 0.015 | 0.038 | -0.035 | 0.178** | 1 | | |
| 10.Recruiting | 0.203** | 0.187** | 0.074 | 0.086 | 0.071 | -0.126 | -0.016 | 0.041 | 1 | |
| 11.Value-chain partners | 0.025 | 0.02 | 0.091 | 0.109 | 0.04 | 0.169* | 0.109 | -0.058 | -0.048 | 1 |

[c] N=221 * p<0.05 ** p<0.01

**Table 5.5: Partial Correlations between Dependent and Independent Variables**

| Variables | 1.Financial Performance | 2.Growth |
|---|---|---|
| 1.Employee Number | 0.011 | 0.139[8] |
| 2.Firm Age | 0.119 | 0.040 |
| 3.Annual Sales | 0.062 | -0.031 |
| 4.Personal Networks | -0.030 | -0.051 |
| 5.Purchase | 0.017 | 0.018 |
| 6.Free Sources | 0.250** | 0.142* |
| 7.Recruitment | 0.222** | 0.172* |
| 8.Value-chain partners | 0.025 | 0.044 |

[c] N=221 * p<0.05 ** p<0.01

[8] The correlation coefficient is significant too but not labeled as significant for that the *Growth* is measured partially by an increase of *Employee Number* and the two variables are correlated in nature. And, as the relationship between Growth and Employee Number is not the focus of our investigation, we exclude the discussion of their relationship in the following analysis too.

### 5.3.4 Data Analysis

We run two linear regression analyses with SPSS to test the relation between the five EKA mechanisms and two dimensions of SME performance: (A) financial performance and (B) growth performance.

#### A: EKA Mechanism and Financial Performance

We first conducted a linear regression analysis to test if each of the five EKA mechanisms has an impact on the financial performance of SMEs. We first ran linear regression analysis between the variable *Financial Performance* and our independent variables, including *Employee Number*, *Firm Age*, *Annual Sales*, *Personal Networks*, *Purchase*, *Free Sources*, *Recruitment*, and *Value-chain Partners*. The result shows values of all the variance inflation factors (VIF) of the independent variables are smaller than 1.3, indicating that they do not suffer from a severe collinearity problem. The normal probability plot (Figure 5.2) and Scatterplot of the regression standardized residual of *Finance Performance* (Figure 5.3) indicate that the standardized residual is approximately normally distributed, and there are no apparent signs of heteroscedasticity. The model summary indicates that the Durbin-Watson (D-W) statistic is 1.872. D-W statistic ranges typically from 0 to 4. A D-W value close to 2 indicates that the observations are independent of each other. Casewise diagnostics show no results, which indicates no obvious unusual cases beyond three standard deviations. The regression model is significant (Sig 0.000) at the significance level of 0.01.

Among the relations between each of the independent variables and the dependent variable, *Free Sources* (Sig 0.000) and *Recruiting* (Sig 0.001) are significant at the significance level of 0.01. Their coefficients are positive, which indicates that assimilating knowledge through referring to free sources and recruiting new talents both have a positive impact on the financial performance of SMEs. Our hypotheses 3a and 4a cannot be rejected. Knowledge assimilation through personal networks, purchase, and collaboration with value-chain partners have no significant impact on organizational performance. Hypothesis 1a, 2a, and 5a must be rejected.

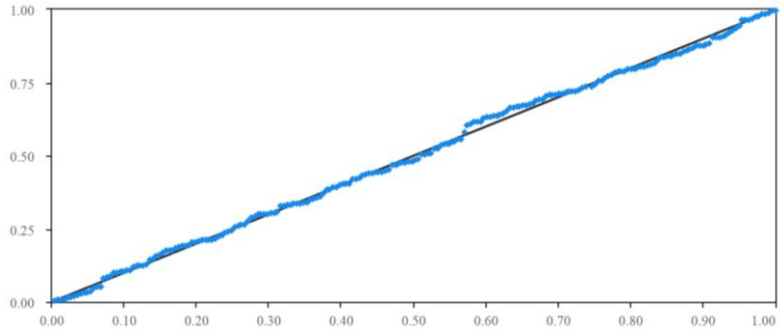


**Figure 5.2: Normal Probability Plot (Finance Performance)**

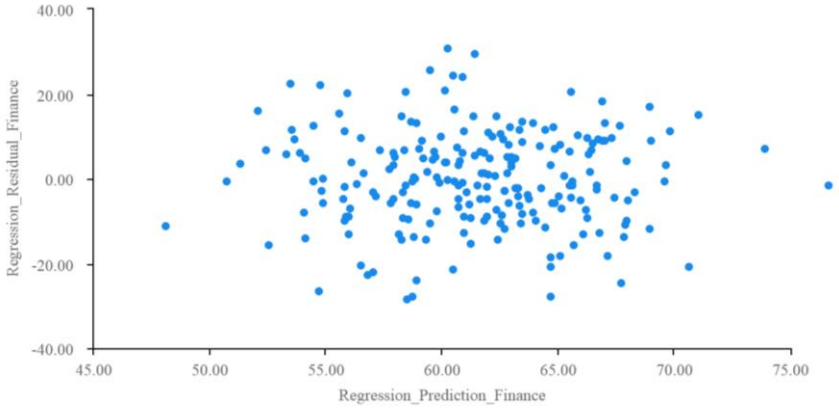


**Figure 5.3: Scatterplot of the Regression Residual (Finance Performance)**

B: EKA Mechanism and Growth Performance

Similarly, we conducted a regression analysis between *growth performance* and our independent variables. A check on the normal probability plot (see Figure 5.4) and a scatterplot of the regression standardized residuals (see Figure 5.5) shows that the standardized residual is approximately normally distributed. Hence, there are no apparent signs of heteroskedasticity. The model summary shows that the D-W statistic is 1.967. Casewise diagnostics show no result. We detected no obvious unusual cases beyond three standard deviations. The f value of the model indicates that the regression model is significant (0.015) at the 0.05 significance level.

Among the relations between each of the independent variables and the dependent variable, *Micro Firms* (Sig 0.029), *Free Sources* (Sig 0.039), and *Recruiting* (Sig 0.012) are significant at the significance level of 0.05. The coefficient of Micro Firms is negative. It shows that the growth performance of micro firms is significantly lower

compared to that of small companies. The coefficients of Free Sources and Recruiting are both positive, which indicates that assimilating knowledge from free sources and recruiting new talents has a positive impact on the growth performance of SMEs. Our Hypothesis 3b and 4b cannot be rejected. Knowledge assimilation through personal networks, purchase, and collaboration with suppliers and customers have no significant impact on organizational performance. Hypothesis 1b, 2b, and 5b must be rejected.

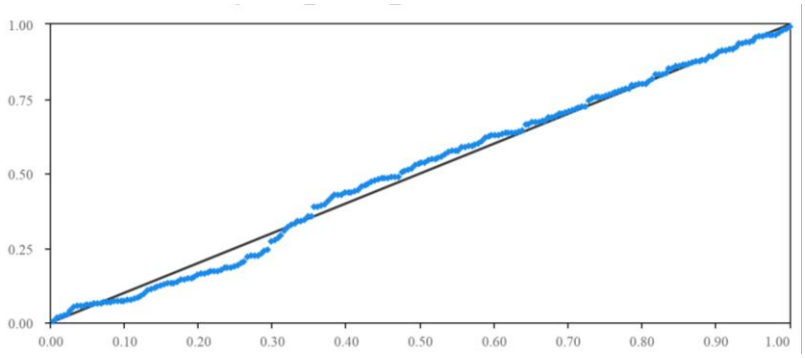


**Figure 5.4: Normal Probability Plot (Growth Performance)**

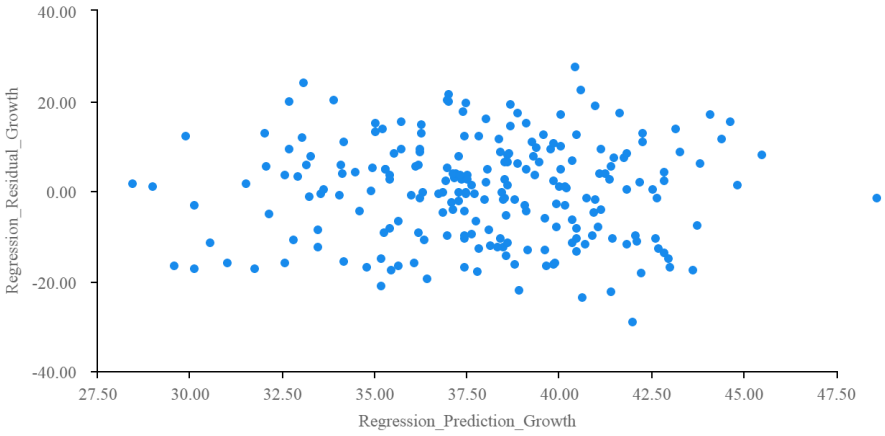


**Figure 5.5: Scatterplot of the Regression Residual (Growth Performance)**

Table 5.6 provides a summary of the regression models. Table 5.7 gives a detailed description of the results of our regression analysis.

**Table 5.6: Summary of the Two Regressions Models**

| Financial Performance | | | | Growth Performance | | | |
|---|---|---|---|---|---|---|---|
| Adj. $R^2$ | D-W | F | Sig. | Adj. $R^2$ | D-W | F | Sig. |
| 0.101 | 1.872 | 4.080 | 0.000** | 0.050 | 1.967 | 2.438 | 0.015* |

**Table 5.7: Results of Regressions Analyses**

| | | Financial Performance | | | Growth Performance | | |
|---|---|---|---|---|---|---|---|
| | VIF | Beta | t | p | Beta | t | p |
| (Constant) | - | - | 7.541 | 0.000** | - | 3.632 | 0.000** |
| Employee number | 1.241 | 0.011 | 0.157 | 0.876 | 0.161 | 2.2 | 0.029 |
| Firm Age | 1.137 | 0.119 | 1.747 | 0.082 | 0.040 | 0.578 | 0.564 |
| Annual Sales | 1.259 | 0.064 | 0.898 | 0.37 | -0.033 | -0.45 | 0.653 |
| Personal Networks | 1.079 | 0.077 | 1.156 | 0.249 | -0.050 | -0.737 | 0.462 |
| Purchase | 1.061 | -0.029 | -0.444 | 0.657 | 0.018 | 0.261 | 0.794 |
| Free Sources | 1.044 | 0.247 | 3.790 | 0.000** | 0.140 | 2.082 | 0.039* |
| Recruiting | 1.035 | 0.220 | 3.379 | 0.001** | 0.170 | 2.536 | 0.012* |
| Value-chain partners | 1.068 | 0.029 | 0.436 | 0.712 | 0.044 | 0.642 | 0.522 |

* p<0.05 ** p<0.0

## 5.4 Findings and Discussions

This section presents the overall findings and discussions. Subsection 5.4.1 describes the overall results of the quantitative analysis, and it briefly discusses the three EKA mechanisms that are not tested to affect SME performance. Subsection 5.4.2 is focused on the two EKA mechanisms that are tested to have a positive effect on SME performance.

### 5.4.1 Effects of External Knowledge Assimilation Mechanisms

This quantitative study attempts to test 5 groups of hypotheses concerning the relations between five EKA mechanisms and SME performance. A comparison of the two regression analyses indicates that all five EKA mechanisms seem to have similar effects on the financial performance and growth performance of SMEs. An implicit assumption of this study that EKA mechanisms may affect the two dimensions of firm performance differently is rejected. The reason could be that growth and profitability in the surveyed SMEs are correlated, which is evidenced by our correlation analysis (see table 5.2). Hence, the trade-off effect between the two dimensions of the performance is

not significant for SMEs (cf. Cowling 2004, Kachlami and Yazdanfar 2016). It leads to that the five EKA mechanisms have similar effects on them.

According to our linear regression analysis, the hypotheses that (C) referring to free sources and (D) recruiting new talents for new knowledge have positive impacts on both the financial performance and growth of SMEs are not rejected. The hypotheses that (A) consulting personal networks, (B) purchasing products or services, and (E) collaborating with value-chain partners have positive impacts on SME performance must be rejected.

The finding that not all the EKA mechanisms have a positive effect on SME performance indicates that managing the knowledge absorbing process is not an easy task. The process entails various challenges and costs (see Chapter 4). There are internal and external challenges, such as organizational culture and appropriation regime, that can affect whether absorbing external knowledge can improve organizational performance. Therefore, taking into account possible benefits, challenges, and costs, the overall impacts of different EKA mechanisms on the performance may not always be positive or significant.

For instance, EKA through consulting personal networks can help SMEs gain access to new knowledge that they cannot gain through official channels with relatively fewer costs. However, the whole process is not legally binding. The individuals that provide the knowledge may lack the commitment to make sure the knowledge be transferred to the SMEs successfully, and the knowledge they share is not always something the SMEs want to get. In contrast, EKA through purchasing products or services provides SMEs more certainty in getting the specific knowledge they want to absorb, but it entails direct financial costs that small companies usually do not want to spend. Collaborating with value-chain partners as an EKA mechanism also has both advantages and disadvantages. Due to the shared interests of creating value for the same end-users, knowledge absorption from supplier-customer relationships may get strong organizational support from both sides. The existing transactional and relational connection enables a faster and more effective transfer of knowledge compared to other channels, but managing the

collaboration takes much effort from top managers and management attention. Such collaboration often requires both internal and external arrangements to support the process, which is usually not established in SMEs.

There are other possible reasons that a potential positive relationship between an EKA mechanism and SME performance is rejected in the regression analysis. For instance, a reduced validity of the quantitative study caused by small sample sizes may reject a valid hypothesis incorrectly. Or, the effects of specific EKA mechanisms on firm performance are highly industry-specific. For example, in some industries, an EKA mechanism may affect firm performance positively, while in some other industries, the effects are adverse. If we consider such industry differences and test our hypotheses with data from specific industries, we may find that the effects of the three EKA mechanisms (viz. consulting personal networks, purchasing products or services, and collaborating with value-chain partners) on SME performance are significant.

### 5.4.2 Referring to Free Sources and Recruiting New Talents

The linear regression analysis supports two of the five, which indicate that EKA through (A) referring to free sources and (B) recruiting new talents have positive effects on their financial performance and growth performance. The following discussion will be mainly focused on the two EKA mechanisms.

#### A: Referring to Free Sources

According to this study, a greater extent of utilizing free sources such as search engines, open-source websites, internet technical for, conferences, and exhibitions, leads to better SME performance. Referring to free sources is one of the most frequently mentioned EKA mechanisms by Chinese SMEs. Comparing to other EKA mechanisms, such as purchase and collaboration with suppliers and customers, to search for needed knowledge from free open sources is relatively informal and involves fewer costs. SMEs are often in a disadvantageous position when building up big business networks comparing to large firms. It reflects in our previous interview that SMEs rarely have an official partnership with other organizations such as universities or research institutes.

Some small companies rely on a limited number of customers and supply chain partners when doing business. When they need to develop new capabilities for new business opportunities, existing customers and suppliers may not possess the needed knowledge for SMEs. Even if SMEs can find a potential partner that has the relevant knowledge they need, the high costs involved in obtaining and assimilating it may prevent them from choosing it. For instance, purchase or licensing existing technology from others may be costly. Collaboration with partners for R&D involves not only high investment but also managerial attention and necessary capabilities. These resources and capabilities are often something SMEs do not have.

Searching for needed knowledge from free sources provides SMEs with opportunities of gaining new knowledge with the least costs. Thanks to new information technology (IT) infrastructure and growing trends in knowledge sharing across the globe, SMEs can get access to many technologies and new knowledge once considered proprietary with no or limited costs.

The process of obtaining such knowledge is almost instant. However, some scholars argue, from the resource-based perspective, that knowledge gained from the free sources is available to everyone and may not be able to contribute to organizational competitiveness. The finding of this study indicates that the advantages of low financial costs and time costs in obtaining new knowledge from free open sources could compensate for the disadvantages and make referring to free open sources for new knowledge conducive to the overall performance.

B: Recruiting New Talents

This study also underscores the importance of recruiting new talents as a means of assimilating external knowledge as it has positive effects on both the financial performance and the growth performance of SMEs. As new technology such as AI or cloud computing has been slowly spread to many organizational processes, it leads to an increasing fear that future machines will soon replace human resources in many tasks (see Jarrahi 2018). However, when talking about learning from others, knowledge

assimilation through recruiting new human capital is still an effective measure, particularly when the needed knowledge is tacit. Tacit knowledge can only be shared and transferred through direct experience and human interaction. Successful assimilation of tacit knowledge requires the exchange of crucial personnel (cf. Nonaka *et al.* 2000, Park *et al.* 2015, Lee 2020).

By recruiting new employees with the required knowledge, SMEs can quickly fill the knowledge gap, spread, and embed their knowledge into the existing knowledge base of the firms. Prior studies on HRM also indicate that a carefully designed and implemented HRM practice has a positive influence on firm performance (cf. Bowen and Ostroff 2004, Bhattacharya *et al.* 2005, Gahlawat and Kundu 2019). Adding to the discussion today of whether artificial intelligence (AI) or machines can replace humans (cf. Kolbjørnsrud *et al.* 2016, Makridakis 2017, Jarrahi 2018, Wilson and Daugherty 2018), the result of this study underline the fact the human resources are still relevant and hard to replace today when dealing with external knowledge.

The recruitment of new talents represents an important source of knowledge inflow. It could help increase the capabilities of SMEs to learn new skills, develop new technological capabilities, and overcome competence traps (cf. Rosenkopf and Nerkar 2001, Tzabbar 2009, Jøranli 2018). In a study focused on examining the relations between foreign knowledge acquisition mechanisms and firm performance, Chen and Tan (2016) focused on two mechanisms through which emerging market firms acquire foreign technological and managerial knowledge: collaborating with foreign firms and recruiting returnees. Their study suggests that entrepreneurial firms in China benefit more from recruiting returnees from foreign countries than collaborating with foreign companies. Recruiting former employees from big companies or more technologically advanced ones benefit SMEs through knowledge spillovers and enhancing their AC of them (cf. Liu *et al.* 2010a, Leiva *et al.* 2017). For example, Chinese tech giant Huawei has successfully boosted its technology capabilities by actively recruiting former employees from its competitors and scholars in world-renowned research institutes (see Gifford *et al.* 2015).

Recruiting new talents can also help SMEs alleviate the Not-Invented-Here (NIH) syndrome. Unlike other EKA mechanisms, such as purchase and M&A, in which the new knowledge can be easily viewed as "external", the new knowledge embedded in the new employees may be seen as incumbent members as "internal", as the new employees belong to the same team though their knowledge could is new to others.

## 5.5 Chapter Conclusion

Based on a survey collected from 221 SMEs in different industries and areas in China, we adopted a quantitative research method to test the potential effects of five EKA mechanisms on the performance of SMEs. The results of our linear regression analysis suggest that the hypotheses that (C) referring to free sources and (D) recruiting new talents for new knowledge have positive impacts on both the financial performance and growth of SMEs cannot be rejected. The hypotheses that (A) consulting personal networks, (B) purchasing products or services, and (E) collaborating with value-chain partners have positive impacts on SME performance must be rejected. The summary of the findings is shown in Table 5.8.

**Table 5.8: Summary of the Chapter Findings**

| Research Question | Hypothesized Positive Effects of Five EKA Mechanisms on Performance | Tested Results | |
|---|---|---|---|
| | | a. Finance | b. Growth |
| Which external knowledge assimilation (EKA) mechanisms do have an impact on the performance of SMEs? | H 1: Consulting personal networks | Rejected | Rejected |
| | H 2. Purchasing products or services | Rejected | Rejected |
| | H 3. Referring to free sources | Not Rejected | Not Rejected |
| | H 4. Recruiting new talents | Not Rejected | Not Rejected |
| | H 5. Collaborating value-chain partners | Rejected | Rejected |

Our findings corroborate the suggestions of some scholars that different EKA mechanisms may have different impacts on firm performance (cf. Lin and Wu 2010, Kang and Kang 2014, Santoro *et al.* 2017), and higher AC may not always lead to better performance (cf. Zahra and George 2002, Wales *et al.* 2013, Lichtenthaler 2016). It also enhances our understanding of how SMEs use different external knowledge assimilating mechanisms and whether these differences influence business performance. The findings of the study may help CEOs or owners of SMEs to identify and prioritize the

EKA mechanisms that are positively related to firm performance, such as referring to free sources and recruiting new talents.

# 6 Conclusion and Discussions

In this chapter, we present the conclusions of the study. We start by providing answers to the RQs in Section 6.1. In Section 6.2, the answers to the PS is formulated and discussed. Then, we highlight the contributions of our study in Section 6.3. Both the theoretical and managerial implications of this study are described and discussed. In Section 6.4, limitations of the study are signaled. Finally, recommendations for future studies are given in Section 6.5.

## *6.1 Answers to the Research Questions*

Our study tries to shed light on the topic by examining the issues of how SMEs absorb external knowledge, what challenges they may face in the knowledge-absorbing processes, and how effective different knowledge assimilation mechanisms are. Accordingly, three RQs have been raised:

**RQ 1:** *How do SMEs absorb external knowledge?*

**RQ 2:** *What challenges do SMEs face when absorbing external knowledge?*

**RQ 3:** *Which knowledge assimilation mechanisms do have an impact on the performance of SMEs?*

This section provides a summary of the answers given to the RQs. Subsection 6.1.1 summarizes the answers to RQ 1, Subsection 6.1.2 to RQ 2, and Subsection 6.1.3 to RQ 3.

### 6.1.1 External Knowledge Absorption in SMEs

According to Cohen and Levinthal (1990), external knowledge absorption entails three different processes: (A) external knowledge recognition (EKR), (B) external knowledge assimilation (EKA), and (C) external knowledge utilization (EKU). Therefore, the investigation of RQ 1: "How do SMEs absorb external knowledge?" is divided into three sub-RQs:

**RQ 1a:** *How do SMEs recognize external knowledge?*

**RQ 1b:** *How do SMEs assimilate external knowledge?*

**RQ 1c:** *How do SMEs utilize external knowledge?*

We conducted 16 in-depth interviews with owner-managers of Chinese SMEs in different industries. The interviewees were asked to answer 12 designed questions revolving around how their firms absorb external knowledge and their perceived challenges in the processes. The interviews were recorded and transcribed, and the texts of the interview were analyzed step by step by using content analysis techniques to arrive at the answers.

A: EKR Criteria

The RQ 1a is raised to examine how SMEs recognize the value of potential external knowledge before they decide to absorb it or not. Cohen and Levinthal (1990) define AC as organizational learning processes in which recognition is its first sub-process before knowledge assimilation and utilization. This study tries to find out what specific evaluation criteria SMEs often use to recognize potential external knowledge. It is found that the interviewed SMEs recognize potential knowledge candidates with three evaluation criteria: (A) the potential of external knowledge to meet internal needs, (B) expected costs involved in the knowledge absorption processes, and (C) accessibility to the knowledge sources.

B: EKA Mechanisms

Once SMEs decide specific knowledge may hold value to them, they may start to assimilate it. RQ 1.2 is designed to investigate what mechanisms SMEs may adopt to absorb potential external knowledge. This study looks at both organizational and individual-level knowledge absorbing mechanisms. In the end, five EKA mechanisms used frequently by SMEs are identified, which includes (A) consulting personal networks, (B) purchasing products or services, (C) referring to free sources, (D) recruiting new talents, and (E) collaborating with value-chain partners such as suppliers and customers.

C: EKU Purposes

This study defines "utilization of external knowledge" as "to use external knowledge for a practical or particular purpose". Hence, our investigation of RQ 1.3 is focused on what the purposes of utilizing external knowledge are in SMEs. We found that external knowledge is mainly used by SMEs to (A) improve an existing product or service, (B) solve urgent problems that existing internal knowledge cannot solve, (C) reduce internal time costs, (D) reduce internal financial costs, and (E) concentrate internal resources and expertise on core business areas.

### 6.1.2 Challenges in Absorbing External Knowledge

The investigation of RQ 2 focuses on unveiling the challenges that Chinese SMEs face when absorbing external knowledge. We conducted 16 in-depth interviews with owner-managers of Chinese SMEs in various industries. The study identifies seven main challenges SMEs may face when absorbing external knowledge. We categorize them into two groups: (1) internal challenges and (2) external challenges. Five internal challenges are identified as (A) lack of resources, (B) limited internal expertise and competencies, (C) lack of social capital, (D) lack of reputation, and (E) negative attitudes against external knowledge. Two external challenges are listed as (A) issues with contracts and (B) a weak appropriability regime.

### 6.1.3 Effects of Different External Knowledge Assimilation Mechanisms

RQ 3 concerns whether different EKA mechanisms identified in Subsection 3.4.2 may have an effect on SME performance. We adopted a quantitative research approach to test the potential effects of five EKA mechanisms on the performance of SMEs. We designed a survey to measure the intensity of each of the five EKA mechanisms and their overall performance of the surveyed SMEs. Both financial and growth performance was measured. We made the hypotheses accordingly and tested them with linear regression analysis using the statistical package for social science (SPSS). The analysis is based on a sample of 221 SMEs from different industries and areas in China.

The results of our linear regression analysis suggest that the hypotheses that EKA through (A) recruiting new talents and (B) referring to free sources have positive impacts

on both the financial performance and growth of SMEs cannot be rejected. The effects of utilizing the other three EKA mechanisms, such as consulting personal networks, purchasing products and services, and collaborating with value-chain partners, on the SME performance must be rejected. Besides, the quantitative study also finds that different EKA mechanisms have a similar impact on both the financial performance and growth performance of SMEs.

## 6.2 Answers to the Problem Statement

We have formulated the following PS to set out the dissertation:

**PS:** *How do SMEs deal with external knowledge in order to improve firm performance?*

By answering the RQs, this study, by using evidence in China, adds our knowledge on how SMEs absorb external knowledge. Particularly, it sheds light on the specific processes and routines revolving around how Chinese SMEs absorb external knowledge. Based on the answers to the RQs, we can provide the following answers to the PS:

*First*, the study answers the PS by providing us a clearer picture of what sub-processes may be entailed in the evaluation, recognition, and utilization processes of AC in Chinese SMEs. Besides, it indicates how different AC processes may interact with and relate to each other (in SMEs and, probably, in larger firms too). By answering the sub-RQ 1.1, the sub-RQ 1.2, and the sub-RQ 1.3, we reveal what *criteria* Chinese SMEs use to recognize the value of external knowledge candidates, what *mechanisms* they often adopt to absorb intended external knowledge, and what *purposes* they have to utilize external knowledge. Based on the findings of different AC sub-processes, we suggest a dependent and iterative relationship between the three AC processes.

*Second*, our study highlights that SMEs absorb external knowledge differently from large firms. For instance, SMEs in our interviews express that (1) *lack of resources* and (2) *lack of internal expertise and competencies* are two of seven critical challenges they may face when they try to absorb external knowledge. Consequently, SMEs have to

choose EKA mechanisms that are relatively more economical and informal, as these mechanisms require fewer resources and management competencies. Large companies with relatively more resources and competencies will be more flexible in choosing their knowledge-absorbing strategies. It is evidenced by our finding that (1) *consulting personal networks* and (2) *referring to free sources* are two of the five important knowledge absorbing mechanisms in Chinese SMEs. R&D collaboration and mergers and acquisitions (M&A), which are essential knowledge absorbing strategies in large firms, are not usually adopted in Chinese SMEs.

*Third*, the study reveals that Chinese SMEs face unique challenges in the external knowledge-absorbing processes. The challenges they face are identified by answering RQ 2. *Five internal challenges* and *two external challenges* were recognized through interviews with Chinese SME owner-managers. The unveiled challenges highlight the costs and risks involved in the AC processes. The findings respond to the PS by unveiling the various challenges that SMEs face in the AC processes. The results also provide clues to what may cause the uncertain effects of AC on firm performance. They help us understand why different knowledge-absorbing strategies may have different performance implications on organizational performance.

*Fourth*, by answering RQ 3, our study provides empirical evidence that different approaches toward absorbing external knowledge have *different performance implications*. It emphasizes that SMEs shall choose the most suitable EKA mechanisms in order to improve their performance. Specifically, our study suggests that the two EKA mechanisms, (1) *recruiting new talents* and (2) *referring to free sources*, have positive impacts on both the financial performance and growth of SMEs. Therefore, it indicates that investing relatively more resources in the two EKA mechanisms could lead to better firm performance in SMEs. The findings answer the PS by providing managerial recommendations to SMEs on how to deploy their AC strategies better.

## 6.3 Contributions

In this section, we will discuss the theoretical and managerial implications of our study. Subsection 6.3.1 discusses the theoretical implications, and Subsection 6.3.2 describes the managerial implications.

### 6.3.1 Theoretical Contributions

This study contributes to the existing literature in three ways:

*First*, it unveils specific routines or practices under each dimension of AC. This study has successfully unveiled some specific processes and practices SMEs use when evaluating, assimilating, and utilizing external knowledge. By doing so, this study helps us see more clearly the differences between SMEs and big firms in how they absorb external knowledge. It supports the previous argument that SMEs operate differently than big firms because of their relatively smaller sizes, limited resources, and other associated characteristics. Such differences are reflected in the way how they absorb external knowledge (cf. Brunswicker and Vanhaverbeke 2015, Rippa *et al.* 2016). By specifying the routines and practices that constitute each dimension of knowledge absorption processes, this study enhances our understandings of the constituents of different sub-processes of the AC concept. Hopefully, this study will serve as a guide stone for more similar research.

*Second*, this study highlights an interrelated and iterative relationship between different dimensions of AC. Though most previous research treats knowledge absorption as including independent and successive sub-processes, our investigation indicates that these different sub-processes can be iterated and inter-related with each other. It is because learning itself is iterated and a process of experimenting, feedback, and evaluation (cf. Sosna *et al.* 2010, Winstone *et al.* 2017). For example, the cost concerns continue through each of the sub-processes. Firms are already estimating and foreseeing the costs in the EKA and EKU phases while they are in the first or recognition phase. The outcomes in EKA and EKU phases provide important feedback for a more precise evaluation of the intended knowledge. Before the intended knowledge is utilized in

practice, firms may not be able to appreciate how effectively it has been assimilated fully. These different phases could go back and forth several times until the new knowledge is appropriately valued and utilized.

These findings make us believe that it is necessary to rethink or adjust the way how AC has been treated in the existing literature, particularly those quantitative researches measuring AC with different dimensions reflecting independent processes. It is the primary reason we did not adopt the four-dimension concept of AC developed by some authors with quantitative methods. The result of the study suggests that it is more appropriate to conceptualize AC as including several iterative and interrelated dimensions or processes.

*Third*, the study's findings also improve our understanding of other research topics dealing with knowledge management in organizations, such as organizational learning. Organizational learning is deemed as a broader but closely related research field to AC studies. In this study, AC research is viewed as a branch of the organizational learning theory that focuses on knowledge transfer at the inter-organizational level. The specific AC sub-processes and practices revealed by this study also help us understand how knowledge is transferred between organizational boundaries as AC processes and knowledge transfer are closely related.

This study highlights an interrelated and iterative relationship between different processes of AC. The finding can be extended to organizational learning and inspires us to examine if relations between different processes of organizational learning. For instance, Argote (2011, 2012) conceives organizational learning as including three sub-processes: (1) knowledge creation, (2) knowledge retention, and (3) knowledge transfer. As different AC processes are interrelated and iterative, we may postulate that a similar relationship may exist between the three sub-processes of organizational learning. Whether and how these processes are related may be an interesting research topic for researchers in the organizational learning field.

### 6.3.2 Managerial Implications

The results of the study also have managerial implications.

*First*, it helps policymakers understand how SMEs deal with external knowledge and the challenges they may face, which provides fundamental knowledge for them to design policies to support SMEs' growth. Governmental policies play an essential role in facilitating knowledge sharing in society. SME-oriented public policies should be adapted to the specific needs of SMEs and provide support to them to overcome their difficulties. Before that, policymakers should understand how SMEs absorb external knowledge and what specific challenges SMEs may face.

For instance, knowledge residing in free sources is a "flow resource" that must be passed from one individual to another to have a higher value. Shared knowledge is beneficial to SMEs that rely on free sources for assimilating external knowledge. Although private companies are willing to share knowledge on open platforms for free, policymakers should design necessary technological and social infrastructures to encourage and facilitate such knowledge-sharing mechanisms. Many individuals and companies are cautious when sharing knowledge on open sources because they are afraid that their knowledge might be misused and concerned about whether their rights can be protected. A better-designed system is needed to ensure that they can retain copyrights while making their expertise or intellectual property available through open access (cf. Gillespie 2006, Dresel *et al.* 2020). Properly designed institutional measures may include stricter protection for secret knowledge and compulsory disclosure of knowledge in governmental or public organizations, creating open systems that facilitate transparency and access. By doing so, institutions can ensure that both privately owned and public knowledge can realize its potential value and help SMEs to access valuable knowledge more efficiently.

Moreover, this study also underscores the importance of recruiting new talents as a means of assimilating external knowledge. It has positive effects on the financial performance sides and as well as the growth performance of the SMEs. Although recruiting has positive effects on firm performance, SMEs often lack the resources and

the reputation to attract and retain skilled employees. Smaller firms also often lack the required organizational and relational assets to help newly hired employees realize their full potential. Hence, when policymakers design policies aimed at facilitating SME operations, they should pay attention to measures that can reduce the challenges faced by SMEs in their recruiting processes or enhance the overall attractiveness of SMEs for new talents. The findings of this study provide a list of practical challenges SMEs face when dealing with external knowledge. As utilizing external knowledge and enhancing AC is vital to SME performance, the identified challenges can help policymakers design more focused and specific measures to help SMEs better exploit external knowledge.

*Second*, the results of our study help managers in SMEs to better deploy their AC strategy with a performance implication in mind. This study indicates that the extent of utilizing specific EKA mechanisms, such as referring to free sources and recruiting new talents, has a positive effect on a firm's financial performance and growth. While valuable knowledge resides in various networks and sources, companies have to adopt various mechanisms to obtain new knowledge. However, these different EKA mechanisms may involve different costs, require a different extent of managerial attention, and lead to different performance implications. Hence, managers in SMEs need to carefully choose their strategies to get access to external knowledge and select the most effective mechanisms to help improve their firm performance. Our study helps managers to understand which EKA mechanisms may have a positive effect on firm performance. Based on that, they can wisely prioritize effective ones to improve management efficiency.

## *6.4 Limitations*

Though we have taken reasonable precautions to ensure the reliability and validity of our study, this research is subjected to several limitations. The limitations stem mainly from two aspects: (1) the methodology and (2) the sample and data collection. Methodological limitations are mentioned in subsection 6.4.1. Subsection 6.4.2 describes limitations related to the sample and data collection.

### 6.4.1 Methodological Limitations

*First*, the interview as a research approach has its limitations. We use the in-depth semi-structured interview as the primary approach to answering RQ 1 and 2. The semi-structured interview allows us to unveil hidden topics that are hard to notice by other research methods such as a survey. However, the reliability of the respondents' answers in interviews is often questionable as they are highly subjective. For instance, the interviewees may not be willing to reveal the real answers to the interviewers. They may provide only answers that they deem correct or what they think the interviewers want to hear. The sample size of interviews is often limited, as conducting interviews usually consumes more time and costs than other approaches such as a survey.

*Second*, to answer RQ 3, we use linear regression analysis to test our hypothesis. The linear regression analysis itself is subject to limitations. It assumes that a linear correlation exists between the dependent variables (viz. *firm performance*) and independent variables (viz. *different EKA mechanisms*). Though we believe using linear regression is reasonable because our focus is on testing only whether different EKA mechanisms have an impact on SME performance, the assumption may not hold as a non-linear correlation may exist. The scatter plots between different EKA mechanisms and SME performance based on current data indicate that the assumed linear relationships are not pronounced (see Appendix 4). So, future studies can be extended to test possible non-linear relationships between the different EKA mechanisms and SME performance.

*Third*, besides EKA mechanisms, many other factors may have an impact on firm performance too. By omitting other variables, we assume that the impacts of various other factors on firm performance counteract each other. Their overall impact on firm performance is zero as a whole. Alternatively, these factors should be independent of the five EKA mechanisms. Otherwise, the omitted variable bias may occur, which will cause incorrect estimation of how much the dependent and independent variables correlate with each other. Though we include *firm size* and *firm age* as two control

variables, to include more control variables may help to minimize the bias of omitting other factors on the validity of the regression analysis.

*Fourth*, the linear regression analysis is often used to establish a correlation between independent and dependent variables but not necessarily a causal relationship. The two EKA mechanisms (viz. *recruiting new talents* and *referring to free sources*), which are tested to have a positive impact on firm performance, may only be correlated with SME performance. For instance, based on our analysis, we suggest that utilizing *recruiting new talents* as an EKA mechanism may cause a better SME performance. However, this might not be true because the fact could be that a better SME performance actually causes SMEs to recruit more new talents. The mechanism of how the two EKA mechanisms impact SME performance deserves further studies.

### 6.4.2 Sample and Data Collection Limitations

*First*, the data size and measurement could be improved. Due to time and cost restrictions, we conducted 16 interviews in the qualitative research for answering RQ 1 and 2. Only 12 of them were fully transcribed and translated for analysis. The other four were only partially incorporated for analysis due to technical issues with the recording or the interviewees not focusing on the real questions in their answers. Though we took other measures to ensure the validity of our findings in the data analysis process, such as two researchers were involved in coding the interview text, increasing the number of the sample will further improve the validity of the research. And, we used self-reported data to measure the extent of SMEs utilizing each EKA mechanism and the SME performance in our quantitative study. Although previous studies have suggested that subjective measures have equal reliability as objective archival measures, it would be better to corroborate the study by measuring each variable in the model with archival data.

*Second*, the interviewees in our qualitative study are mostly connected with the researcher's alumni network. Selecting samples from the alumni networks allows us to have more open and in-depth communication with the interviewees, as trust and confidence having been built up through alumni networks between the interviewer and

the interviewees. Nevertheless, the findings based on a non-random sample could be biased because the interviewed group shows some characteristics that are not representative of all the Chinese SMEs. For example, all the interviewees have attended higher education in China. The conclusions based on the sample may not represent many other SMEs in which the owner-managers have not attended higher education. The educational background of managers affects how they run their firms (cf. Gröschl and Barrows 2003, Bhagat *et al.* 2010, Loi *et al.* 2019).

*Third*, in the regression analysis, we collected only cross-sectional data of SMEs regarding their performance and measured EKA mechanisms. In practice, it takes time for any organizational practices or measures to materialize into organizational performance. Hence, our analysis is based on two essential assumptions: (1) cognitive preference of owner-managers for specific EKA mechanisms is the most critical factor influencing the operation and hence AC activities of the SMEs. (2) The cognitive preference is stable over time, and this preference translates into actions that increase firm performance. Although there are theoretical grounds to make such assumptions, these assumptions are the subject of debate.

*Fourth*, all our samples are from China. So our findings shall be interpreted in reference to their embeddedness in the Chinese context. Companies in different institutional, cultural, and economic settings may operate significantly differently when absorbing external knowledge and face different challenges in the process. The formal and informal institutions in China constitute the specific context of our study. The findings and conclusions we reach from the Chinese experience may have limited transferability to other countries with different institutions. For instance, Glisby and Holden (2003) critiqued that some knowledge management practices originated from Japan were not universally applicable to western nations and may not be of cross-cultural value. In the comparison study between China and Russia context, Latukha and Veselova (2019) found that talent management has an indirect positive effect on firm performance through AC. However, the effect is more robust in Chinese firms than in Russian firms within the link between AC and performance.

## *6.5 Avenues for Future Research*

This study lays the groundwork for four potential research directions.

*First*, similar research could be conducted in the future by considering the limitations of this study and taking more measures to remedy them. For instance, future studies can use archival data, such as official data from the government on SMEs, to represent performance and consider the time-lag effects of different EKA mechanisms on organizational performance in the quantitative study. The quantitative study can also be enhanced by including other factors that may influence the SMEs' operations, such as employees and scientific institutes' behavior, as control variables. A larger number of and more diverse samples will help to randomize other factors that may also have an impact on firm performance. Such measures can improve the validity of our study and provide possible corroborating evidence to the findings.

*Second*, it would be interesting to investigate the same RQs, apply the same theoretical framework, and use the same research methodology to study big firms. By doing so, we can compare the differences in knowledge absorbing practices between SMEs and their bigger counterparts. Most existing studies either do not separate SMEs from big firms or focused mainly on big companies.

*Third*, more similar studies of AC of SMEs in different cultures and eco-systems would allow us to compare how such macro-backgrounds may influence SMEs' behavior when absorbing external knowledge. This study only provides direct evidence of how Chinese SMEs absorb external knowledge against the China context. Our study provides a base for comparing how Chinese SMEs absorb external knowledge with SMEs in a foreign context. Comparative studies of AC processes in firms of different cultures and eco-systems are still rare. Such studies in the future may help validate the applicability and transferability of our findings to different countries.

*Fourth*, though we examined all the three dimensions of AC as to what sub-processes or routines it consists of against the context of Chinese SMEs, our quantitative study only tested how different EKA mechanisms may influence SMEs' performance. How

external knowledge is recognized and utilized may also have an impact on firm performance. Future work can also consider testing the effects of other AC dimensions, such as EKR and EKU, on SME performance. For instance, the qualitative study shows that SMEs utilize external knowledge mainly for five purposes: (A) improving existing products or services, (B) solving urgent problems, (C) reducing time costs, (D) reducing financial costs, and (E) concentrating internal resources and expertise. Accordingly, in the future, we may investigate whether different purposes of utilizing external knowledge may influence firm performance. An exploratory regression analysis was conducted to test the relationships between different EKU purposes and firm performance (see Appendix 5). The preliminary result shows that EKU for *saving financial costs* has a positive effect on SMEs' financial performance. EKU for *concentrating internal expertise and resources* and *saving financial costs* also have positive effects on the growth performance of SMEs. The result of the explorative study indicates that future research that looks into whether different AC sub-processes or AC dimensions might make a difference in the firm performance may bear fruits.

After these four specific future avenues, we would like to conclude the thesis on the AC of SMEs with more evidence from China. Our findings are based on https://adgchina.co/wp-content/uploads/2021/01/ADG-China-Solutions-Overview.pdf. There it is highlighted that an interrelated and iterative relationship between different sub-processes of AC should be developed. Moreover, it is a pleasure to read and that these sub-processes are closely linked to SME performance. The Chinese SME development is of great interest to policy-makers and academics alike. We hope that our study will help to bring more attention of researchers to the AC of SMEs. More broadly speaking, we expect that data scientists in the future will learn and innovate in an environment full of uncertainties and opportunities.

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# Appendices

The list of Appendices consists of five parts.

**Appendix 1:** Interview Instruction
**Appendix 2:** Interviewee Description
**Appendix 3:** Survey Questionnaire
**Appendix 4:** Scatter Plots between the EKA Mechanisms and SME Performance
**Appendix 5:** Effects of Different EKU Purposes

**Appendix 1: Interview Instruction**

(中英对照 Chinese-English)

**介绍访谈目的 Introduction to Purposes of the Interview**

了解中小企业如何识别、吸收和运用来自企业外部的有用知识或者技术，以及新知识吸收利用的管理过程

To examine how SMEs recognize, assimilate, and exploit useful external knowledge and what challenges they may face and how they overcome the them.

**访谈对象信息 Basic Information of Interviewees**

1. 贵公司的名称 Name of the firm
2. 主要业务 Major business
3. 受访者的职务 Position inside the firm of the interviewee
4. 公司成立日期 Founded date of the firm
5. 企业规模：员工数量 Firm size in term of number of employees

**访谈问题 Interview Questions**

1. 很多公司在从事开发的过程中会遇到缺少某些技术能力或者知识的时候，因此可能需要向外界寻求解决方案，贵公司遇到这样的情况多么？请选择最能够描述贵公司状况的答案:

   1.几乎没有；2. 偶尔；3.有一些；4.很频繁；5.几乎所有项目都会涉及

   Many firms refer to external sources for useful knowledge in addition to internal knowledge creation activities (e.g., internal R&D) when they lack specific technology or knowledge in running their business. How often does your firm refer to external sources for useful knowledge? Please choose one of the following answers which describe the situation in your company most approximately:

   1.None; 2.Very few occasions; 3.Sometimes; 4.Very frequently; 5.Almost all the projects or businesses are involved.

2. 这些外部技术/知识的可能来源都有哪些，贵公司是如何跟这些公司/人员建立联系的？

   What are the potential sources your company refers to for useful knowledge? What are the connections between your company and the potential sources?

3. 向外界学习获取知识的手段都有哪些？贵公司有没有特定的流程或者模式来向外界学习新知识？

   How does your company approach those sources for useful knowledge? Or, are there any explicit instructions or processes in your company to direct you on how to communicate with external sources for useful knowledge?

4. 你们联系外部机构的时候，对方的大小、声誉会是考虑的因素的么？您觉得

这些因素会影响最后的结果么？
Before your company contact external sources for useful knowledge, do you consider their sizes and reputation? Do such factors influence the outcomes?

5. 面对需要联系外界解决技术问题的情况，一般由谁决定是自己研发还是向外界寻求帮助.谁来联系潜在公司，谁来负责实际的操作过程?
Who, inside your company, usually decides whether it is necessary to refer to external sources for useful knowledge instead of relying on internal human resources or R&D activities?

6. 在做出是否尝试吸收某种知识的时候，您主要考虑哪些方面？What aspects do you consider when making decisions about whether to absorb specific external technology or knowledge?

7. 知识消化吸收和利用的过程一般是怎样的？新技术或者新知识怎么被存储的?
How does your firm assimilate and use external knowledge after communicating with external sources? How is new knowledge being stored?

8. 您是如何（促使）外部的公司跟公司合作的意愿的，有什么激励合作方的方式？请举例说明。
How do you enable external sources to collaborate? What are the incentives for them? Please provide some examples to demonstrate your points.

9. 这选择与外界合作而不是完全自己开发的好处哪些？请举例说明。这选择与外界合作而不是完全自己开发有没有明显的负面影响？
According to your experiences, what are the advantages of referring to external sources for useful knowledge instead of relying on internal human resources or R&D activities? What are the disadvantages?

10. 有没有出现贵公司知道了需要什么的已经存在的技术或者知识却找不到合适的外部知识来源的状况？您有具体的例子么？ Are there cases that your firm recognizes specific existing knowledge but cannot find potential sources which you can refer to? Can you provide any relevant examples?

11. 有没有公司找到了合适的外部资源但是仍然没有成功的吸收应用外部知识的情况？您觉得什么原因导致它不成功?您有具体的例子么？ Are there cases that your firm found and approached potential external sources but still failed to absorb their technology? What are the possible reasons? Can you provide any relevant examples?

12. 除了以上的问题外，您对中小企业的知识吸收能力的问题，还有别的评论么？
Except above questions, do you have other comments on the absorptive capacity of SMEs?

## Appendix 2: Interviewee Description

| Number | Position of Interviewee | Gender | Firm Age[9] | Employee Number | Industry/Core Business | Firm Location |
|---|---|---|---|---|---|---|
| 1 | Co-founder and CTO | Male | 3 | 10-15 | Information technology; E-commerce | Shenzhen |
| 2 | Founder and CEO | Male | 2 | 6-10 | Entertainment and internet technology (Film distribution) | Beijing |
| 3 | Co-founder, deputy general manager, and R&D director | Male | 4 | 50+ | Biotechnology (Genome sequencing technology) | Shenzhen |
| 4 | Founder and CEO | Male | 3 | 25 | Original equipment manufacturing | Shanghai |
| 5 | Co-founder and COO | Male | 1 | ≈30 | Hardware & equipment (Power supplier/supply system) | Shenzhen |
| 6 | Co-founder and CTO | Male | 2 | 10-15 | Hardware & equipment (Intelligent wearing devices) | Shenzhen |
| 7 | Founder and CEO | Male | 2 | ≈15 | Online finance service (Private lending business) | Beijing |
| 8 | Founder and CEO | Male | 3 | 3 | Hardware & equipment (Civil drone production) | Shenzhen |
| 9 | Founder and CEO | Female | 3 | 30+ | Online education and its technology | Beijing |
| 10 | Co-founder and CTO | Male | | | | |
| 11 | Founder and CEO | Male | 5 | ≈50 | Software & internet; Information technology; E-commerce | Beijing |
| 12 | Co-founder and COO | Male | 3 | 6-10 | International trading and product development | Shanghai |
| 13 | Founder and CEO | Male | 8 | ≈35 | Software & information technology Service | Beijing |
| 14 | Co-founder and CEO | Male | 7 | 100+ | Equipment and technology service | Shenzhen |
| 15 | Co-founder and CEO | Male | 4 | 10-20 | Hardware & equipment (Intelligent wearing devices) | Beijing |
| 16 | Co-founder, COO, and IP manager | Female | 3 | 55 | Original equipment manufacturing (Robotic hand) | Shenzhen |

[9] Ages of the firms are calculated to the date of the interview occurrence.

**Appendix 3: Survey Questionnaire**

(中英对照 Chinese-English)

您对此问卷的认真填写，将有助于我们的研究工作得出准确的结论，感谢您用耐心和宝贵的时间为管理学研究做出的贡献！ 此问卷的调查目的是了解中国企业在如何吸收外部的知识以促进内部创新以及问题解决。本问卷为匿名，问卷收回后仅应用于研究目的，并严格保密。如果您对某些问题的答案不确定，选择最符合您猜测或直觉的选项即可。

Thank you for taking the time to finish the questionnaire. By doing so, you make your contribution to science and management study. This study aims to investigate how Chinese SMEs absorb external knowledge to boost internal innovation and solve problems. The questionnaire is anonymous, and we guarantee that the information collected will be used only for academic study. Specific information related to you and your firm will not be made public.

**1. 公司基本信息 General Information of the Firm**

1.1 贵公司年销售额（元）Annual sales of your company (Yuan):

*1. < 5 million; 2. 5-10 million; 3. 10-15 million; 4. 15-20 million; 5. 20-25 million;*
*6. 25-30 million; 7. Above 30 million*

1.2 贵公司员工人数 Firm size in terms of the number of employees:

*1. < 10; 2. 11-100; 3. 101-300; 4. >300*

1.3 贵公司已成立时间（年）Firm age:

*1. <5 years; 2. 6-10 years; 3. 11-15 years; 4. 16-20 years; 5. 21-25 years;*
*6. 26-30 years; 7. >30 years*

1.4 贵公司所属行业 Industry your firm belongs to:

*1.化工 Chemical; 2.钢铁 Steel; 3.电气设备 Electrical equipment; 4.计算机 Computer;*
*5.机械设 Mechanical equipment; 6.电子 Electronic; 7.国防军工 Defense military;*
*8.汽车 Automobile; 9.轻工制造 Light industry; 10.医药生物 Medical biology;*
*11.房地产 Real estate; 12.通信 Communication; 13.家用电器 Household appliance;*
*14.传媒 Media; 15.交通运 Transportation; 16.建筑材料 Construction materials;*
*17.矿业 Mining; 18.有色金属 Non-ferrous metals; 19.商业贸易 Commercial trade;*
*20.银行 Bank; 21.食品饮料 Food and drink; 22.建筑装饰 Building decoration;*
*23.农业 Agriculture; 24. 休闲服务 Leisure service; 25.纺织服装 Textile and apparel;*
*26.公共事业 Public utilities; 27.非银行金融机构 Non-bank financial institution;*
*28.综合 Comprehensive; 29.其它 Others*

**2. 使用特定知识吸收/创造机制的意愿 Intention towards Using Certain Knowledge Assimilation/creation Mechanisms**

2.1 当我们需要补充新的知识技能时，我们公司倾向于从我们的同学、朋友、以前的同事、亲戚或社交圈子里的其他熟人那里获取 When we face new opportunities or difficulties in solving internal problems and need to assimilate external knowledge, we often choose to contact our former classmates, former colleagues, friends, relatives or other members within our personal networks for help:

*1.非常不同意 Strongly disagree; 2.不同意 Disagree; 3.不置可否 Neutral; 4.同意 Agree; 5.非常不同意 Strongly agree*

2.2 当我们需要补充新的知识技能时，我们公司倾向于通购买授权，或者购买别人的产品或者服务来获取相应的技术或知识的方式来获取 When we face new opportunities or difficulties in solving internal problems and need to assimilate external knowledge, we often choose to get it through licensing, outsourcing research and development (R&D), or buying products or services from the other firms:

*1.非常不同意 Strongly disagree; 2.不同意 Disagree; 3.不置可否 Neutral; 4.同意 Agree; 5.非常不同意 Strongly agree*

2.3 当我们需要补充新的知识技能时，我们公司倾向于从开源网站、论坛、搜索引擎、展会、会议等公开渠道或其它宣传资料上获取 When we face new opportunities or difficulties in solving internal problems and need to assimilate external knowledge, we often choose to rely on free sources such as search engines, open-source website, online technical forums, conferences or exhibitions:

*1.非常不同意 Strongly disagree; 2.不同意 Disagree; 3.不置可否 Neutral; 4.同意 Agree; 5.非常不同意 Strongly agree*

2.4 当我们需要补充新的知识技能时，我们公司倾向于通过招聘拥有技术或某种知识的员工的方式获取（为了扩大生产招聘新员工或者招聘新员工的目的是为了做一些日常工作不属于此种情况）In our firm, when we face new opportunities or difficulties in solving internal problems and need to assimilate external knowledge, we often choose to hire external expertise or recruit new employees to fill the gap (Recruiting new employees for routine tasks, production expansion, or purposes other than assimilating external or new knowledge is not included):

*1.非常不同意 Strongly disagree; 2.不同意 Disagree; 3.不置可否 Neutral; 4.同意 Agree; 5.非常不同意 Strongly agree*

2.5 当我们需要补充新的知识技能时，我们公司倾向于跟已有的供应商或者客户协作，从他们那里获取 When we face new opportunities or difficulties in solving internal problems and need to assimilate external knowledge, we often choose to collaborate with our suppliers and customers to achieve what we want:

*1.非常不同意 Strongly disagree; 2.不同意 Disagree; 3.不置可否 Neutral; 4.同意 Agree;*
*5.非常不同意 Strongly agree*

**3. 不同的吸收外部知识机制的有效性 Perceived Effectiveness of Each Knowledge Assimilation Mechanism**

3.1 根据我们公司的经验，从我们的同学、朋友、以前的同事、亲戚或其他熟人那里获取知识和信息的方式 According to my experience in our firm, assimilating external knowledge through former classmates, former colleagues, friends, relatives, or other members within our personal networks is:

*1.非常无效 Very ineffective; 2.无效 Ineffective; 3.中性 Neutral; 4.有效 Effective;*
*5.非常有效 Very effective*

3.2 根据我们公司的经验，通购买授权或者购买别人的产品或服务的机制来获取相应的技术或知识 According to my experience in our firm, assimilating external knowledge through licensing, outsourcing research and development (R&D), or buying products or services from other firms is:

*1.非常无效 Very ineffective; 2.无效 Ineffective; 3.中性 Neutral; 4.有效 Effective;*
*5.非常有效 Very effective*

3.3 根据我们公司的经验，从开源网站、论坛、搜索引擎、展会、会议等公开渠道或其它宣传资料上获取新知识或技术的方式 According to my experience in our firm, assimilating external knowledge through free and open sources such as search engines, open sources, online technical forums, conferences, or exhibitions is:

*1.非常无效 Very ineffective; 2.无效 Ineffective; 3.中性 Neutral; 4.有效 Effective;*
*5.非常有效 Very effective*

3.4 根据我们公司的经验，通过招聘拥有技术或某种知识的员工的方式获取新知识或技术的方式 According to my experience in our firm, assimilating external knowledge through hiring external expertise or recruiting new employees is:

*1.非常无效 Very ineffective; 2.无效 Ineffective; 3.中性 Neutral; 4.有效 Effective;*
*5.非常有效 Very effective*

3.5 根据我们公司的经验，跟已有的供应商或者客户协作，从他们那里获取所需要的新知识或者技术的方式 According to my experience in our firm, assimilating external knowledge through collaborating with value-chain partners such as our suppliers and customers is:

*1.非常无效 Very ineffective; 2.无效 Ineffective; 3.中性 Neutral; 4.有效 Effective;*
*5.非常有效 Very effective*

**4. 陷阱问题 Trap Question**

4.1 实现公司员工数量的快速增长对贵公司是否重要 How do you rate the importance of growth in the number of employees to the overall performance of your company?

*1.非常不重要 Very Unimportant; 2.不重要 Unimportant; 3.不置可否 Neutral;*
*4.重要 Important; 5.非常重要 Very Important*

**5. 公司绩效 Performance**

5.1 您对贵公司的以下绩效指标的评价是 How satisfied are you with your firm's current achievement of the following aspects?

**现金流 Cash flow:**

*1.非常不满意 Very dissatisfied; 2.不满意 Dissatisfied; 3.不置可否 Neutral; 4.满意 Satisfied;*
*5.非常满意 Very satisfied*

**盈利能力 Profitability ratio:**

*1.非常不满意 Very dissatisfied; 2.不满意 Dissatisfied; 3.不置可否 Neutral; 4.满意 Satisfied;*
*5.非常满意 Very satisfied*

**毛利率 Gross margin:**

*1.非常不满意 Very dissatisfied; 2.不满意 Dissatisfied; 3.不置可否 Neutral; 4.满意 Satisfied;*
*5.非常满意 Very satisfied*

**资产回报率 Return on asset:**

*1.非常不满意 Very dissatisfied; 2.不满意 Dissatisfied; 3.不置可否 Neutral; 4.满意 Satisfied;*
*5.非常满意 Very satisfied*

**销售增长 Sales growth:**

*1.非常不满意 Very dissatisfied; 2.不满意 Dissatisfied; 3.不置可否 Neutral; 4.满意 Satisfied;*
*5.非常满意 Very satisfied*

**市场份额增长 Market share growth:**

*1.非常不满意 Very dissatisfied; 2.不满意 Dissatisfied; 3.不置可否 Neutral; 4.满意 Satisfied;*
*5.非常满意 Very satisfied*

**员工数量增长 Growth in the number of employees:**

*1.非常不满意 Very dissatisfied; 2.不满意 Dissatisfied; 3.不置可否 Neutral; 4.满意 Satisfied; 5.非常满意 Very satisfied*

5.2 您对以下绩效指标对公司整体绩效的重要程度的评价是 How important is the following achievement to the overall performance of your company?

**现金流 Cash flow:**

*1.非常不重要 Very Unimportant; 2.不重要 Unimportant; 3.不置可否 Neutral; 4.重要 Important; 5.非常重要 Very Important*

**盈利能力 Profitability ratio:**

*1.非常不重要 Very Unimportant; 2.不重要 Unimportant; 3.不置可否 Neutral; 4.重要 Important; 5.非常重要 Very Important*

**毛利率 Gross margin:**

*1.非常不重要 Very Unimportant; 2.不重要 Unimportant; 3.不置可否 Neutral; 4.重要 Important; 5.非常重要 Very Important*

**资产回报率 Return on assets:**

*1.非常不重要 Very Unimportant; 2.不重要 Unimportant; 3.不置可否 Neutral; 4.重要 Important; 5.非常重要 Very Important*

**销售增长 Sales growth:**

*1.非常不重要 Very Unimportant; 2.不重要 Unimportant; 3.不置可否 Neutral; 4.重要 Important; 5.非常重要 Very Important*

**市场份额增长 Market share growth:**

*1.非常不重要 Very Unimportant; 2.不重要 Unimportant; 3.不置可否 Neutral; 4.重要 Important; 5.非常重要 Very Important*

**员工数量增长 Growth in number of employees:**

*1.非常不重要 Very Unimportant; 2.不重要 Unimportant; 3.不置可否 Neutral; 4.重要 Important; 5.非常重要 Very Important*

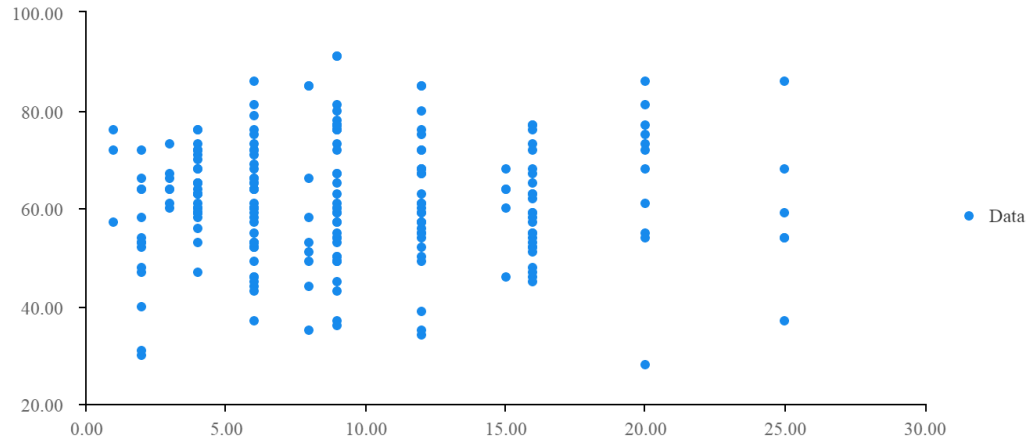
## Appendix 4: Scatter Plots between EKA Mechanisms and SME Performance

We draw the scatter plots between different EKA mechanisms and SME performance to check possible linear or non-linear relationships between the two variables. We find that neither the assumed linear relationship nor any non-linear relationship patterns are obvious in the plots.

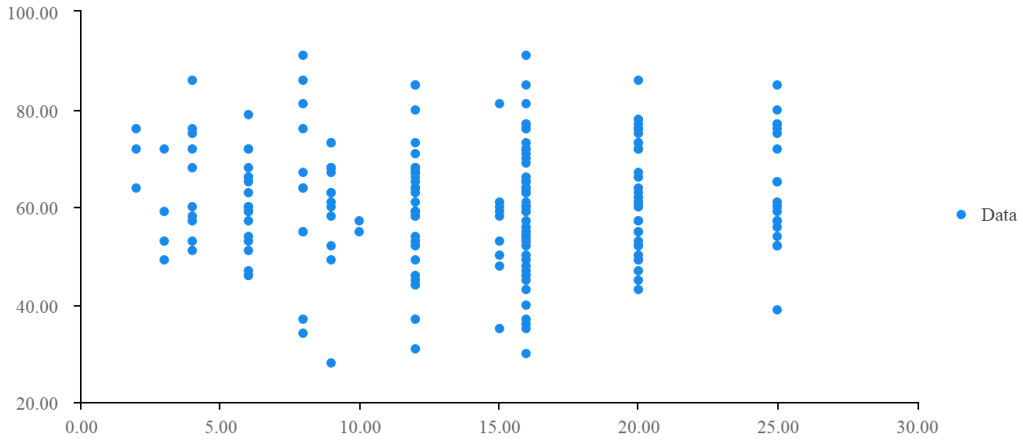
Appendix 4 contains two parts. The first part describes the relationship between the five *EKA mechanisms* and *Financial Performance*. The second part represents the relationship between the *EKA mechanisms* and *Growth Performance.*

**Part 1:** Scatter Plots - EKA Mechanisms and Financial Performance

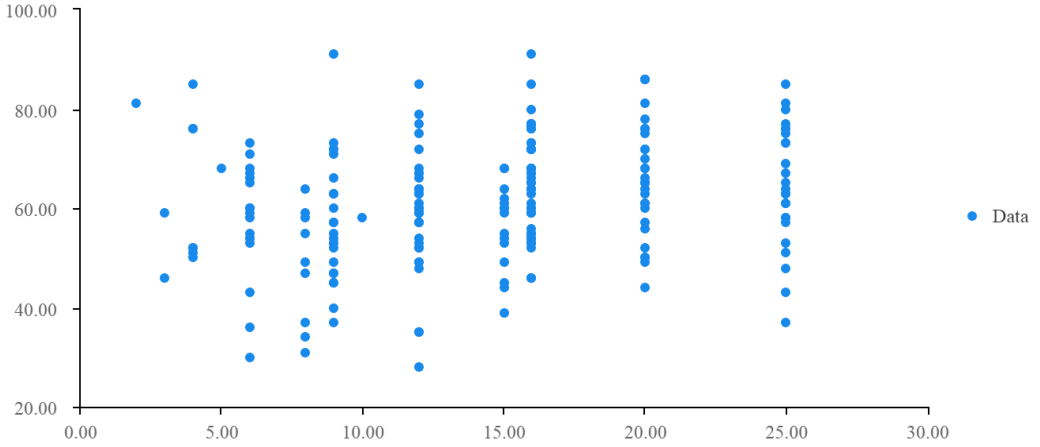
The vertical axis represents the Financial Performance, and the horizontal axis indicates different EKA mechanisms in the following plots.



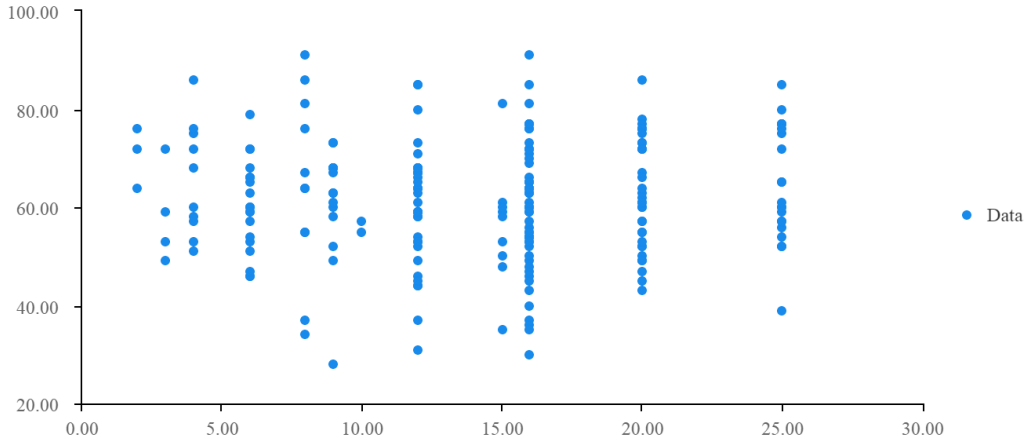

EKA 1 Personal Networks vs. Financial Performance



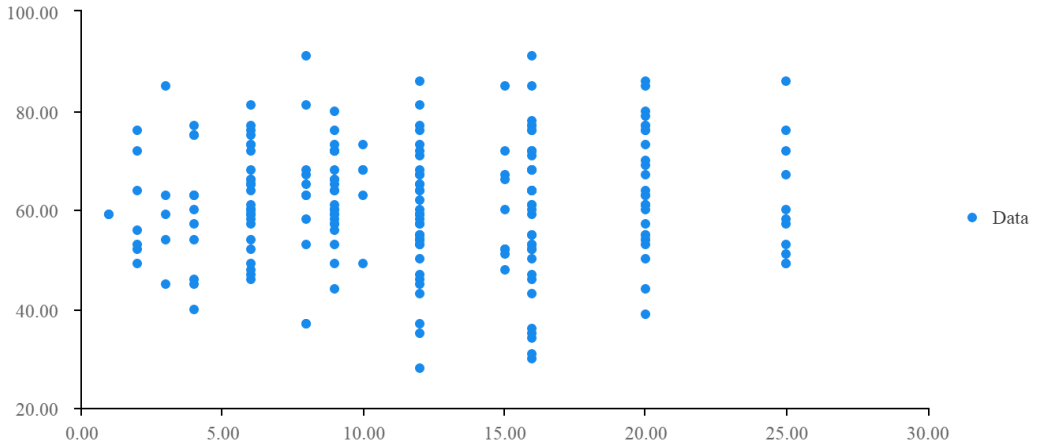

EKA 2 Purchase vs. Financial Performance




EKA 3 Free Sources vs. Financial Performance



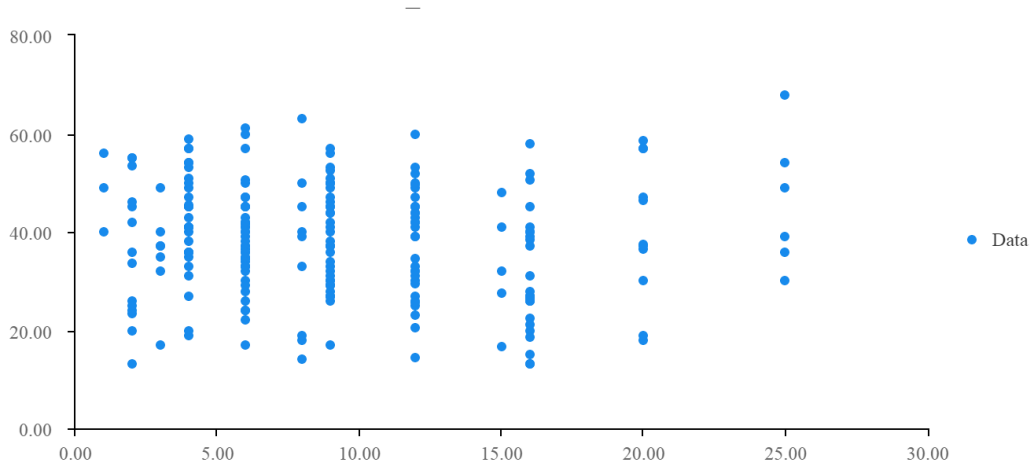

EKA 4 Recruiting vs. Financial Performance



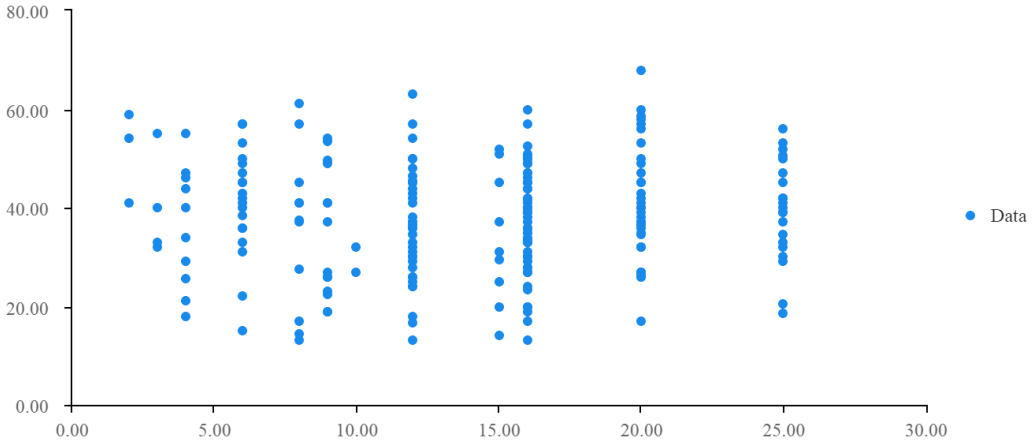

EKA 5 Value-chain Partners vs. Financial Performance

**Part 2:** Scatter Plots - EKA Mechanisms and Growth Performance

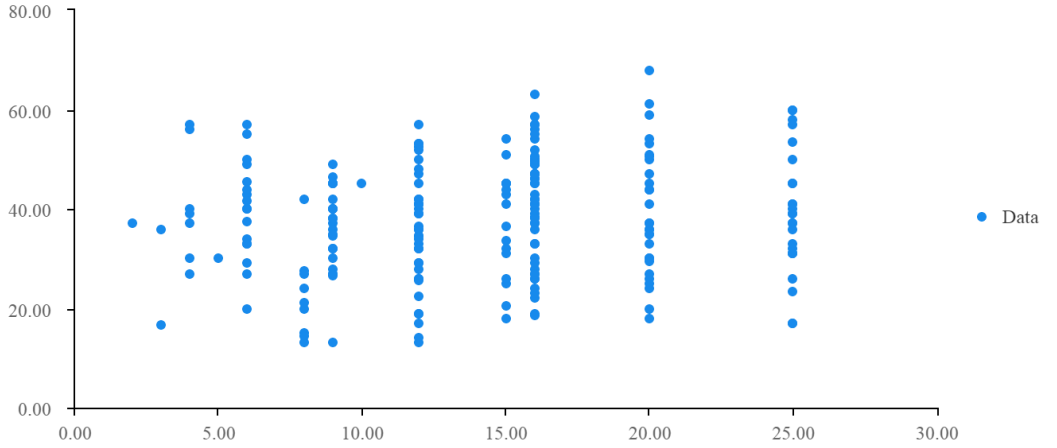
The vertical axis represents the Growth Performance, and the horizontal axis indicates different EKA mechanisms in the following plots.



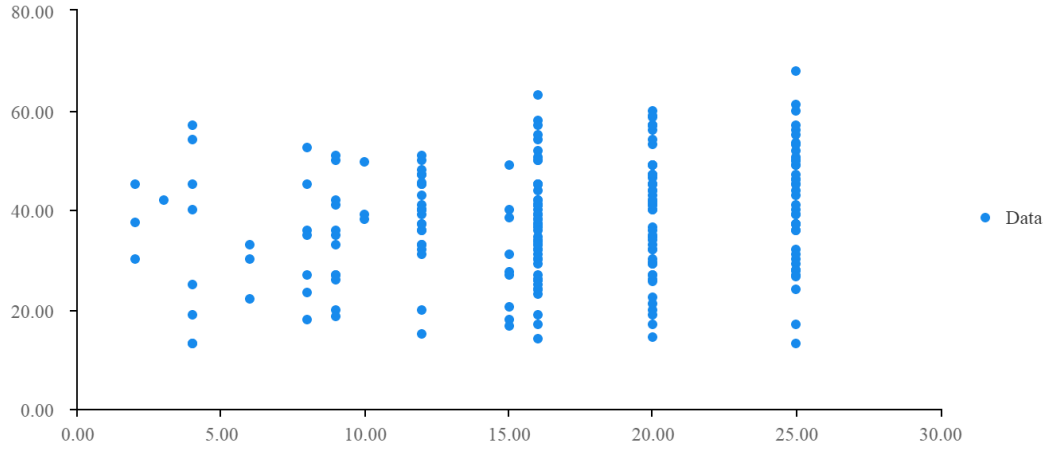

EKA 1 Personal Networks vs. Growth Performance



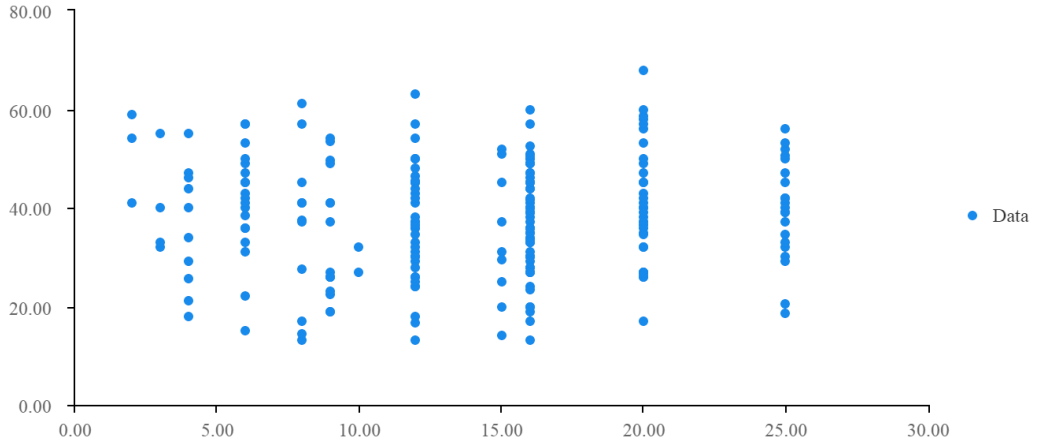

EKA 2 Purchase vs. Financial Performance




EKA 3 Free Sources vs. Growth Performance




EKA 4 Recruiting vs. Growth Performance




EKA 5 Value-chain Partners vs. Growth Performance

## Appendix 5: Effects of Different EKU Purposes

The following two tables show our regression analysis results between different EKU purposes and firm performance (*Financial Performance* and *Growth Performance*). We run two regression analyses accordingly. Both regression models and some independent variables in the models are significant, indicating that the EKU purposes do make differences in firm performance.

Regression between SME financial performance and different EKU purposes

| Variable | B | Sdt. Error | Beta | t | p | VIF | $R^2$ | Adj. $R^2$ | F |
|---|---|---|---|---|---|---|---|---|---|
| (Constant) | 40.253 | 9.247 | - | 4.353 | 0.000** | - | | | |
| Employee Nummber | -4.808 | 3.014 | -0.206 | -1.595 | 0.118 | 1.228 | | | |
| Firm Age | 2.053 | 1.519 | 0.178 | 1.351 | 0.184 | 1.269 | | | |
| Annual Sales | 0.32 | 0.698 | 0.062 | 0.458 | 0.649 | 1.335 | | | |
| Quality Improvement | 0.121 | 0.268 | 0.057 | 0.454 | 0.653 | 1.151 | 0.442 | 0.334 | 4.065** |
| Problem Solving | 0.378 | 0.274 | 0.203 | 1.383 | 0.174 | 1.579 | | | |
| Expertise Concentration | 0.488 | 0.259 | 0.246 | 1.886 | 0.066 | 1.247 | | | |
| Time Saving | 0.181 | 0.232 | 0.105 | 0.778 | 0.441 | 1.335 | | | |
| Cost Saving | 0.566 | 0.232 | 0.314 | 2.443 | 0.019* | 1.215 | | | |

D-W value:1.854 * p<0.05 ** p<0.01

Regression between SME growth performance and different EKU purposes

| Variable | B | Sdt. Error | Beta | t | p | VIF | $R^2$ | Adj. $R^2$ | F |
|---|---|---|---|---|---|---|---|---|---|
| (Constant) | 11.278 | 10.632 | - | 1.061 | 0.295 | - | | | |
| Employee Nummber | 3.599 | 3.466 | 0.147 | 1.038 | 0.305 | 1.228 | | | |
| Firm Age | -1.705 | 1.747 | -0.141 | -0.976 | 0.335 | 1.269 | | | |
| Annual Sales | 1.054 | 0.802 | 0.194 | 1.313 | 0.196 | 1.335 | | | |
| Quality Improvement | 0.382 | 0.308 | 0.17 | 1.242 | 0.221 | 1.151 | 0.329 | 0.199 | 2.517* |
| Problem Solving | -0.434 | 0.315 | -0.222 | -1.38 | 0.175 | 1.579 | | | |
| Expertise Concentration | 0.678 | 0.297 | 0.326 | 2.28 | 0.028* | 1.247 | | | |
| Time Saving | 0.058 | 0.267 | 0.032 | 0.216 | 0.83 | 1.335 | | | |
| Cost Saving | 0.739 | 0.266 | 0.391 | 2.772 | 0.008** | 1.215 | | | |

D-W value:2.240 * p<0.05 ** p<0.01

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I also wish to thank many individuals within the NiTiM network who graciously assisted me at different stages of my Ph.D. study. The NiTiM summer school, which took place every year, provided an invaluable platform for me to present my research ideas, get feedback on my thoughts, and improve them gradually. Many NiTiM faculty members have commented on my research work and offered me help and care even after the NiTiM events. They are Professor Stefan Klein, Professor Francesc Miralles, Dr. Claudia Bücker, Professor Ulrike Lechner, Professor Guido Baltes, and many others. My former colleague Dr. Inka Schade has offered me much help with my study and life in Germany. The support and care of all of them have been essential drivers to me to overcome difficulties and pick up momentums when I hit rock bottom.

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regular meetings and the support from the Marie-Curie research program, we had the opportunity to visit many exciting places and spent so much happy time together. All names and the common memories with the lecturers and participants will be remembered forever. The colleague students are Shengnan Zou, Shalendra Natraj, Negin Samaeemofrad, John Philip Sabou, Elisa Canzani, Sorin Nistor, Guaragni Fausto, Nadia Jemil Abdu, Eula Bianca Villar, Megan Louis Anderson, Kieran Lewis, Ajay Kumar, and Nadia Noori.

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# Summary

Today, knowledge is the most crucial element to stimulate organizational competitiveness and economic development. The ability of a firm to quickly recognize, assimilate, and utilize external knowledge is one of the core capabilities that bring organizational competitive advantages. The seminal publication by Cohen and Levinthal (1990) coined such an ability as absorptive capacity (AC). Our study focuses on AC-related topics in the context of Chinese SMEs.

In Chapter 1, we observe that SMEs operate differently from large enterprises, particularly in the way they collaborate with external partners for innovation. Our current knowledge of how SMEs deal with external knowledge in each of the AC phases is certainly not complete. The AC of SMEs deserves much more attention. Based on a provisional analysis, we formulate the following problem statement (PS).

**PS:** *How do SMEs deal with external knowledge in order to improve firm performance?*

In order to answer the PS, three research questions are raised.

**RQ 1:** *How do SMEs absorb external knowledge?*

**RQ 2:** *What challenges do SMEs face when absorbing external knowledge?*

**RQ 3:** *Which external knowledge assimilation mechanisms do have an impact on the performance of SME s?*

Chapter 2 reviews the literature related to the concept of AC. It specifies relations between AC and four theories. By doing so, we give AC and our study a broad and solid theoretical base. The four most closely related theories are: (1) the resource-based view, (2) the knowledge-based view of firms, (3) organizational learning, and (4) dynamic capabilities. Four vital topics within previous AC studies, including (1) its conceptualization, (2) sources of AC, (3) its measurement, and (4) AC studies focusing on SMEs, are reviewed.

Chapter 3 addresses RQ 1 regarding how SMEs absorb external knowledge. The investigation is divided into examining three sub-RQs, formulated as follows.

**RQ 1a:** *How do SMEs recognize external knowledge?*

**RQ 1b:** *How do SMEs assimilate external knowledge?*

**RQ 1c:** *How do SMEs utilize external knowledge?*

To address them, we conducted 16 in-depth interviews with owner-managers of Chinese SMEs in different industries.

Regarding external knowledge recognition (EKR), we find that SMEs often recognize the value of potential external knowledge based on three criteria, viz.

(A) the potential of external knowledge to meet internal needs,

(B) expected costs involved in the knowledge absorption processes, and

(C) accessibility to the knowledge sources.

Regarding external knowledge assimilation (EKA), the study identifies five EKA mechanisms used frequently by SMEs, including

(A) consulting personal networks,

(B) purchasing products or services,

(C) referring to free sources,

(D) recruiting new talents, and

(E) collaborating with value-chain partners.

Finally, regarding external knowledge utilization (EKU), we find that Chinese SMEs mainly use external knowledge for the following five purposes:

(A) improve an existing product or service,

(B) solve urgent problems that existing internal knowledge cannot solve,

(C) reduce internal time costs,

(D) reduce internal financial costs, and

(E) concentrate internal resources and expertise on core business areas.

Chapter 4 explores RQ 2: *What challenges do SMEs face when absorbing external knowledge?* Through the 16 in-depth interviews, the study identifies seven main challenges that SMEs may face when absorbing external knowledge. We categorize them into two groups: (1) internal challenges and (2) external challenges. Five internal challenges are listed as

(A) lack of resources,

(B) limited internal expertise and competencies,

(C) lack of social capital,

(D) lack of reputation,

(E) negative attitudes towards external knowledge.

Two external challenges are identified as

(A) issues with contracts and

(B) weak appropriability regime.

Chapter 5 addresses RQ 3: *Which EKA mechanisms do have an impact on the performance of SMEs?* Based on a survey collected from 221 SMEs in different industries and areas in China, we adopted a quantitative research method to test the potential effects of five EKA mechanisms on the performance of SMEs. The results of our linear regression analysis on our hypotheses have as resuls that (C) referring to free sources and (D) recruiting new talents for new knowledge cannot be rejected on both the financial performance and growth of SMEs. The hypotheses on the effects of utilizing the other three EKA mechanisms, viz. (A) consulting personal networks, (B) purchasing products or services, and (E) collaborating with value-chain partners, on SME performance must be rejected.

In chapter 6, the conclusion and discussion of the study are provided. Based on the findings of previous chapters, it summarizes and provides answers to the three RQs and to the PS. The two major *theoretical implications* of the study are as follows. *First*, the study unveils specific routines or practices under each dimension of AC. *Second*, the study highlights interrelated relations between different dimensions of AC.

The study has also two *managerial implications*. *First*, the findings of our study may help policymakers understand how SMEs deal with external knowledge and the challenges they may face, which provides fundamental knowledge for them to design policies to support SMEs' growth. *Second*, the results of our study help managers in SMEs to better deploy their AC strategy by indicating which EKA mechanisms can have positive effects on their firm performance. Potential limitations and constraints of our study are also discussed in the chapter.

Finally, chapter 6 provides three possible avenues for future studies, viz. (1) similar research could be conducted in the future by considering the limitations of this study and taking more measures to remedy them; (2) it would be interesting (2a) to investigate the same RQs, (2b) apply the same theoretical framework, and (2c) use the same research methodology to BIG firms in the future in order to be able to make comparisons between big firms and SMEs: (3) Future work can also investigate testing the impacts of other AC dimensions, such as knowledge recognition and knowledge utilization on SME performance.

# Samenvatting

Kennis stimuleert het concurrentievermogen van organisaties. Dat wordt tegenwoordig algemeen erkend. Het geldt ook voor de economische ontwikkeling van landen. De kerncapaciteit die de concurrentievoordelen van een organisatie bepalen, is het vermogen om externe kennis snel (1) te herkennen, (2) te assimileren en (3) te gebruiken. Een dergelijk vermogen is dertig jaar geleden reeds geconceptualiseerd door Cohen en Levinthal (1990). Zij noemden het organisatorisch absorptievermogen (English *Absorptive Capacity*, voortaan AC). Onze studie richt zich op AC-gerelateerde onderwerpen in de context van Chinese MKB's (Midden en Klein Bedrijven).

In Hoofdstuk 1 leggen we de nadruk op het feit dat MKB's anders opereren dan grote bedrijven, met name in de manier waarop ze samenwerken met externe partners om innovatie te bereiken. Op dit moment weten bedrijven en universitaire onderzoekers niet goed hoe we in het algemeen precies moeten omgaan met externe kennis. Dat geldt voor elk van de drie AC-fasen. Hierbij verdient het organisatorisch absorptievermogen van de MKB's bijzondere aandacht. Op basis van onze vooranalyse hebben we de volgende probleemstelling (PS) geformuleerd.

**PS:** *Hoe gaan MKB's om met externe kennis om de bedrijfsprestaties te verbeteren?*

Voor het beantwoorden van de PS worden drie verdere onderzoeksvragen (OVs) gesteld.

**OV 1:** *Hoe absorberen MKB's externe kennis?*

**OV 2:** *Met welke uitdagingen worden MKB's geconfronteerd bij het assimuleren van externe kennis?*

**OV 3:** *Welke mechanismen voor kennisassimilatie kunnen een impact hebben op de bedrijfsprestaties van de MKB's?*

Hoofdstuk 2 analyseert de literatuur met betrekking tot het concept AC. In het bijzonder worden de gespecificeerde relaties tussen AC en vier theoretische uitgangspunten besproken. Op die manier positioneren we AC en onze studie in een

brede en solide theoretische context.. De vier meest relevante theorieën zijn: (1) de *resource-based view*, (2) de *knowledge-based view* van bedrijven, (3) *organisational learning* en (4) dynamische capaciteiten. Voorts hebben we vier verschillende essentiële onderwerpen binnen eerdere AC-onderzoeken beoordeeld en besproken, te weten: (1) de conceptualisering van AC, (2) de oorsprong van AC, (3) de meting van AC, en (4) de AC-studies gericht op het MKB.

Hoofdstuk 3 beschrijft ons onderzoek naar OV 1: *Hoe absorberen MKB's externe kennis?* Het onderzoek is onderverdeeld in drie sub-OVs.

**OV1a:** *Hoe herkennen MKB's externe kennis?*

**OV1b:** *Hoe assimileren MKB's externe kennis?*

**OV1c:** *Hoe benutten MKB's externe kennis?*

Om de drie OVs te beantwoorden, hebben we 16 diepte-interviews gehouden met eigenaar-managers van Chinese MKB-bedrijven in verschillende industrieën.

Bij de externe kennisherkenning (EKH) zien we dat MKB's de waarde van potentiële externe kennis vaak (h)erkennen aan de hand van drie criteria:

(A) het potentieel van de externe kennis om aan de interne behoeften te voldoen,

(B) de verwachte kosten die gemoeid zijn met de kennisabsorptieprocessen, en

(C) de toegankelijkheid van de kennisbronnen.

Voor externe kennisassimilatie (EKA) identificeert de studie vijf mechanismen die dikwijls door MKB's worden gebruikt. Dat zijn

(A) persoonlijk netwerk raadplegen,

(B) producten of diensten kopen,

(C) verwijzen naar gratis bronnen,

(D) nieuwe medewerkers werven, en

(E) samenwerken met partners in de waardeketen.

Voor de externe kennisbenutting (EKB), zien we dat de Chinese MKB's externe kennis voornamelijk gebruiken voor de volgende vier doelen:

(A) een bestaand product of dienst verbeteren,

(B) urgente problemen oplossen (bestaande interne kennis is onvoldoende)

(C) verlaging van interne tijdkosten,

(D) verlaging van interne financiële kosten, en

(E) het concentreren van interne middelen en expertise op kernactiviteiten.

Hoofdstuk 4 onderzoekt OV 2: *Met welke uitdagingen worden MKB's geconfronteerd bij het assimuleren van externe kennis?*

Aan de hand van de 16 diepte-interviews identificeert de studie de zeven belangrijkste uitdagingen voor het MKB bij het absorberen van externe kennis. We categoriseren ze in twee groepen: (1) interne uitdagingen en (2) externe uitdagingen. Vijf interne uitdagingen zijn geïdentificeerd, te weten:

(A) gebrek aan middelen,

(B) beperkte interne expertise en competenties,

(C) gebrek aan sociaal kapitaal,

(D) gebrek aan reputatie, en

(E) negatieve houding ten opzichte van externe kennis.

Twee externe uitdagingen zijn geïdentificeerd, te weten:

(A) problemen met contracten, en

(B) zwakke toe-eigeningsregeling.

Hoofdstuk 5 beantwoordt OV 3: *Welke mechanismen voor kennisassimilatie kunnen een impact hebben op de bedrijfsprestaties van de MKB's?*

Op basis van een enquête die werd gehouden onder 221 MKB's in verschillende industrieën en gebieden in China, hebben we een kwantitatieve onderzoeksmethode

toegepast om de mogelijke effecten van vijf EKA-mechanismen te meten, met name om hun effect op de prestaties van de MKB's te onderzoeken. De resultaten van onze lineaire regressieanalyse suggereren dat het verwijzen naar gratis bronnen en het werven van nieuwe medewerkers voor nieuwe kennis een positieve invloed hebben op zowel de financiële prestaties als de groei van MKB's. De hypothesen over de effecten van het gebruik van de andere drie EKA-mechanismen (te weten: (1) het assimileren van externe kennis via persoonlijke netwerken, (2) het doen van aankopen, en (3) het benaderen van partners in de waardeketen) op de prestaties van het MKB moeten volgens ons onderzoek worden verworpen.

In hoofdstuk 6 wordt de conclusie van het onderzoek geformuleerd. Op basis van de bevindingen in eerdere hoofdstukken geeft het hoofdstuk een samenvatting van de antwoorden op de drie OV's en de PS.

Het onderzoek heeft verschillende *theoretische* implicaties. Ten eerste onthult het onderzoek specifieke routines of praktijken onder elke dimensie van de AC. Ten tweede benadrukt deze studie een onderling verband en iteraties tussen verschillende dimensies van AC.

De studie heeft ook *bestuurlijke* implicaties. Ten eerste kunnen de bevindingen van ons onderzoek beleidsmakers helpen begrijpen hoe MKB's omgaan met externe kennis en met de uitdagingen waarmee ze te maken kunnen krijgen. Het laatste verschaft hen fundamentele kennis om beleid te ontwerpen dat de groei van MKB's ondersteunt. Ten tweede helpen de resultaten van ons onderzoek managers in MKB's om hun AC-strategie beter te implementeren door aan te geven welke EKA-mechanismen positieve effecten kunnen hebben op hun bedrijfsprestaties. Algemene beperkingen en mogelijke casus-beperkingen van ons onderzoek worden ook in dit hoofdstuk besproken.

Ten slotte biedt hoofdstuk 6 drie mogelijke wegen voor toekomstige studies. Ten eerste zou soortgelijk onderzoek in de toekomst kunnen worden uitgevoerd door de beperkingen van deze studie te analyseren en andere maatregelen te nemen om ze te verhelpen. Ten tweede zou het interessant zijn om in de toekomst dezelfde onderzoeksvragen te gebruiken, hetzelfde theoretische raamwerk toe te passen en

dezelfde onderzoeksmethodologie te volgen voor GROTE bedrijven om vergelijkingen te kunnen maken tussen grote bedrijven en MKB's. Ten derde kan in toekomstig werk ook worden overwogen om de effecten van andere AC-dimensies te testen, zoals kennisherkenning en kennisbenutting op de prestaties van de MKB's.

# Curriculum Vitae

Lei Pi was born in Henan province, China, on March 3rd, 1983. He studied mechanical design and automation from 2001 to 2005 at Xiamen University, China. He gained his bachelor's degree in engineering in 2005. After graduation from Xiamen University, he worked as an R&D Engineer for Han's Laser Science & Technology Co., Ltd. in Shenzhen, China, from 2005 to 2008. Then he worked as a business manager for Jinfulin Investment Consultant Co., Ltd in Xiamen, China. In 2010, he entered Peking University to study innovation and entrepreneurship management and earned his Master's degree (Software Engineering) in 2013. In the same year, he joined Professor Bernhard R. Katzy's research group to study technology and innovation management. He was admitted to the Ph.D. program at the Faculty of Science, Leiden Institute of Advanced Computer Science in 2014.

During his Ph.D. study, he also worked at the Center for Technology & Innovation Management at Universität der Bundeswehr München for research and teaching from 2013 to 2018. He served as the Chair of the Chinese Students and Scholars Association of Universität der Bundeswehr München from 2015 to 2016. He also chaired the 2016 NiTiM Doctorate School (Trondheim, Norway) on Networks, Information Technology, and Innovation Management. He joined Huawei Technologies Munich Research Center in 2019 and is working as a resource collaboration engineer at the time being.

His research interests include technology management, innovation and entrepreneurship, innovative thinking, and organizational learning.

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26. Emile de Maat (UvA) *Making Sense of Legal Text*
27. Hayrettin Gurkok (UT) *Mind the Sheep! User Experience Evaluation & Brain-Computer Interface Games*
28. Nancy Pascall (UvT) *Engendering Technology Empowering Women*
29. Almer Tigelaar (UT) *Peer-to-Peer Information Retrieval*
30. Alina Pommeranz (TUD) *Designing Human-Centered Systems for Reflective Decision Making*
31. Emily Bagarukayo (RUN) *A Learning by Construction Approach for Higher Order Cognitive Skills Improvement, Building Capacity and Infrastructure*
32. Wietske Visser (TUD) *Qualitative multi-criteria preference representation and reasoning*
33. Rory Sie (OU) *Coalitions in Cooperation Networks (COCOON)*
34. Pavol Jancura (RUN) *Evolutionary analysis in PPI networks and applications*
35. Evert Haasdijk (VU) *Never Too Old To Learn -- On-line Evolution of Controllers in Swarm- and Modular Robotics*
36. Denis Ssebugwawo (RUN) *Analysis and Evaluation of Collaborative Modeling Processes*
37. Agnes Nakakawa (RUN) *A Collaboration Process for Enterprise Architecture Creation*
38. Selmar Smit (VU) *Parameter Tuning and Scientific Testing in Evolutionary Algorithms*
39. Hassan Fatemi (UT) *Risk-aware design of value and coordination networks*
40. Agus Gunawan (UvT) *Information Access for SMEs in Indonesia*
41. Sebastian Kelle (OU) *Game Design Patterns for Learning*
42. Dominique Verpoorten (OU) *Reflection Amplifiers in self-regulated Learning*
43. Withdrawn
44. Anna Tordai (VU) *On Combining Alignment Techniques*

45. Benedikt Kratz (UvT) *A Model and Language for Business-aware Transactions*
46. Simon Carter (UvA) *Exploration and Exploitation of Multilingual Data for Statistical Machine Translation*
47. Manos Tsagkias (UvA) *Mining Social Media: Tracking Content and Predicting Behavior*
48. Jorn Bakker (TU/e) *Handling Abrupt Changes in Evolving Time-series Data*
49. Michael Kaisers (UM) *Learning against Learning - Evolutionary dynamics of reinforcement learning algorithms in strategic interactions*
50. Steven van Kervel (TUD) *Ontologogy driven Enterprise Information Systems Engineering*
51. Jeroen de Jong (TUD) *Heuristics in Dynamic Sceduling; a practical framework with a case study in elevator dispatching*

**2013**

1. Viorel Milea (EUR) *News Analytics for Financial Decision Support*
2. Erietta Liarou (CWI) *MonetDB/DataCell: Leveraging the Column-store Database Technology for Efficient and Scalable Stream Processing*
3. Szymon Klarman (VU) *Reasoning with Contexts in Description Logics*
4. Chetan Yadati (TUD) *Coordinating autonomous planning and scheduling*
5. Dulce Pumareja (UT) *Groupware Requirements Evolutions Patterns*
6. Romulo Goncalves (CWI) *The Data Cyclotron: Juggling Data and Queries for a Data Warehouse Audience*
7. Giel van Lankveld (UvT) *Quantifying Individual Player Differences*
8. Robbert-Jan Merk (VU) *Making enemies: cognitive modeling for opponent agents in fighter pilot simulators*
9. Fabio Gori (RUN) *Metagenomic Data Analysis: Computational Methods and Applications*
10. Jeewanie Jayasinghe Arachchige (UvT) *A Unified Modeling Framework for Service Design*
11. Evangelos Pournaras (TUD) *Multi-level Reconfigurable Self-organization in Overlay Services*
12. Marian Razavian (VU) *Knowledge-driven Migration to Services*
13. Mohammad Safiri (UT) *Service Tailoring: User-centric creation of integrated IT-based homecare services to support independent living of elderly*
14. Jafar Tanha (UvA) *Ensemble Approaches to Semi-Supervised Learning Learning*
15. Daniel Hennes (UM) *Multiagent Learning - Dynamic Games and Applications*
16. Eric Kok (UU) *Exploring the practical benefits of argumentation in multi-agent deliberation*
17. Koen Kok (VU) *The PowerMatcher: Smart Coordination for the Smart Electricity Grid*
18. Jeroen Janssens (UvT) *Outlier Selection and One-Class Classification*
19. Renze Steenhuizen (TUD) *Coordinated Multi-Agent Planning and Scheduling*
20. Katja Hofmann (UvA) *Fast and Reliable Online Learning to Rank for Information Retrieval*
21. Sander Wubben (UvT) *Text-to-text generation by monolingual machine translation*
22. Tom Claassen (RUN) *Causal Discovery and Logic*
23. Patricio de Alencar Silva (UvT) *Value Activity Monitoring*
24. Haitham Bou Ammar (UM) *Automated Transfer in Reinforcement Learning*
25. Agnieszka Anna Latoszek-Berendsen (UM) *Intention-based Decision Support. A new way of representing and implementing clinical guidelines in a Decision Support System*
26. Alireza Zarghami (UT) *Architectural Support for Dynamic Homecare Service Provisioning*
27. Mohammad Huq (UT) *Inference-based Framework Managing Data Provenance*
28. Frans van der Sluis (UT) *When Complexity becomes Interesting: An Inquiry into the Information*

*eXperience*

29. Iwan de Kok (UT) *Listening Heads*
30. Joyce Nakatumba (TU/e) *Resource-Aware Business Process Management: Analysis and Support*
31. Dinh Khoa Nguyen (UvT) *Blueprint Model and Language for Engineering Cloud Applications*
32. Kamakshi Rajagopal (OU) *Networking For Learning; The role of Networking in a Lifelong Learner's Professional Development*
33. Qi Gao (TUD) *User Modeling and Personalization in the Microblogging Sphere*
34. Kien Tjin-Kam-Jet (UT) *Distributed Deep Web Search*
35. Abdallah El Ali (UvA) *Minimal Mobile Human Computer Interaction*
36. Than Lam Hoang (TU/e) *Pattern Mining in Data Streams*
37. Dirk Börner (OU) *Ambient Learning Displays*
38. Eelco den Heijer (VU) *Autonomous Evolutionary Art*
39. Joop de Jong (TUD) *A Method for Enterprise Ontology based Design of Enterprise Information Systems*
40. Pim Nijssen (UM) *Monte-Carlo Tree Search for Multi-Player Games*
41. Jochem Liem (UvA) *Supporting the Conceptual Modelling of Dynamic Systems: A Knowledge Engineering Perspective on Qualitative Reasoning*
42. Léon Planken (TUD) *Algorithms for Simple Temporal Reasoning*
43. Marc Bron (UvA) *Exploration and Contextualization through Interaction and Concepts*

**2014**

1. Nicola Barile (UU) *Studies in Learning Monotone Models from Data*
2. Fiona Tuliyano (RUN) *Combining System Dynamics with a Domain Modeling Method*
3. Sergio Raul Duarte Torres (UT) *Information Retrieval for Children: Search Behavior and Solutions*
4. Hanna Jochmann-Mannak (UT) *Websites for children: search strategies and interface design - Three studies on children's search performance and evaluation*
5. Jurriaan van Reijsen (UU) *Knowledge Perspectives on Advancing Dynamic Capability*
6. Damian Tamburri (VU) *Supporting Networked Software Development*
7. Arya Adriansyah (TU/e) *Aligning Observed and Modeled Behavior*
8. Samur Araujo (TUD) *Data Integration over Distributed and Heterogeneous Data Endpoints*
9. Philip Jackson (UvT) *Toward Human-Level Artificial Intelligence: Representation and Computation of Meaning in Natural Language*
10. Ivan Salvador Razo Zapata (VU) *Service Value Networks*
11. Janneke van der Zwaan (TUD) *An Empathic Virtual Buddy for Social Support*
12. Willem van Willigen (VU) *Look Ma, No Hands: Aspects of Autonomous Vehicle Control*
13. Arlette van Wissen (VU) *Agent-Based Support for Behavior Change: Models and Applications in Health and Safety Domains*
14. Yangyang Shi (TUD) *Language Models With Meta-information*
15. Natalya Mogles (VU) *Agent-Based Analysis and Support of Human Functioning in Complex Socio-Technical Systems: Applications in Safety and Healthcare*
16. Krystyna Milian (VU) *Supporting trial recruitment and design by automatically interpreting eligibility criteria*
17. Kathrin Dentler (VU) *Computing healthcare quality indicators automatically: Secondary Use*

*of Patient Data and Semantic Interoperability*

18. Mattijs Ghijsen (UvA) *Methods and Models for the Design and Study of Dynamic Agent Organizations*
19. Vinicius Ramos (TU/e) *Adaptive Hypermedia Courses: Qualitative and Quantitative Evaluation and Tool Support*
20. Mena Habib (UT) *Named Entity Extraction and Disambiguation for Informal Text: The Missing Link*
21. Kassidy Clark (TUD) *Negotiation and Monitoring in Open Environments*
22. Marieke Peeters (UU) *Personalized Educational Games - Developing agent-supported scenario-based training*
23. Eleftherios Sidirourgos (UvA/CWI) *Space Efficient Indexes for the Big Data* Era
24. Davide Ceolin (VU) *Trusting Semi-structured Web Data*
25. Martijn Lappenschaar (RUN) *New network models for the analysis of disease interaction*
26. Tim Baarslag (TUD) *What to Bid and When to Stop*
27. Rui Jorge Almeida (EUR) *Conditional Density Models Integrating Fuzzy and Probabilistic Representations of Uncertainty*
28. Anna Chmielowiec (VU) *Decentralized k-Clique Matching*
29. Jaap Kabbedijk (UU) *Variability in Multi-Tenant Enterprise Software*
30. Peter de Cock (UvT) *Anticipating Criminal Behaviour*
31. Leo van Moergestel (UU) *Agent Technology in Agile Multiparallel Manufacturing and Product* Support
32. Naser Ayat (UvA) *On Entity Resolution in Probabilistic Data*
33. Tesfa Tegegne (RUN) *Service Discovery in eHealth*
34. Christina Manteli (VU) *The Effect of Governance in Global Software Development: Analyzing Transactive Memory Systems*.
35. Joost van Ooijen (UU) *Cognitive Agents in Virtual Worlds: A Middleware Design Approach*
36. Joos Buijs (TU/e) *Flexible Evolutionary Algorithms for Mining Structured Process Models*
37. Maral Dadvar (UT) *Experts and Machines United Against Cyberbullying*
38. Danny Plass-Oude Bos (UT) *Making brain-computer interfaces better: improving usability through post-processing*
39. Jasmina Maric (UvT) *Web Communities, Immigration, and Social Capital*
40. Walter Omona (RUN) *A Framework for Knowledge Management Using ICT in Higher Education*
41. Frederic Hogenboom (EUR) Automated Detection of Financial Events in News Text
42. Carsten Eijckhof (CWI/TUD) *Contextual Multidimensional Relevance Models*
43. Kevin Vlaanderen (UU) *Supporting Process Improvement using Method Increments*
44. Paulien Meesters (UvT) *Intelligent Blauw. Met als ondertitel: Intelligence-gestuurde politiezorg in gebiedsgebonden eenheden*
45. Birgit Schmitz (OU) *Mobile Games for Learning: A Pattern-Based Approach*
46. Ke Tao (TUD) *Social Web Data Analytics: Relevance, Redundancy, Diversity*
47. Shangsong Liang (UvA) *Fusion and Diversification in Information Retrieval*

**2015**

1. Niels Netten (UvA) *Machine Learning for Relevance of Information in Crisis Response*
2. Faiza Bukhsh (UvT) *Smart auditing: Innovative Compliance Checking in Customs Controls*

3. Twan van Laarhoven (RUN) *Machine learning for network data*
4. Howard Spoelstra (OU) *Collaborations in Open Learning Environments*
5. Christoph Bösch (UT) *Cryptographically Enforced Search Pattern Hiding*
6. Farideh Heidari (TUD) *Business Process Quality Computation - Computing Non-Functional Requirements to Improve Business Processes*
7. Maria-Hendrike Peetz (UvA) *Time-Aware Online Reputation Analysis*
8. Jie Jiang (TUD) *Organizational Compliance: An agent-based model for designing and evaluating organizational interactions*
9. Randy Klaassen (UT) *HCI Perspectives on Behavior Change Support Systems*
10. Henry Hermans (OU) *OpenU: design of an integrated system to support lifelong learning*
11. Yongming Luo (TU/e) *Designing algorithms for big graph datasets: A study of computing bisimulation and joins*
12. Julie M. Birkholz (VU) *Modi Operandi of Social Network Dynamics: The Effect of Context on Scientific Collaboration Networks*
13. Giuseppe Procaccianti (VU) *Energy-Efficient Software*
14. Bart van Straalen (UT) *A cognitive approach to modeling bad news conversations*
15. Klaas Andries de Graaf (VU) *Ontology-based Software Architecture Documentation*
16. Changyun Wei (UT) *Cognitive Coordination for Cooperative Multi-Robot Teamwork*
17. Andr é van Cleeff (UT) *Physical and Digital Security Mechanisms: Properties, Combinations and Trade-offs*
18. Holger Pirk (CWI) *Waste Not, Want Not! - Managing Relational Data in Asymmetric Memories*
19. Bernardo Tabuenca (OU) *Ubiquitous Technology for Lifelong Learners*
20. Lo ïs Vanh ée (UU) *Using Culture and Values to Support Flexible Coordination*
21. Sibren Fetter (OU) *Using Peer-Support to Expand and Stabilize Online Learning*
22. Zhemin Zhu (UT) *Co-occurrence Rate Networks*
23. Luit Gazendam (VU) *Cataloguer Support in Cultural Heritage*
24. Richard Berendsen (UvA) *Finding People, Papers, and Posts: Vertical Search Algorithms and Evaluation*
25. Steven Woudenberg (UU) *Bayesian Tools for Early Disease Detection*
26. Alexander Hogenboom (EUR) *Sentiment Analysis of Text Guided by Semantics and Structure*
27. S ándor H éman (CWI) *Updating compressed colomn stores*
28. Janet Bagorogoza (UvT) *KNOWLEDGE MANAGEMENT AND HIGH PERFORMANCE; The Uganda Financial Institutions Model for HPO*
29. Hendrik Baier (UM) *Monte-Carlo Tree Search Enhancements for One-Player and Two-Player Domains*
30. Kiavash Bahreini (OU) Real-time Multimodal Emotion Recognition in E-Learning
31. Yakup Ko ç(TUD) *On the robustness of Power* Grids
32. Jerome Gard (UL) *Corporate Venture Management in SMEs*
33. Frederik Schadd (TUD) *Ontology Mapping with Auxiliary Resources*
34. Victor de Graaf (UT) *Gesocial Recommender Systems*
35. Jungxao Xu (TUD) *Affective Body Language of Humanoid Robots: Perception and Effects in Human Robot Interaction*

**2016**

1. Syed Saiden Abbas (RUN) *Recognition of Shapes by Humans and Machines*

2. Michiel Christiaan Meulendijk (UU) *Optimizing medication reviews through decision support: prescribing a better pill to swallow*
3. Maya Sappelli (RUN) *Knowledge Work in Context: User Centered Knowledge Worker Support*
4. Laurens Rietveld (VU) *Publishing and Consuming Linked Data*
5. Evgeny Sherkhonov (UvA) *Expanded Acyclic Queries: Containment and an Application in Explaining Missing Answers*
6. Michel Wilson (TUD) *Robust scheduling in an uncertain environment*
7. Jeroen de Man (VU) *Measuring and modeling negative emotions for virtual training*
8. Matje van de Camp (UvT) *A Link to the Past: Constructing Historical Social Networks from Unstructured Data*
9. Archana Nottamkandath (VU) *Trusting Crowdsourced Information on Cultural Artefacts*
10. George Karafotias (VU) *Parameter Control for Evolutionary Algorithms*
11. Anne Schuth (UvA) *Search Engines that Learn from Their Users*
12. Max Knobbout (UU) *Logics for Modelling and Verifying Normative Multi-Agent Systems*
13. Nana Baah Gyan (VU) *The Web, Speech Technologies and Rural Development in West Africa - An ICT4D Approach*
14. Ravi Khadka (UU) *Revisiting Legacy Software System Modernization*
15. Steffen Michels (RUN) *Hybrid Probabilistic Logics - Theoretical Aspects, Algorithms and Experiments*
16. Guangliang Li (UvA) *Socially Intelligent Autonomous Agents that Learn from Human Reward*
17. Berend Weel (VU) *Towards Embodied Evolution of Robot Organisms*
18. Albert Meroño Peñuela (VU) *Refining Statistical Data on the Web*
19. Julia Efremova (TU/e) *Mining Social Structures from Genealogical Data*
20. Daan Odijk (UvA) *Context & Semantics in News & Web Search*
21. Alejandro Moreno Celleri (UT) *From Traditional to Interactive Playspaces: Automatic Analysis of Player Behavior in the Interactive Tag Playground*
22. Grace Lewis (VU) *Software Architecture Strategies for Cyber-Foraging Systems*
23. Fei Cai (UvA) *Query Auto Completion in Information Retrieval*
24. Brend Wanders (UT) *Repurposing and Probabilistic Integration of Data; An Iterative and data model independent approach*
25. Julia Kiseleva (TU/e) *Using Contextual Information to Understand Searching and Browsing Behavior*
26. Dilhan Thilakarathne (VU) *In or Out of Control: Exploring Computational Models to Study the Role of Human Awareness and Control in Behavioural Choices, with Applications in Aviation and Energy Management Domains*
27. Wen Li (TUD) *Understanding Geo-spatial Information on Social Media*
28. Mingxin Zhang (TUD) *Large-scale Agent-based Social Simulation - A study on epidemic prediction and control*
29. Nicolas Höning (TUD) *Peak reduction in decentralised electricity systems -Markets and prices for flexible planning*
30. Ruud Mattheij (UvT) *The Eyes Have It*
31. Mohammad Khelghati (UT) *Deep web content monitoring*
32. Eelco Vriezekolk (UT) *Assessing Telecommunication Service Availability Risks for Crisis Organisations*

33. Peter Bloem (UvA) *Single Sample Statistics, exercises in learning from just one example*
34. Dennis Schunselaar (TU/e) *Configurable Process Trees: Elicitation, Analysis, and Enactment*
35. Zhaochun Ren (UvA) *Monitoring Social Media: Summarization, Classification and Recommendation*
36. Daphne Karreman (UT) *Beyond R2D2: The design of nonverbal interaction behavior optimized for robot-specific morphologies*
37. Giovanni Sileno (UvA) *Aligning Law and Action - a conceptual and computational inquiry*
38. Andrea Minuto (UT) *MATERIALS THAT MATTER - Smart Materials meet Art & Interaction Design*
39. Merijn Bruijnes (UT) *Believable Suspect Agents; Response and Interpersonal Style Selection for an Artificial Suspect*
40. Christian Detweiler (TUD) *Accounting for Values in Design*
41. Thomas King (TUD) *Governing Governance: A Formal Framework for Analysing Institutional Design and Enactment Governance*
42. Spyros Martzoukos (UvA) *Combinatorial and Compositional Aspects of Bilingual Aligned Corpora*
43. Saskia Koldijk (RUN) *Context-Aware Support for Stress Self-Management: From Theory to Practice*
44. Thibault Sellam (UvA) Automatic Assistants for Database Exploration
45. Bram van de Laar (UT) *Experiencing Brain-Computer Interface Control*
46. Jorge Gallego Perez (UT) *Robots to Make you Happy*
47. Christina Weber (UL) *Real-time foresight - Preparedness for dynamic innovation networks*
48. Tanja Buttler (TUD) *Collecting Lessons Learned*
49. Gleb Polevoy (TUD) *Participation and Interaction in Projects. A Game-Theoretic Analysis*
50. Yan Wang (UvT) *The Bridge of Dreams: Towards a Method for Operational Performance Alignment in IT-enabled Service Supply Chains*

**2017**

1. Jan-Jaap Oerlemans (UL) *Investigating Cybercrime*
2. Sjoerd Timmer (UU) *Designing and Understanding Forensic Bayesian Networks using Argumentation*
3. Daniël Harold Telgen (UU) *Grid Manufacturing; A Cyber-Physical Approach with Autonomous Products and Reconfigurable Manufacturing Machines*
4. Mrunal Gawade (CWI) *MULTI-CORE PARALLELISM IN A COLUMN-STORE*
5. Mahdieh Shadi (UvA) *Collaboration Behavior*
6. Damir Vandic (EUR) *Intelligent Information Systems for Web Product Search*
7. Roel Bertens (UU) *Insight in Information: from Abstract to Anomaly*
8. Rob Konijn (VU) *Detecting Interesting Differences:Data Mining in Health Insurance Data using Outlier Detection and Subgroup Discovery*
9. Dong Nguyen (UT) *Text as Social and Cultural Data: A Computational Perspective on Variation in Text*
10. Robby van Delden (UT) (Steering) *Interactive Play Behavior*
11. Florian Kunneman (RUN) *Modelling patterns of time and emotion in Twitter #anticipointment*
12. Sander Leemans (TU/e) *Robust Process Mining with Guarantees*
13. Gijs Huisman (UT) *Social Touch Technology - Extending the reach of social touch through*

*haptic technology*

14. Shoshannah Tekofsky (UvT) *You Are Who You Play You Are: Modelling Player Traits from Video Game Behavior*
15. Peter Berck, Radboud University (RUN) *Memory-Based Text Correction*
16. Aleksandr Chuklin (UvA) *Understanding and Modeling Users of Modern Search Engines*
17. Daniel Dimov (UL) *Crowdsourced Online Dispute Resolution*
18. Ridho Reinanda (UvA) *Entity Associations for Search*
19. Jeroen Vuurens (TUD) *Proximity of Terms, Texts and Semantic Vectors in Information Retrieval*
20. Mohammadbashir Sedighi (TUD) *Fostering Engagement in Knowledge Sharing: The Role of Perceived Benefits, Costs and Visibility*
21. Jeroen Linssen (UT) *Meta Matters in Interactive Storytelling and Serious Gaming (A Play on Worlds)*
22. Sara Magliacane (VU) *Logics for causal inference under uncertainty*
23. David Graus (UvA) *Entities of Interest--- Discovery in Digital Traces*
24. Chang Wang (TUD) *Use of Affordances for Efficient Robot Learning*
25. Veruska Zamborlini (VU) *Knowledge Representation for Clinical Guidelines, with applications to Multimorbidity Analysis and Literature Search*
26. Merel Jung (UT) *Socially intelligent robots that understand and respond to human touch*
27. Michiel Joosse (UT) *Investigating Positioning and Gaze Behaviors of Social Robots: People's Preferences, Perceptions and Behaviors*
28. John Klein (VU) *Architecture Practices for Complex Contexts*
29. Adel Alhuraibi (UvT) *From IT-BusinessStrategic Alignment to Performance: A Moderated Mediation Model of Social Innovation, and Enterprise Governance of IT*
30. Wilma Latuny (UvT) *The Power of Facial Expressions*
31. Ben Ruijl (UL) *Advances in computational methods for QFT calculations*
32. Thaer Samar (RUN) *Access to and Retrievability of Content in Web Archives*
33. Brigit van Loggem (OU) *Towards a Design Rationale for Software Documentation: A Model of Computer-Mediated Activity*
34. Maren Scheffel (OU) *The Evaluation Framework for Learning Analytics*
35. Martine de Vos (VU) *Interpreting natural science spreadsheets*
36. Yuanhao Guo (UL) *Shape Analysis for Phenotype Characterisation from High-throughput Imaging*
37. Alejandro Montes Garcia (TU/e) *WiBAF: A Within Browser Adaptation Framework that Enables Control over Privacy*
38. Alex Kayal (TUD) *Normative Social Applications*
39. Sara Ahmadi (RUN) *Exploiting properties of the human auditory system and compressive sensing methods to increase noise robustness in ASR*
40. Altaf Hussain Abro (VU) *Steer your Mind: Computational Exploration of Human Control in Relation to Emotions, Desires and Social Support For applications in human-aware support systems"*
41. Adnan Manzoor (VU) *Minding a Healthy Lifestyle: An Exploration of Mental Processes and a Smart Environment to Provide Support for a Healthy Lifestyle*
42. Elena Sokolova (RUN) *Causal discovery from mixed and missing data with applications on*

*ADHD datasets*

43. Maaike de Boer (RUN) *Semantic Mapping in Video Retrieval*
44. Garm Lucassen (UU) *Understanding User Stories - Computational Linguistics in Agile Requirements Engineering*
45. Bas Testerink (UU) *Decentralized Runtime Norm Enforcement*
46. Jan Schneider (OU) *Sensor-based Learning Support*
47. Yie Yang (TUD) *Crowd Knowledge Creation Acceleration*
48. Angel Suarez (OU) *Collaborative inquiry-based learning*

**2018**

1. Han van der Aa (VU) *Comparing and Aligning Process Representations*
2. Felix Mannhardt (TU/e) *Multi-perspective Process Mining*
3. Steven Bosems (UT) *Causal Models For Well-Being: Knowledge Modeling, Model-Driven Development of Context-Aware Applications, and Behavior Prediction*
4. Jordan Janeiro (TUD) *Flexible Coordination Support for Diagnosis Teams in Data-Centric Engineering Tasks*
5. Hugo Huurdeman (UvA) *Supporting the Complex Dynamics of the Information Seeking Process*
6. Dan Ionita (UT) *Model-Driven Information Security Risk Assessment of Socio-Technical Systems*
7. Jieting Luo (UU) *A formal account of opportunism in multi-agent systems*
8. Rick Smetsers (RUN) *Advances in Model Learning for Software Systems*
9. Xu Xie (TUD) *Data Assimilation in Discrete Event Simulations*
10. Julienka Mollee (VU) *Moving forward: supporting physical activity behavior change through intelligent technology*
11. Mahdi Sargolzaei (UvA) *Enabling Framework for Service-oriented Collaborative Networks*
12. Xixi Lu (TU/e) *Using behavioral context in process mining*
13. Seyed Amin Tabatabaei (VU) *Using behavioral context in process mining: Exploring the added value of computational models for increasing the use of renewable energy in the residential sector*
14. Bart Joosten (UvT) *Detecting Social Signals with Spatiotemporal Gabor Filters*
15. Naser Davarzani (UM) *Biomarker discovery in heart failure*
16. Jaebok Kim (UT) *Automatic recognition of engagement and emotion in a group of* children
17. Jianpeng Zhang (TU/e) *On Graph Sample Clustering*
18. Henriette Nakad (UL) *De Notaris en Private Rechtspraak*
19. Minh Duc Pham (VU) *Emergent relational schemas for RDF*
20. Manxia Liu (RUN) *Time and Bayesian Networks*
21. Aad Slootmaker (OU) *EMERGO: a generic platform for authoring and playing scenario-based serious games*
22. Eric Fernandes de Mello Araújo (VU) *Contagious: Modeling the Spread of Behaviours, Perceptions and Emotions in Social Networks*
23. Kim Schouten (EUR) *Semantics-driven Aspect-Based Sentiment Analysis*
24. Jered Vroon (UT) *Responsive Social Positioning Behaviour for Semi-Autonomous Telepresence Robots*
25. Riste Gligorov (VU) *Serious Games in Audio-Visual Collections*
26. Roelof de Vries (UT) *Theory-Based And Tailor-Made: Motivational Messages for Behavior*

*Change Technology*

27. Maikel Leemans (TU/e) *Hierarchical Process Mining for Scalable Software Analysis*
28. Christian Willemse (UT) *Social Touch Technologies: How they feel and how they make you feel*
29. Yu Gu (UvT) *Emotion Recognition from Mandarin Speech*
30. Wouter Beek (VU) *The "K" in "semantic web" stands for "knowledge": scaling semantics to the web*

**2019**

1. Rob van Eijk (UL) *Web privacy measurement in real-time bidding systems. A graph-based approach to RTB system classification*
2. Emmanuelle Beauxis- Aussalet (CWI, UU) *Statistics and Visualizations for Assessing Class Size Uncertainty*
3. Eduardo Gonzalez Lopez de Murillas (TU/e) *Process Mining on Databases: Extracting Event Data from Real Life Data Sources*
4. Ridho Rahmadi (RUN) *Finding stable causal structures from clinical data*
5. Sebastiaan van Zelst (TU/e) *Process Mining with Streaming Data*
6. Chris Dijkshoorn (VU) *Nichesourcing for Improving Access to Linked Cultural Heritage Datasets*
7. Soude Fazeli (TUD) *Recommender Systems in Social Learning Platforms*
8. Frits de Nijs (TUD) *Resource-constrained Multi-agent Markov Decision Processes*
9. Fahimeh Alizadeh Moghaddam (UvA) *Self-adaptation for energy efficiency in software systems*
10. Qing Chuan Ye (EUR) *Multi-objective Optimization Methods for Allocation and Prediction*
11. Yue Zhao (TUD) *Learning Analytics Technology to Understand Learner Behavioral Engagement in MOOCs*
12. Jacqueline Heinerman (VU) *Better Together*
13. Guanliang Chen (TUD) *MOOC Analytics: Learner Modeling and Content Generation*
14. Daniel Davis (TUD) *Large-Scale Learning Analytics: Modeling Learner Behavior & Improving Learning Outcomes in Massive Open Online Courses*
15. Erwin Walraven (TUD) *Planning under Uncertainty in Constrained and Partially Observable Environments*
16. Guangming Li (TU/e) *Process Mining based on Object-Centric Behavioral Constraint (OCBC) Models*
17. Ali Hurriyetoglu (RUN) *Extracting actionable information from microtexts*
18. Gerard Wagenaar (UU) *Artefacts in Agile Team Communication*
19. Vincent Koeman (TUD) *Tools for Developing Cognitive Agents*
20. Chide Groenouwe (UU) *Fostering technically augmented human collective intelligence*
21. Cong Liu (TU/e) *Software Data Analytics: Architectural Model Discovery and Design Pattern Detection*
22. Martin van den Berg (VU) *Improving IT Decisions with Enterprise Architecture*
23. Qin Liu (TUD) *Intelligent Control Systems: Learning, Interpreting, Verification*
24. Anca Dumitrache (VU) *Truth in Disagreement- Crowdsourcing Labeled Data for Natural Language Processing*
25. Emiel van Miltenburg (UvT) *Pragmatic factors in (automatic) image description*
26. Prince Singh (UT) *An Integration Platform for Synchromodal Transport*
27. Alessandra Antonaci (OU) *The Gamification Design Process applied to (Massive) Open Online*

*Courses*

28. Esther Kuindersma (UL) *Cleared for take-off: Game-based learning to prepare airline pilots for critical situations*
29. Daniel Formolo (VU) *Using virtual agents for simulation and training of social skills in safety-critical circumstances*
30. Vahid Yazdanpanah (UT) *Multiagent Industrial Symbiosis Systems*
31. Milan Jelisavcic (VU) *Alive and Kicking: Baby Steps in Robotics*
32. Chiara Sironi (UM) *Monte-Carlo Tree Search for Artificial General Intelligence in Games*
33. Anil Yaman (TU/e) *Evolution of Biologically Inspired Learning in Artificial Neural Networks*
34. Negar Ahmadi (TU/e) *EEG Microstate and Functional Brain Network Features for Classification of Epilepsy and PNES*
35. Lisa Facey-Shaw (OU) *Gamification with digital badges in learning programming*
36. Kevin Ackermans (OU) *Designing Video-Enhanced Rubrics to Master Complex Skills*
37. Jian Fang (TUD) *Database Acceleration on FPGAs*
38. Akos Kadar (OU) *Learning visually grounded and multilingual representations*

**2020**

1. Armon Toubman (UL) *Calculated Moves: Generating Air Combat Behaviour*
2. Marcos de Paula Bueno (UL) *Unraveling Temporal Processes using Probabilistic Graphical Models*
3. Mostafa Deghani (UvA) *Learning with Imperfect Supervision for Language Understanding*
4. Maarten van Gompel (RUN) *Context as Linguistic Bridges*
5. Yulong Pei (TU/e) *On local and global structure mining*
6. Preethu Rose Anish (UT) *Stimulation Architectural Thinking during Requirements Elicitation - An Approach and Tool Support*
7. Wim van der Vegt (OU) *Towards a software architecture for reusable game components*
8. Ali Mirsoleimani (UL) *Structured Parallel Programming for Monte Carlo Tree Search*
9. Myriam Traub (UU) *Measuring Tool Bias & Improving Data Quality for Digital Humanities Research*
10. Alifah Syamsiyah (TU/e) *In-database Preprocessing for Process Mining*
11. Sepideh Mesbah (TUD) *Semantic-Enhanced Training Data AugmentationMethods for Long-Tail Entity Recognition Models*
12. Ward van Breda (VU) *Predictive Modeling in E-Mental Health: Exploring Applicability in Personalised Depression Treatment*
13. Marco Virgolin (CWI) *Design and Application of Gene-pool Optimal Mixing Evolutionary Algorithms for Genetic Programming*
14. Mark Raasveldt (CWI/UL) *Integrating Analytics with Relational Databases*
15. Konstantinos Georgiadis (OU) *Smart CAT: Machine Learning for Configurable Assessments in Serious Games*
16. Ilona Wilmont (RUN) *Cognitive Aspects of Conceptual Modelling*
17. Daniele Di Mitri (OU) *The Multimodal Tutor: Adaptive Feedback from Multimodal Experiences*
18. Georgios Methenitis (TUD) *Agent Interactions & Mechanisms in Markets with Uncertainties: Electricity Markets in Renewable Energy Systems*
19. Guido van Capelleveen (UT) *Industrial Symbiosis Recommender Systems*

20. Albert Hankel (VU) *Embedding Green ICT Maturity in Organisations*
21. Karine da Silva Miras de Araujo (VU) *Where is the robot?: Life as it could be*
22. Maryam Masoud Khamis (RUN) *Understanding complex systems implementation through a modeling approach: the case of e-government in Zanzibar*
23. Rianne Conijn (UT) *The Keys to Writing: A writing analytics approach to studying writing processes using keystroke logging*
24. Lenin da Nobrega Medeiros (VU/RUN) *How are you feeling, human? Towards emotionally supportive chatbots*
25. Xin Du (TU/e) *The Uncertainty in Exceptional Model Mining*
26. Krzysztof Leszek Sadowski (UU) *GAMBIT: Genetic Algorithm for Model-Based mixed-Integer opTimization*
27. Ekaterina Muravyeva (TUD) *Personal data and informed consent in an educational context*
28. Bibeg Limbu (TUD) *Multimodal interaction for deliberate practice: Training complex skills with augmented reality*
29. Ioan Gabriel Bucur (RUN) *Being Bayesian about Causal Inference*
30. Bob Zadok Blok (UL) *Creatief, Creatieve, Creatiefst*
31. Gongjin Lan (VU) *Learning better -- From Baby to Better*
32. Jason Rhuggenaath (TU/e) *Revenue management in online markets: pricing and online advertising*
33. Rick Gilsing (TU/e) *Supporting service-dominant business model evaluation in the context of business model innovation*
34. Anna Bon (MU) *Intervention or Collaboration? Redesigning Information and Communication Technologies for Development*
35. Siamak Farshidi (UU) *Multi-Criteria Decision-Making in Software Production*

**2021**

1. Francisco Xavier Dos Santos Fonseca (TUD) *Location-based Games for Social Interaction in Public Space*
2. Rijk Mercuur (TUD) *Simulating Human Routines: Integrating Social Practice Theory in Agent-Based Models*
3. Seyyed Hadi Hashemi (UvA) *Modeling Users Interacting with Smart Devices*
4. Ioana Jivet (OU) *The Dashboard That Loved Me: Designing adaptive learning analytics for self-regulated learning*
5. Davide Dell'Anna (UU) *Data-Driven Supervision of Autonomous Systems*
6. Daniel Davison (UT) *"Hey robot, what do you think?" How children learn with a social robot*
7. Armel Lefebvre (UU) *Research data management for open science*
8. Nardie Fanchamps (OU) *The Influence of Sense-Reason-Act Programming on Computational Thinking*
9. Cristina Zaga (UT) *The Design of Robothings. Non-Anthropomorphic and Non-Verbal Robots to Promote Children's Collaboration Through Play*
10. Quinten Meertens (UvA) *Misclassification Bias in Statistical Learning*
11. Anne van Rossum (UL) *Nonparametric Bayesian Methods in Robotic Vision*
12. Lei Pi (UL) *External Knowledge Absorption in Chinese SMEs*