UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

Scuola Politecnica e delle Scienze di Base

Department of Industrial Engineering

XXVIII PHD PROGRAMME
IN
SCIENCE AND TECHNOLOGY MANAGEMENT

Knowledge Management in Supply Chain

PHD THESIS SUPERVISOR

Prof. Mario Raffa

PHD PROGRAM COORDINATOR

Prof. Giuseppe Zollo

PHD CANDIDATE

Roberto Cerchione

Index

ACKNOWLEDGMENTS

Many people have contributed to the completion thesis in one way or another. Thinking back about the people I would like thank inevitably brings back memories of these last years. It has been also a period full of unexpected events, but enjoyable nonetheless. So, it's time to start thanking everybody who walked the path with me these years.

I express my gratitude to my supervisor Prof. Mario Raffa for his confidence, his goodness, his encouragement and his excellent guidance. He has allowed me to feed a curiosity towards our history of Engineering Management and to learn the power of both research and practice, writing and dissemination.

I express my gratitude to Prof. Emilio Esposito who has been my supervisor from the time of my bachelor and master degree. He brought this new fast developing scientific research topic called knowledge management to my attention and remind me during our daily "socratic conversations" what a PhD means.

I express my gratitude to my PhD Program Coordinator Prof. Giuseppe Zollo who has explained me how knowledge is more complex than it appears in research papers.

I express my gratitude to Prof. Alessandro Ancarani who has been for me my international supervisor for his research guidelines, and has been helpful and inspirational during the AiIG and Ipsera conferences, and during the organisation of the AiIG Summer School Brixen 2015.

I express my gratitude to Prof. Francesco Castagna for helping me during my third year as Teaching Assistant Entrepreneurship Course with his expertise in business, management, startups, and for our pleasant collaboration.

I express my gratitude to Prof. Sergio Cotecchia who has been the assistant supervisor of my master degree thesis and together with Prof. Emilio Esposito inspired me to seize the opportunity of a PhD.

I express my gratitude to Prof. Bruno Iaccarino who has shared with me his teaching expertise in finance and entrepreneurship.

I express my gratitude to Giovanni Pastore for his generosity and helpfulness.

I express my gratitude to my colleagues at the Department of Industrial Engineering and in particular Benedetta Capano who started with me this PhD experience.

I express my gratitude to the young and old AiIG, Ipsera and Ifkad friends.

I express my gratitude to my family for their support and making me aware of all the other aspects of life, particularly my Mum, Dad and brother Claudio; and my aunts Renata (I dedicate to her this thesis) and Adriana.

Finally, I really thank my endless love Piera. Without your presence, my humor when I am with you, our love, and your understanding, my life would not be complete.

1. Introduction

The aim of this thesis is to analyse the role of knowledge management in supply chain starting from a systematic literature review on the topic. Knowledge management (KM) has been defined by Davenport (1994) as the process of acquisition, distribution, and application of knowledge. Starting from this definition, in the following years Duhon (1998) provides a new definition of KM as a discipline that allows to identify, evaluate, retrieve, and share with the environment firm's information assets (e.g. expertise, experiences, procedures, policies, documents, databases). These two definitions imply both an organisational and networking orientation of managing corporate knowledge.

With these premises, KM is acquiring nowadays a pivotal role in the context of supply chain. Nevertheless, although in the field of supply chain there is an increasing number of papers regarding KM, the adoption of knowledge management systems (KMSs) by small and medium enterprises (SMEs) in supply chain remains still limited. In recent years several papers show that the factors preventing the adoption of KMSs by SMEs are connected to three main aspects (Desouza and Awazu, 2006; Egbu et al., 2005; Frey, 2001; McAdam and Reid, 2001; Pillania, 2006; Sparrow, 2001; Wong, 2005; Wong and Aspinwall, 2005):

1) knowledge is mainly human embedded;
2) knowledge is shared to all members of the organization;
3) knowledge is mainly acquired from the external environment due to the resource scarcity characterising small and medium suppliers.

Moreover, considering that SMEs generally do not have dedicated resources to capture and follow the rapid technological and organisational evolution affecting KM, this forces them to remain in a waiting position. Therefore, SMEs seek to adapt the practices they already know to support the process of knowledge management. The second peculiarity is connected to the nature of knowledge. Knowledge of small firms is mainly embedded in human resources, and this hinders a wide diffusion of formal practices. Unlike tools, practices can be learned from customers or suppliers. This aspect highlights how SMEs may improve their business through subcontracting strategies.

However, in recent years the dynamically continuous innovations affecting the ICTs are driving the development and the introduction of new information tools that are cheaper, easier to use and more effective and efficient than traditional ones (Garrigos-Simon et al. 2012).

The thesis is structured in seven chapters. After this **first chapter** dedicated to the introduction, the aim of the **second chapter** is to provide a systematic review on knowledge management in

supply chain in order to identify the state of art in the literature, highlight research gaps and define appropriate research questions to be addressed. The review was carried out using Scopus and Web of Science databases from 1960 to 2014. A total of seventy papers were selected and studied in detail. The chapter highlights that knowledge management in supply chain is a crossroad research issue that includes a variety of contributions coming from different research areas. The chapter also shows that although there is a growing number of papers addressing knowledge management in supply chain, many research issues are still neglected. The content analysis of the papers highlights seven main gaps in the literature. Starting from these seven gaps eight research questions are formulated. These research questions represent possible areas of investigation to improve the body of knowledge in the field of knowledge management in supply chain.

The **third chapter** provides a systematic review of the literature on knowledge management (KM) in small and medium enterprises (SMEs) and SME networks. The main objective is to highlight the state-of-the-art of KM from the management point of view in order to identify relevant research gaps. The review highlights that in recent years the trend of papers on the topic is growing and involves a variety of approaches, methodologies and models from different research areas. The vast majority of papers analysed focus on the topic of knowledge management in the SME while there are only few papers analysing KM in networks populated by SMEs. The content analysis of the papers highlights six areas of investigation from which were derived ten research questions concerning three perspectives: the factors affecting KM; the impact of KM on firm's performance; the knowledge management systems (KMSs).

The **fourth chapter** deals with knowledge management (KM) in small and medium enterprises (SMEs). Three research questions have been identified concerning the barriers hindering the spread of KM practices in SMEs, the main knowledge management systems (KMSs) adopted by SMEs and the impact of the use of KM practices on SME performance. The research questions were subsequently addressed through a field analysis conducted on a sample of SMEs. The empirical evidence highlights that the scenario has changed in the space of but a few years. Although SMEs are generally characterized by poor financial and human resources, they are able to overcome the barriers preventing the spread of KM practices. The SMEs investigated perceive the strategic value of KM and consequently adopt a variety of KMSs. Nevertheless, such systems are generally outdated in comparison with cheaper, more recent, and user-friendly applications. Finally, the chapter emphasizes that the use of KM practices can contribute to the overall growth of SMEs by simultaneously and significantly enhancing their performance.

The **fifth chapter** provides an overview on the knowledge management systems (KMSs) adopted by small and medium enterprises (SMEs). KMSs are divided into two categories: knowledge management tools (KM-Tools) and knowledge management practices (KM-Practices). On the base of the analysis of the literature two research questions (RQs) were identified and addressed through semi-structured interviews carried out in a sample of 35 SMEs operating in high-tech industries. The first RQ concerns the degree of adoption of KMSs by SMEs. The second RQ regards the relationship between KM-Tools and KM-Practices. As far as the degree of adoption of KMSs, the chapter highlights that SMEs are not a homogeneous world but there are a variety of approaches and behaviours. As far as the relationship between the degree of adoption of KM-Tools and KM-Practices, the chapter identifies three groups of SMEs that seem to point out the stages of the process of adoption of KMSs: Introduction, SMEs that deal with the process of knowledge management exploiting practices and tools that already know; Growth, SMEs that adopt specialist practices of knowledge management acquiring new organizational and managerial competence in the field of knowledge management; Maturity, SMEs that invest in new technology and that acquire new technological competence in the field of knowledge management.

The **sixth chapter** aims to highlight the degree of diffusion and the intensity of use of knowledge management systems (KMSs) among small and medium enterprises (SMEs) and to propose a taxonomy that synthesises the strategies of using KMSs on the part of SMEs. Starting from a literature review on KMSs used by SMEs and from a focus group with consultants/researchers operating in the field of information technology in SMEs, an empirical investigation was designed, developed and conducted through semi-structured interviews involving 61 selected SMEs operating in high tech industries. The chapter highlights three main issues regarding the use of KMSs. Firstly, SMEs adopt and use more intensively traditional tools (KM-Tools) rather than new and more updated ones that are generally cheaper and easier to use. Secondly, SMEs adopt and make more intensive use of practices (KM-Practices) that do not exclusively focus on the knowledge management process, but seek to adapt practices they already know to the requirements of knowledge management. Finally, the chapter points out that there is a relationship of reciprocity between KM-Tools and KM-Practices: one reinforces the other and vice versa. The chapter proposes a taxonomy bringing together SME strategies for using KMSs. Specifically, four strategies are identified: guidepost, explorer, exploiter, and latecomer.

The **seventh chapter** analyses the alignment between knowledge management systems and the nature of small and medium enterprises' knowledge. Based on a Delphi panel involving senior

KM consultants and a field analysis conducted in 61 SMEs operating in complex manufacturing and service industries, a software in Matlab language named *KM-Alignment Evaluation System (KM-AES)* has been designed to elaborate the collected data. The methodology used by the software is based on a three-dimensional fuzzy term set. The results highlight that KM-Tools used by the firms are aligned with KM-Practices they should support according to the epistemological and ontological dimensions identified by Nonaka. Specifically, there is a relation of reciprocity between KM-Tools and KM-Practices used by the firms: the higher the degree of coverage of KM-Tools with KM-Practices, the higher the degree of coverage of KM-Practices with KM-Tools and vice versa. Nevertheless, both KM-Tools and KM-Practices are misaligned with firm's corporate knowledge used in five macro-processes identified (planning, production, organization, market relationships, strategic relationships). Moreover, the chapter allows to identify four different strategies of KMSs adoption for SMEs: misaligned SMEs, efficiently misaligned SMEs, effectively misaligned SMEs, aligned SMEs. The findings show that the majority of surveyed firms are efficiently misaligned SMEs. These latter have great potential for growth and through appropriate learning and training processes involving KM experts and/or KMSs' providers, they can become aligned SMEs**.** Finally, the **eighth chapter** summarises the conclusions and implications of the thesis.

The thesis has been supervised by Prof. Mario Raffa and part of field analysis is conducted by the author in the research project KITE.it, **PII "Nuove Tecnologie per il Made In Italy"** D.M. 10.07.2008.

In addition, parts of this thesis are co-authored with other researchers: the chapter 1 is co-authored with Prof. Emilio Esposito; the chapters 2-3 are co-authored with Prof. Emilio Esposito and Maria Rosaria Spadaro; the chapters 4-5-6 are co-authored with Prof. Emilio Esposito; the chapter 7 is co-authored with Piera Centobelli and Prof. Emilio Esposito.

References

Davenport TH (1994) Saving IT's Soul: Human Centered Information Management *Harvard Business Review* 72(2), 119-131.

Desouza KC and Awazu Y (2006) Knowledge management at SMEs: five peculiarities *Journal of Knowledge Management* 10(1), 32-43.

Duhon B (1998) It's All in our Heads *Inform* 12(8), 8-13.

Egbu CO, Hari S and Renukappa SH (2005) Knowledge management for sustainable competitiveness in small and medium surveying practices *Structural Survey* 23(1), 7-21.

Frey RS (2001) Knowledge management, proposal development, and small businesses *The Journal of Management Development* 20(1), 38-54.

McAdam R and Reid R (2001) SMEs and large organisation perceptions of knowledge management: comparisons and contrasts *Journal of Knowledge Management* 5(3), 231-241.

Pillania RK (2006) Leveraging knowledge for sustainable competitiveness in SMEs *International Journal of Globalisation and Small Business* 1(4), 393-406.

Sparrow J (2001) Knowledge management in small firms *Knowledge and Process Management* 8(1), 3-16.

Wong KY (2005) Critical Success factors for implementing knowledge management in small and medium enterprises *Industrial Management & Data Systems* 105(3), 261-279.

Wong KY and Aspinwall E (2005) An empirical study of the important factors for knowledge-management adoption in the SME sector *Journal of Knowledge Management* 9(3), 64-82.

2. Literature Review on Knowledge Management in Supply Chain: State of Art and Research Opportunities

2.1 Abstract

The aim of this chapter is to provide a systematic review on knowledge management in supply chain in order to identify the state of art in the literature, highlight research gaps and define appropriate research questions to be addressed. The review was carried out using Scopus and Web of Science databases from 1960 to 2014. A total of seventy papers were selected and studied in detail. The chapter highlights that knowledge management in supply chain is a crossroad research issue that includes a variety of contributions coming from different research areas. The chapter also shows that although there is a growing number of papers addressing knowledge management in supply chain, many research issues are still neglected. The content analysis of the papers highlights seven main gaps in the literature. Starting from these seven gaps eight research questions are formulated. These research questions represent possible areas of investigation to improve the body of knowledge in the field of knowledge management in supply chain.

Keywords - barriers; factors affecting KM; KMSs; knowledge management; performance; supply chain.

2.2 Introduction

The literature regarding the evolution of the supply chain has highlighted that since the seventies, supply systems have undergone massive changes (Womack et al., 1990; Van Kooij, 1991; Pickernell, 1997; Bidault et al., 1998; Kinder, 2003; Zhang, 2006).

In the 1970s, the literature was influenced by the growth poles theory (Perroux, 1961). Papers underline three main typologies of supplying: customer acquisition of additional labour capacity from suppliers (capacity supplying); suppliers providing the customer with new techniques (specialization supplying); and contracting out of design, methods, development and manufacturing (supply-type supplying) (Sallez, 1975; Chaillou, 1977; Berthomieu et al., 1983). In the '70s, the supply system was a star-shaped organization characterized by direct relationships between customer and suppliers.

In the 1980s, the literature was influenced by the transaction costs theory (Williamson, 1979; Williamson, 1985), the theory of the firm as a set of contracts (Klein et al., 1978) and co-operative game theory of the firm (Aoki, 1984). The papers devote much of their attention to the Japanese industrial system, based on well-developed supply relationships (MITI, 1991; Minato, 1992; Oliver, Wilkinson, 1992; Lecler, 1992). Supply systems evolved towards a pyramidal organization structure and mutual trust between customer and first-tier suppliers, which developed through shared knowledge and the exchange of information, at the basis of the organizational and cultural changes associated with the development of the new customer-supplier relationships (Asanuma, 1989; Smitka, 1991; Sako, 1992; Lamming, 1993).

In the 1990s the literature on customer-supplier relationships was affected by the debate on strategic alliances (Contractor, Lorange, 1988). Supply systems were characterized by an intense network of collaborative/competitive relationships between firms (De Toni, Nassimbeni, 1995; Wong, 1999), which involved the entire supply system (Speakman et al, 1998; McIvor, 2000). Supply systems had a pyramidal organization co-ordinated by the customer (customer visible hand). Relationships could be represented by a variety of actions driven by the customer, which encouraged the circulation of knowledge within the system, eased the innovation process, and reduced the opportunism of individual suppliers (Itami and Senbongi 1992; Hines, 1994; Colombo, Mariotti, 1998).

In the early 2000s, supply systems were strongly influenced by the phenomenon of globalization. The literature was also influenced by the debate on extended enterprise and virtual enterprise (Kornelius, Wamelink, 1998; Browne, Zhang, 1999; Kinder, 2003; Esposito, Evangelista, 2014). Many authors highlightd both the impact of globalization on the supply chain and the forces that drove firms towards globalization (Arnold, 1999; Levy, Grewal, 2000; Quintens et al. 2006;

Gelderman, Semeijn, 2006). Many authors stressed the importance of control factors influencing procurement, processing and distribution by means a suitable information system (Prasad, Sounderpandian, 2003). Knowledge management (KM) was an increasingly critical factor in governing supply systems (Yang et al., 2009, Blome et al. 2014).

In the last decade, supply systems appeared to be affected by the debate on sustainability. Due to increasing stringent environmental requirements affecting manufacturing productions, increasing attention was given to developing environmental management strategies for the supply systems (Vachon, Klassen, 2008; Seuring, Müller, 2008). The literature on supply systems was influenced by the debate on the circular economy. Many authors stressed that green supply systems based on the circular economy offered new opportunities and represented a new view for sustainable manufacturing (Zhu, 2006, Park et al., 2010; Dhakal et al., 2016; Whinkler, 2011; Zhu et al., 2011). New concepts such as the resilient supply system, the risk supply system, the green supply chain, the financial supply chain, and circular supply system began to spread, which highlighted that the supply chain is a complex circular process where a relevant role is played by the circulation of information and knowledge (Dao et al., 2011; Schrettle et al., 2014).

Nowadays, the supply chain is a multi-objective system (economic, productive, strategic, environmental, social, etc.) crossed by a variety of flows (financial, material, information, technology, etc). In such a complex system, management of the processes of acquisition, sharing and diffusion of knowledge appears to be the necessary response to the new challenges posed to the supply chain by globalization and sustainability issues. Nevertheless, although there is a vast literature highlighting that knowledge management (KM) is becoming a key strategic factor in the new industrial environment, in the field of supply chain management the role of knowledge management still seems to be neglected.

This latter point is also underlined by the two literature reviews dealing with the issue of knowledge management in the supply chain.

The first is that of Martin et al. (2006), which reviews 36 papers on knowledge management practices in the sustainable supply chain. Authors analyse the extent to which knowledge management practices support sustainable competitive advantage. The literature is analysed from four perspectives: the reasons knowledge management enables sustainability of business competitiveness; knowledge management practices in the supply chain; knowledge management in supply chain alliances and networks; knowledge management in hard and soft supplier networks.

Marra et al. (2012) review 58 papers. The aim is to evaluate the relationship between knowledge management and supply chain management. The review analyses knowledge exploration and

exploitation processes in some areas of supply chain management and identifies different theoretical and methodological characteristics concerning the way knowledge management applications are proposed in the context of the supply chain. The review also shows that there is little evidence for the positive relationship between the use of knowledge management practices and firms' performance.

Both these reviews highlight an increasing interest in the application of knowledge management practices in the supply chain. Nevertheless, they do not analyse the literature highlighting the specificity of the diverse phases of the KM process and do not even indicate whether the unit of analysis concerns customer-supplier dyadic relationships or supply chain relationships.

However, these two analytical perspectives are crucial and could highlight important additional issues. In fact, the factors affecting the adoption of KM practices in the various phases of the knowledge management process (adoption, creation, storage, transfer, sharing and application) are not necessarily the same. Even the systems of knowledge management (KMSs) used are different (i.e.: crowdsourcing systems concern the phase of creation, whereas the database and data warehouse concern the storage phase). As for the unit of analysis, the relationship between customer and first-tier supplier is different (in terms of exchange of information and knowledge) from the relationship between first-tier supplier and second-tier supplier (Hines, 1994; Esposito, Passaro, 2009). Moreover, within the supply chain, the first-tier supplier plays a central role since it develops relationships with the customer upstream and downstream with the second-tier supplier. Consequently its behaviour, together with that of the customer, affects the characteristics of the supply chain. In other words, the supply chain is not the sum of dyadic relationships, and the problems of KM regarding the supply chain as whole are not the sum of the ones concerning dyadic relationships.

In this framework, the main aim of this chapter is to provide a comprehensive overview of knowledge management in the field of the supply chain that is complementary to the two previous literature reviews, in that it considers three perspectives at the same time: the unit of analysis (dyadic relationship, supply network), the phases of the KM process (adoption, creation, storage, transfer, sharing, and application), and the topic area (factors affecting KM, KMSs, barriers to the adoption of KM, and KM and performance). This chapter has three main objectives. The first is to offer an analytical overview of the existing research in the field of investigation. The second is to carry out a detailed analysis of the main issues covered by research on knowledge management in the supply chain context. The third is to identify research gaps in the literature as well as to define appropriate research questions to address. These

research questions represent possible areas of investigation to improve the body of knowledge in the field of knowledge management in the supply chain context.

This chapter consists of five sections. After the introduction, in the second section the methodology is illustrated. The paper selection phase is shown in the third section. The fourth section is dedicated to the descriptive and content analysis phase. Lastly, the conclusions and implications are set out.

2.3 Methodology

In this chapter we propose a systematic review dealing with knowledge management in supply chain. A systematic review is an overview of primary studies that use explicit and reproducible methods (Greenhalgh, 1997).

According to Greenhalgh, Pittaway et al. (2004) propose a systematic literature review organised into ten steps: Identification of key words; Construction of search strings; Initial search and identification of further key words; Choice of the citation databases; Review of the selected citation databases using the search strings; Review of the citations identified according to the inclusion and exclusion criteria; Review of the citation abstracts and separation into different lists; Encoding of abstracts according to their content; Review of significant papers; Added of Additional papers, according to professional recommendation and references from reviewed papers.

Petticrew and Roberts (2006) define a systematic review as a "review that strives to comprehensively identify, appraise and synthesize all relevant studies on a given topic" and suggest a review process organised into 12 steps: Define the question; Consider drawing together a steering or advisory group; Write a protocol and have it reviewed; Carry out the literature search; Screen the references; Assess the remaining studies against the inclusion/exclusion criteria; Data extraction; Critical appraisal; Synthesis of the primary studies; Consider the effects of publication bias, and other internal and external biases; Writing up the report; Wider dissemination.

Easterby-Smith et al. (2012) identify two main processes of a systematic review. The first consists in defining the review protocol and mapping the field by accessing, retrieving and judging the quality and the relevance of studies in the research field under investigation. The second describes findings to identify gaps in the existing body of knowledge. The authors suggest five stages in carrying out a systematic review: Planning the review; Identifying and Evaluating Studies; Extracting and Synthesising data; Reporting; Utilising the findings.

Summarising the above contributions, our literature review is organised into two main phases

that in their turn are divided into two steps:

1. Phase of papers selection:
    a. Material comprehensive search. This step includes the identification of key words, construction of search strings, choice of databases to be investigated (Scopus, Web of Science, etc.), review of the databases using the search strings;
    b. Selection of papers to be analysed in detail. This step includes the definition of criteria for inclusion/exclusion and the process of selection according to the criteria of inclusion/exclusion;
2. Phase of descriptive and content analysis of the selected papers:
    a. Descriptive analysis. The papers are aggregated according to different perspectives to give a summary view of the selected papers;
    b. Content analysis. Papers are reviewed and studied in deep. The analysis of papers highlights strengths and weaknesses in the literature, evidences research gaps and identifies appropriate research questions to be investigated.

2.4 Phase of papers selection

2.4.1 Material comprehensive search

In order to provide a high level of rigorousness the search is conducted using two databases (Scopus, Web of Science) from 1960 until 2014. A set of selected keywords such as “supply chain”, “suppl*” and “subcontr*” is used in combination with “knowledge management”, “KM”, “knowledge creation”, “knowledge storage”, “knowledge sharing”, “knowledge transfer”, “knowledge application”. The use of keywords such as “suppl*” “subcontract*” allows to select papers containing the terms “supply”, “supplying”, “supplier”, “suppliers”, “subcontract”, “subcontracting”, “subcontractor”, “subcontractors”. Initially, 517 hits in total are found in two databases as shown in table 1.

Table 1. Material search

Keywords used	("supply chain" OR "suppl*" OR "subcontr*") AND (“knowledge management” OR “KM” OR “knowledge creation” OR “knowledge storage” OR “knowledge sharing” OR “knowledge transfer” OR “knowledge application”)
Date range	Published from 1960 to present
Scopus database	429 hits
Web of Science database	226 hits
Total hits retrieved in two databases	655
Duplicates	138
Number of hits excluding duplicates	**517**

2.4.2 Selection of papers

In order to focus on the research products closer to the topic under investigation, three criteria for inclusion/exclusion of research products were defined as reported in table 2.

Table 2. Criteria for inclusion/exclusion

First criterion: focus of the abstracts	Abstracts focusing on supply chain and knowledge management have been included
Second criterion: focus of the papers	Papers focusing on supply chain and knowledge management have been included
Third criterion: cited references	Papers not included in Scopus and Web of Science but cited in the literature on knowledge management have been included

The *first criterion* follows the approach proposed by Pittaway et al. (2004). It allows to select only those papers whose abstracts focus on knowledge management in the context of supply chain. In order to achieve this objective, abstracts of the 517 papers were read in parallel by two researchers, plus a third one in case of uncertainty. According with Petticrew and Roberts (2006), Easterby-Smith et al. (2012) and Pittaway et al. (2004) papers were categorized into the following three lists as shown in table 3:

- List A includes papers with a focus on both supply chain and knowledge management;
- List B includes papers with a prevalent focus on knowledge management but scarce or insignificant reference to supply chain;
- List C includes papers with a predominant focus on supply chain but scarce or inconsiderable reference to knowledge management.

Table 3. First step selection

List	Description	Number of papers
C	Papers with a predominant focus on supply chain but scarce or inconsiderable reference to knowledge management	
B	Papers with a prevalent focus on knowledge management but scarce or insignificant reference to supply chain	171
A	Papers with a focus on both supply chain and knowledge management	75
Total		**517**

The papers contained in List C (280 papers) and List B (121 papers) were excluded as they were out of the scope of the research. The 75 papers contained in List A were fully considered and subjected to the second criterion to be analysed in detail. The *second criterion* is related to the focus of the paper. For this purpose papers have been read in full by two researchers. The phase of in-depth reading allowed us to exclude 11 papers (out of 75) not focused on the research topic. The *third criterion* concerns references cited in the literature analysed but not included in Scopus and Web of Science. Six additional papers were identified. Therefore the papers selected for the subsequent phase of descriptive analysis are 70.

2.5 Phase of descriptive and content analysis

2.5.1 Descriptive analysis

The descriptive analysis of the papers aims to give a helicopter view analysis of the papers that deal with the topic of knowledge management in the context of supply chain. For the evaluation of the 70 selected papers six perspectives were identified:

1. Papers over time;
2. Papers across journals;

3. Papers by methodology;
4. Papers by unit of analysis;
5. Papers by topic area;
6. Papers by KM process.

2.5.1.1 Papers over time

According to distribution over time (Figure 1) a significant percentage of papers belongs to the years 2009 with 9 papers. Specifically there are 10 papers written from 2000 to 2004, 25 papers from 2005 to 2009, 35 papers from 2010 to 2014. The trend of papers on this topic is therefore growing in recent years.

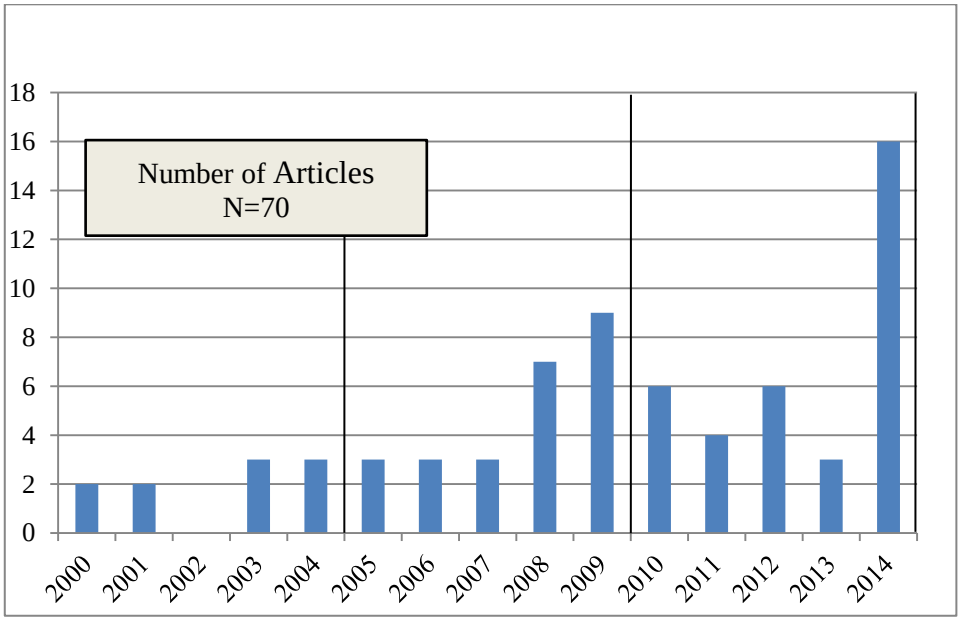


Figure 1. Papers distribution over time

2.5.1.2 Papers across journals

Using the functionalities provided by the platform SCImago Journal Rank (SJR) ten journal subject areas are identified (Table 4): *"Agricultural and Biological Sciences", "Business, Management and Accounting", "Decision Sciences", "Engineering", "Computer Science", "Social Sciences", "Economics, Econometrics and Finance", "Environmental Science", "Materials Science", "Multidisciplinary"*. Table 4 highlights two main aspects. Firstly, although the most of papers focusing on knowledge management in supply chain are placed in the subject area of "Business, management and accounting", it is evident that this is a crossroad research topic, which involves a variety of journals that focus on different subject areas. Secondly, knowledge management in supply chain is a research area still neglected not only by journals of

supply management (6 papers out of 70) but also by journals of knowledge management (3 papers out of 70).

Table 4. Papers distribution by journals

Journal		Journal subject area										Number of papers
		Agricultural and Biological Sciences	Business, Management and Accounting	Decision Sciences	Engineering	Computer Science	Social Sciences	Economics, Econometrics and Finance	Environmental Science	Materials Science	Multidisciplinary	
AMJ	Academy of Management Journal		x									1
ASCJ	Applied Soft Computing					x						1
BPMJ	Business Process Management Journal		x									1
CEA	Computers and Electronics in Agriculture	x				x						1
ECRA	Electronic Commerce Research and Applications		x									1
EJB	Euromed Journal of Business		x					x				2
EJPSM	European Journal of Purchasing and Supply Management		x									1
ESA	Expert Systems with Applications					x						3
FTEE	Fibres and Textiles in Eastern Europe		x		x				x	x		1
IMM	Industrial Marketing Management		x									4
IM	Information and Management		x									3
ISR	Information Systems Research						x					1
IJBIR	International Journal of Business Innovation and Research		x									1
IJIM	International Journal of Information Management		x									5
IJLM	International Journal of Logistics Management		x				x					1
IJMDM	International Journal of Management and Decision Making			x								1
IJNVO	International Journal of Networking and Virtual Organisations		x	x		x						1
IJPDLM	International Journal of Physical Distribution and Logistics Management		x									1
IJPE	International Journal of Production Economics			x	x			x				7
IJTM	International Journal of Technology Management		x									2
JAMS	Journal of the Academy of Marketing Science		x					x				1
JBL	Journal of Business Logistics		x	x								1
JBEM	Journal of Business Economics and Management		x									1
JIM	Journal of Intelligent Manufacturing				x	x						1
JKM	Journal of Knowledge Management		x									2
JMS	Journal of Management Studies		x									2
JOM	Journal of Operations Management		x									5
JPIM	Journal of Product Innovation Management		x		x							1
JSIS	Journal of Strategic Information Systems		x									1
JORS	Journal of the Operational Research Society		x	x								1
KPM	Knowledge and Process Management		x									1
MEJSR	Middle East Journal of Scientific Research										x	1
MQ	Mis Quarterly		x									1
PPC	Production Planning and Control		x	x	x	x						1
RCIM	Robotics and Computer-Integrated Manufacturing				x							1
SMJ	Strategic Management Journal		x									2
SCM	Supply Chain Management: An International Journal		x									5
TFSC	Technological Forecasting and Social Change		x				x		x			1
TRPE	Transportation Research, Part E: Logistics and Transportation Review		x	x			x					1
VINE	VINE					x	x					1

2.5.1.3 Methodology

In relation to the research methodology adopted, the vast majority of papers are based on quantitative methodologies, with few papers using qualitative, conceptual or mixed approaches (Figure 2).

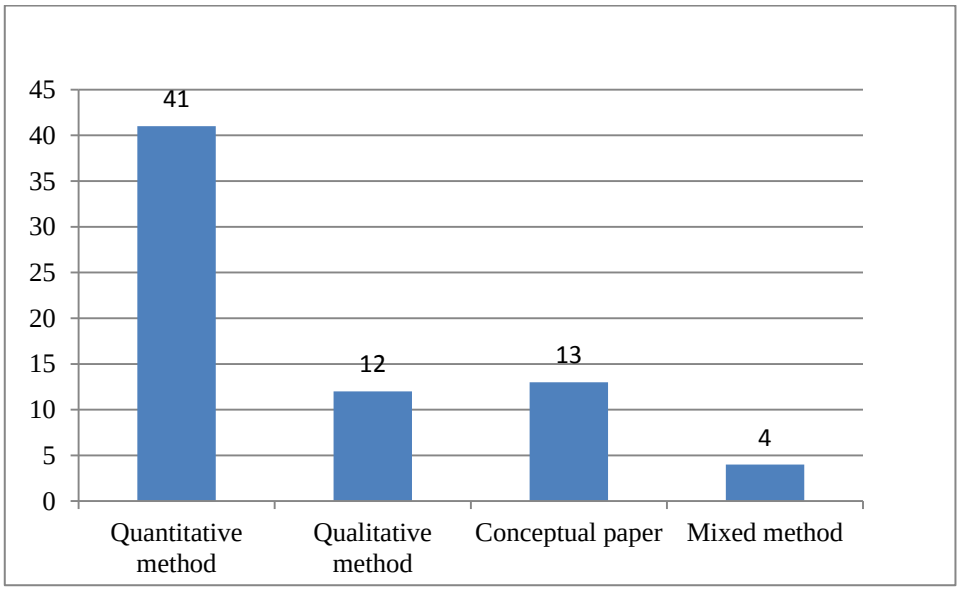


Figure 2. Papers distribution by methodology

The forty-one papers based on quantitative methods are divided into 35 surveys, 2 mathematical models, 4 simulation models. Regarding the 35 surveys, there are 4 different ways of collecting data: e-mail (24), online form (5), face-to-face (4) and telephone (2). The low percentage of face-to-face mode identifies a significant literature gap for a qualitative topic as knowledge management in supply chain.

The twelve papers based on qualitative methods are single (3) or multiple (9) case studies.

The thirteen conceptual papers are based on previous theoretical approaches and do not use empirical data but secondary data and information.

The four papers based on mixed methods combine qualitative and quantitative methodologies.

2.5.1.4 Unit of analysis

In the last few years an increasing number of researches on supplying has enlarged the object of investigation from the simply customer-supplier relationship to the network, including supplier-supplier relationships. Wilhelm (2011) underlines that these supplier-supplier relationships constitute a missing link between the traditional analysis of supply chain that focuses on the customer-supplier dyad and the concept of supply network.

In line with this approach papers are divided into two categories:

1. Papers analysing dyadic relationship between customer and supplier;
2. Papers analysing supply network.

A large part of selected papers focuses on dyadic relationship (48) whereas 22 papers deal with the supply network (Figure 3).

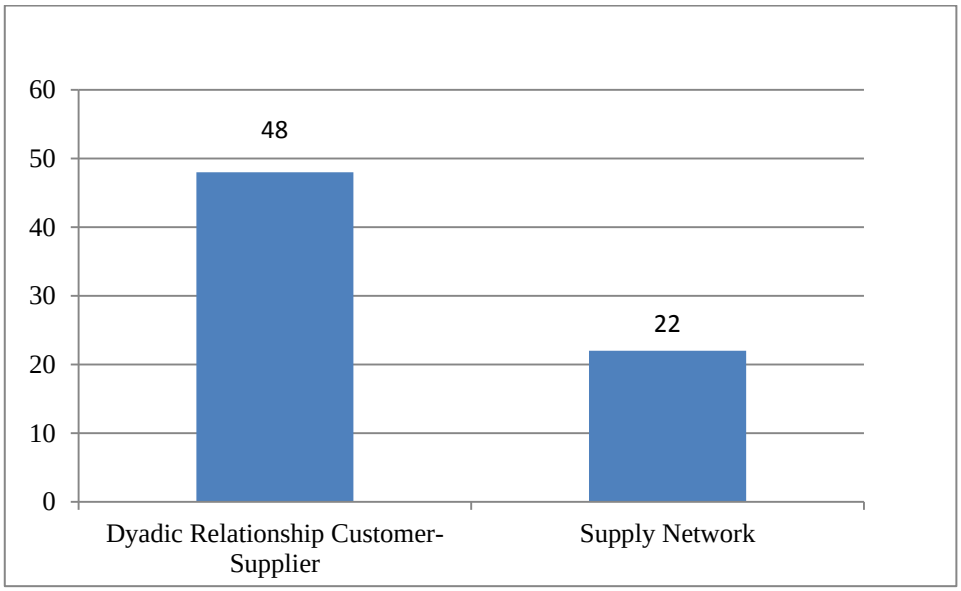


Figure 3. Papers distribution by unit of analysis

Intersecting the two perspectives "unit of analysis" and "methodology", it emerges that among the 41 papers that adopt quantitative methodology, 31 papers investigate dyadic relationship between customers and suppliers and 10 papers investigate the supply network. Even in the case of qualitative methodologies, there is a prevalence of papers focusing on dyadic relationship between customer and supplier instead of supply network (Table 5).

Table 5. Taxonomy of papers by unit of analysis and methodology

	Quantitative methodology	Qualitative methodology	Mixed methodology	Conceptual paper	**Total**
Dyadic Relationship Customer-Supplier	31	8	2	7	**48**
Supply Network	10	4	2	6	**22**
Total	**41**	**12**	**4**	**13**	**70**

Summarising, the taxonomy of papers by unit of analysis and methodology shows two main evidences:

1. Prevalence of papers dealing with dyadic relationship customer-supplier;
2. Prevalence of quantitative approaches compared to qualitative and conceptual approaches.

2.5.1.5 Topic area

Papers are clustered according to 4 topic areas identified in order to get a full overview of the problem:

1. "Factors affecting knowledge management", in which main drivers related to the introduction of knowledge management in supply chain are identified;
2. "Knowledge management systems" (KMSs), in which appropriate tools and practices facilitating knowledge management in supply chain are analysed;
3. "Barriers to the adoption of knowledge management", in which main obstacles related to the introduction of knowledge management in supply chain are described;
4. "Knowledge management and performance", in which it is shown the relationship between knowledge management and supply chain performance.

Table 6 highlights that "knowledge management and performance" is the topic area with the highest number of papers (28), "factors affecting knowledge management" includes 27 papers; "knowledge management systems" includes 13 papers; "barriers to the adoption of knowledge management" includes 2 papers. This latter seems to be a relatively unexplored topic area.

Table 6. Papers by topic area

TOPIC AREA	REFERENCES	
1. FACTORS AFFECTING KNOWLEDGE MANAGEMENT	Blome et al. (2014) Breite and Koskinen (2014) Chen et al. (2014) Chang et al. (2012) Cheng et al. (2008) Cheng (2011) Cheng and Fu (2013) Cheung and Myers (2008) Cheung et al. (2010) Desouza et al. (2003) He et al. (2013) Hernandez-Espallardo et al. (2010) Ke and Wei (2007) Kim et al. (2012)	Lee et al (2009) Li et al. (2011) Liu et al. (2014) Luo et al. (2009) Loke et al. (2012) Mak and Ramaprasad (2003) Nikabadi (2014) Patil and Kant (2014a) Paton and McLaughlin (2008) Samuel et al. (2011) Sudhindra et al. (2014) Tatikonda and Stock (2003) Zhang and Zhou (2013)
2. KNOWLEDGE MANAGEMENT SYSTEMS	Al-Mutawah et al. (2009) De Vries and Brijder (2000) Douligeris and Tilipakis (2003) Goel et al. (2005) Huang and Lin (2010) Kovacs and Spens (2010) Malhotra et al. (2005)	Malhotra et al. (2007) Martin et al. (2008) Shih et al. (2012) Wang et al. (2008) Wu (2001) Zahay and Handfield (2004)
3. BARRIERS TO THE ADOPTION OF KNOWLEDGE MANAGEMENT	Patil and Kant (2014b) Patil and Kant (2014c)	
4. KNOWLEDGE MANAGEMENT AND PERFORMANCE	Abid and Ali (2014) Briscoe et al. (2001) Cantor et al. (2014) Dyer and Hatch (2006) Dyer and Nobeoka (2000) Esper et al. (2010) Fletcher and Polychronakis (2007) Fugate et al. (2012) Halley et al. (2010) He et al. (2013) Hernandez-Espallardo et al. (2010) Hult el al. (2004) Hult et al. (2006) Kanat and Atilgan (2014)	Lakshman and Parente (2008) Liu et al. (2012) Lu et al. (2014) Paulray et al. (2008) Pedroso and Nakano (2009) Raisinghani and Meade (2005) Rollins et al. (2011) Sambasivan et al. (2009) Saxena and Wadhwa (2009) Schoenherr et al. (2014) Sivakumar and Roy (2004) Tseng (2009) Tseng (2014) Yang et al. (2009)

2.5.1.6 Knowledge management process

Papers are clustered according to knowledge management processes:

- Knowledge management adoption in which principles to manage knowledge are introduced in the organization;
- Knowledge management development, which consists in all systematic activities that the organization uses to create, store, exchange (transfer and sharing) and apply knowledge.

The process of "knowledge management development" is categorised into 5 different phases (Table 7): Knowledge creation, in which different types of knowledge are acquired (18 papers); Knowledge storage, in which different types of knowledge are retained (7 papers); Knowledge transfer, in which an actor transfers knowledge to another actor (15 papers); Knowledge sharing, in which two actors exchange and share different types of knowledge (38 papers); Knowledge application, in which different types of knowledge are used (8 papers).

The process of "knowledge management adoption" includes only 9 papers.

Table 7. Papers by process

PROCESS		REFERENCES	
KNOWLEDGE MANAGEMENT ADOPTION		Liu et al. (2014) Loke et al. (2012) Mak and Ramaprasad (2003) Martin et al. (2008) Patil and Kant (2014a)	Patil and Kant (2014b) Patil and Kant (2014c) Sudhindra et al. (2014) Zahay and Handfield (2004)*
KNOWLEDGE MANAGEMENT DEVELOPMENT	Knowledge creation	Breite and Koskinen (2014) De Vries and Brijder (2000) Dyer and Nobeoka (2000)* Esper et al. (2010)* Fletcher and Polychronakis (2007) * Fugate et al. (2012)* He et al. (2013) Hult et al. (2004)* Kanat and Atilgan (2014)*	Li et al. (2011) Malhotra et al. (2005) Malhotra et al. (2007) Raisinghani and Meade (2005)* Sambasivan et al. (2009)* Samuel et al. (2011) Tseng (2009) Tseng (2014)* Zahay and Handfield (2004)*
	Knowledge storage	Hult et al. (2004)* Hult et al. (2006)* Kanat and Atilgan (2014) Nikabadi (2014)	Raisinghani and Meade (2005)* Tseng (2014)* Zahay and Handfield (2004)*
	Knowledge transfer	Blome et al. (2014) Desouza et al. (2003) Dyer and Nobeoka (2000)* Fugate et al. (2012)* Hernandez-Espallardo et al. (2010)* Kanat and Atilgan (2014)* Kim et al. (2012) Lee et al . (2009)	Lu et al. (2014) Paton and McLaughlin (2008) Raisinghani and Meade (2005)* Schoenherr et al. (2014) Tatikonda and Stock (2003) Tseng (2014)* Zhang and Zhou (2013)
	Knowledge sharing	Abid and Ali (2014) Al-Mutawah et al. (2009) Briscoe et al. (2001) Cantor et al. (2014) Chang et al. (2012) Chen et al. (2014) Cheng et al. (2008) Cheng (2011) Cheng and Fu (2013) Cheung and Myers (2008) Cheung et al. (2010) Douligeris and Tilipakis (2003) Dyer and Hatch (2006) Dyer and Nobeoka (2000)* Esper et al. (2010)* Fletcher and Polychronakis (2007) * Fugate et al. (2012)* Goel et al. (2005) Halley et al. (2010)	Hernandez-Espallardo et al. (2010)* Huang and Lin (2010) Hult et al. (2004)* Ke and Wei (2007) Kovacs and Spens (2010) Lakshman and Parente (2008) Liu et al. (2012) Luo et al. (2009) Paulray et al. (2008) Pedroso and Nakano (2009) Raisinghani and Meade (2005)* Rollins et al. (2011) Saxena and Wadhwa (2009) Shih et al. (2012) Sivakumar and Roy (2004) Tseng (2014)* Wang et al. (2008) Wu (2001) Yang et al. (2009)
	Knowledge application	Dyer and Nobeoka (2000)* Esper et al. (2010)* Hult et al. (2006)*	Raisinghani and Meade (2005)* Sambasivan et al. (2009)* Tseng (2014)*
* These papers deal with more than one phase of the process of knowledge management			

2.5.2 Content analysis and results

The content analysis of the 70 papers aims to give a detailed overview of the issues covered by literature on knowledge management in supply chain context. Three content perspectives are identified: the topic area (factors affecting KM, KMSs, barriers to adoption of KM, KM and performance); the knowledge management process, namely KM adoption and KM development (creation, storage, transfer, sharing and application); the unit of analysis (customer/supplier

relationship and supply network).

According to the topic area and knowledge management process, six areas where identified (Table 8):

Area 1: Factors affecting knowledge management adoption (5 papers);

Area 2: Factors affecting knowledge management development (22 papers);

Area 3: Knowledge management systems to support knowledge management adoption (2 papers);

Area 4: Knowledge management systems to support knowledge management Development (12 papers);

Area 5: Barriers to the adoption of knowledge management (2 Papers);

Area 6: Knowledge management development and performance (50 papers).

Areas 1, 2 and 3 are in turn divided into two subareas according to the unit of analysis (customer/supplier, supply network). Areas 2, 4, and 6 into ten subareas, considering both the unit of analysis and the phases of knowledge management development (creation, storage, transfer, sharing and application).

These six areas are analysed in the following paragraphs.

Table 8. Categorization of papers by topic area, phases of KM process and unit of analysis*

		PHASES OF KM PROCESS							
		KM ADOPTION	KM DEVELOPMENT						
			Knowledge Creation	Knowledge Storage	Knowledge Transfer	Knowledge Sharing	Knowledge Application		
TOPIC AREA	Factors affecting KM	4	3	1	6	8		Customer/Supplier	UNIT OF ANALYSIS
		1	1		1	2		Supply Network	
	KMSs	2	1	1		3		Customer/Supplier	
			2			5		Supply Network	
	Barriers to the adoption of KM	2						Customer/Supplier	
								Supply Network	
	KM and performance		6	4	5	15	5	Customer/Supplier	
			5	1	3	5	1	Supply Network	

* Since some papers deal with more than one phase of the process of knowledge management, the total in table is 93 but the number of papers analysed is 70

2.5.2.1 Factors affecting knowledge management adoption (Area 1)

The first area includes 5 papers and deals with factors that might positively influence knowledge management adoption. Specifically four papers deal with dyadic relationship (Liu et al., 2014; Mak and Ramaprasad, 2003; Patil and Kant, 2014a; Sudhindra et al., 2014), and one paper focuses on supply network (Loke et al., 2012).

As far as dyadic relationship customer-supplier, Mak and Ramaprasad (2003) introduce the concept of "Knowledge Supply Network" defined as a knowledge-based set of competencies used to design and deliver final products or service to market. Liu et al. (2014) analyse the knowledge chain management framework to support integrated decisions considering the knowledge of global market, global capacity and global supply network configuration.

As far as the paper focusing on supply network, Loke et al. (2012) highlight that the adoption of Total Quality Management can have an effect on knowledge management and learning ability of the entire supply network to create organizational units that are responsible for overseeing the management of knowledge.

Both the papers focusing on dyadic relationship and the papers focusing on supply network analyse only some specific factors (Knowledge Supply Network and Total Quality Management), but do not offer a clear and exhaustive framework of the set of factors that affect the adoption of KM practices. This latter point highlights the need of a systemic approach to identify and analyse the set of factors that influence the adoption of the knowledge management, both in supply network and in dyadic relationship.

In summary, this piece of literature points out the need of a more comprehensive analysis of the factors affecting the adoption of knowledge management practices both in dyadic relationship and in supply network (first gap).

2.5.2.2 Factors affecting knowledge management development (Area 2)

The second area includes 22 papers and deals with key factors that might affect knowledge management development. Specifically 18 papers focus on dyadic relationship and 4 papers on supply network.

As far as the dyadic relationship customer-supplier three papers regard knowledge creation phase (Breite and Koskinen, 2014; Li et al., 2011; Samuel et al., 2011), one paper deals with knowledge storage (Nikabadi, 2014), six papers focus on knowledge transfer (Blome et al., 2014; Kim et al., 2012; Lee et al., 2009; Paton and McLaughlin, 2008; Tatikonda and Stock, 2003;

Zhang and Zhou, 2013), and eight papers treat knowledge sharing (Chen et al., 2014; Cheng et al., 2008; Cheng, 2011; Cheng and Fu, 2013; Cheung et al., 2010; Hernandez-Espallardo et al., 2010; Ke and Wei, 2007; Luo et al., 2009).

Li et al. (2011) provide a conceptual model for examining the effects of cooperation and conflicts between customer and supplier as two key aspects affecting manufacturer's knowledge creation process. Samuel et al. (2011) develop a model based on Nonaka's four stages spiral model (SECI) to analyse knowledge creation phase. The authors identify the critical success factors affecting knowledge creation during each stage of the knowledge spiral (socialization, externalization, internalization, combination).

Lee et al. (2009) analyse the process of knowledge transfer and point out that equipment quality, production technology, service level, cost management and execution are the most important factors affecting knowledge transfer. Kim et al. (2012) show that overall inter-organizational trust and knowledge complementarity promote knowledge transfer behaviour in a supply channel. Zhang and Zhou (2013) describe how the mechanisms of informal relationships, such as trust, and the mechanisms of formal relationships, such as contracts and controls, affect knowledge transfer in customer-supplier relationship. Tatikonda and Stock (2003) analyse how the environment context affects the knowledge transfer (technology uncertainty, inter-organizational interaction and product technology transfer effectiveness). Paton and McLaughlin (2008) examine how the management of knowledge workers has a key role in knowledge transfer within service sector. Blome et al. (2014) demonstrate how both internal and external knowledge transfer influence positively dyadic relationship flexibility.

Hernandez-Espallardo et al. (2010) define the *managerial factors* as a set of company policies (incentives, socialization and control) that influence the process of knowledge sharing between the firm and other actors in dyadic relationship. Ke and Wei (2007) show that socio-political factors (trust towards the partner and the partner's power) affect firm's decision on whether to share knowledge with partners. Cheung et al. (2010) analyse how environmental conditions (uncertainty and dissimilarity), inter-organizational properties (organizational fit, idiosyncratic investments), relationship learning and cultural distance are important factors affecting knowledge sharing between dyad members. Cheng (2011), in the context of green supply chain, shows that relational risk affects the firm's willingness to share knowledge and this association is negatively influenced by the tangible relational value and intangible relational value. Cheng et al. (2008) underline that trust has a significant influence on inter-organizational knowledge sharing. Luo et al. (2009) indicate that the relationship-specific investment of company reduces opportunism and conflict as well as increases knowledge sharing. Cheng and Fu (2013) suggest

that a good practice to improve knowledge sharing in dyadic relationship is to reinforce their relationship orientation and institutional orientation.

As far as papers focusing on supply network one paper analyses knowledge creation phase (He et al., 2013), one paper deals with knowledge transfer phase (Desouza et al., 2003), and two papers regard knowledge sharing phase (Chang et al., 2012; Cheung and Myers, 2008).
He et al. (2013) examine that the power of a relationship measured by the availability of alternatives and moderation in its use may affect the creation of knowledge.
Desouza et al. (2003) indicate that there are different factors influencing knowledge transfer in supply network. The most important factors are the knowledge acceptance behaviour, entropy and noise.
Chang et al. (2012) analyse how relation-specific assets, complementary resources and capabilities, knowledge sharing routines, and network position are the most important factors affecting firms at the upstream level and at the downstream level. Cheung and Myers (2008) classify different types of factors affecting the sustainability of a knowledge sharing network in three categories: resource fit, management fit and market-related fit. These factors are relational capital, shared identity and flexibility.

In summary, the literature that focuses on this second area highlights a variety of factors that affect KM development, these factors may be classified into four main categories: *managerial factors* (equipment quality, production technology, service level, incentives, organizational fit, idiosyncratic investments, etc.); *relational factors* (cooperation, conflicts, partnerships, exchanging structured documents, contracts, joint project experience, inter-organizational trust, relationship-specific investment, etc.); *environmental factors* (technology uncertainty, product technology transfer effectiveness, uncertainty, dissimilarity, etc.); *socio-political factors* (socialization, partner's power, opportunistic behaviour, institutional orientation, etc.).
Nevertheless, it doesn't consider *human and cultural factors*, such as human resources, people skill, motivation, training and education, culture of collaboration; *technical factors*, such as degree of IT applications, information system, infrastructure, degree of KM adoption, and TQM practices; *firm specific factors*, such as international interactions and organisational proximity and organisational size.
This conclusion highlights the need of analysing these latter categories of factors (human and cultural, technical, firm specific) that affect the development of knowledge management in supply network and in dyadic relationship.
The content analysis of this area evidences two main gaps:

1. The first concerns the lack of papers regarding human, cultural, technical and firm specific factors affecting knowledge management development, both in dyadic relationship and in supply network (second gap).
2. The second concerns the factors affecting knowledge storage and knowledge application that are not analysed both in dyadic relationship and in supply network (third gap).

2.4.2.3 Knowledge management systems to support knowledge management adoption (Area 3)

The third area includes 2 papers focusing on knowledge management systems to support knowledge management adoption. In our approach a KMS is an information system and/or a managerial practice adopted to support companies in creating, storing, transferring, sharing or applying knowledge (Corso et al., 2003).
The two papers included in this category deals with dyadic relationship. Specifically, Zahay and Handfield (2004) analyse how the top suppliers implement web-based tools to support knowledge management adoption. Authors underline that both the technical capabilities and the learning ability allow suppliers to automate their dyadic relationship processes using KMSs. Martin et al. (2008) investigate the use of an e-commerce system and how the transition to the new knowledge management systems affects knowledge management adoption in dyadic relationship.
In summary, the papers that focus on this third area analyse how a specific knowledge management system (Ariba or E-commerce system) influences the process of knowledge management adoption. Nevertheless, they do not offer an exhaustive framework concerning the set of KMSs (tools and practices) that may support the phase of knowledge management adoption.
Content analysis of "knowledge management systems to support knowledge management adoption" shows the need of an integrated approach to analyse a set of different tools and practices, implemented by individual companies to improve the efficiency and effectiveness of knowledge management adoption in supply network and in dyadic relationship.
In conclusion, literature highlights that *the issue of knowledge management systems to support knowledge management adoption needs a more extensive analysis, both in supply network and in dyadic relationship (fourth gap).*

2.5.2.4 Knowledge management systems to support knowledge management development (Area 4)

The fourth area includes 12 papers focusing on knowledge management systems development. Specifically 5 papers deal with dyadic relationship and 7 papers focus on supply network.

As far as dyadic relationship customer-supplier one paper regards knowledge creation phase (De Vries and Brijder, 2000), one paper focuses on knowledge storage phase (Zahay and Handfield, 2004), and three papers deal with knowledge sharing phase (Goel et al., 2005; Shih et al., 2012; Wu, 2001).

De Vries and Brijder (2000) examine the key role of information technology and shows how it contributes to the process of knowledge creation.

Zahay and Handfield (2004) show how KMSs contribute to knowledge storage and underline the four information-processing capabilities: generation, memory, dissemination and interpretation.

Wu (2001) examines specific multi-agent systems (LivingFactory, DragonChain, StrategyFinder, eBAC) used by firms to improve knowledge sharing phase. Goel et al. (2005) analyse how the use of multi-agent systems (Farm Smart 2000, Heifer Management System, Casa) and on-line auction applications (Agriculture.com, Comdaq.net, Agex.com, Team.com, eBay.com) facilitate knowledge sharing and transparent economic transactions. Shih et al. (2012) highlight that the knowledge sharing process, when combined with adequate KMSs, could bridge the gaps between different partners with conflicting objectives.

As far as papers focusing on supply network, two papers analyse knowledge creation phase (Malhotra et al., 2005; Malhotra et al., 2007), and five papers focus on knowledge sharing phase (Al-Mutawah et al., 2009; Douligeris and Tilipakis, 2006; Huang and Lin, 2010; Kovacs and Spens, 2010; Wang et al., 2008).

Malhotra et al. (2005) explore the nature and composition of a knowledge management system analysing how collaboration between supply network partners can lead to new knowledge creation in supply network, even when it may not be an explicit goal. Malhotra et al. (2007) describe how the use of a standard electronic business interfaces (SEBIs) improve the flexibility of supply network partnership and positively influences adaptive knowledge creation process by enabling collaborative information exchange between supply network partners.

Al-Mutawah et al. (2009) propose a multi-agent system (MAS) for tacit knowledge sharing between manufacturing companies. Huang and Lin (2010) analyse how current technologies (EDI, RosettaNet, the current Web, etc.) are useful for sharing data or information, rather than knowledge and underline that a category of technologies to improve knowledge sharing process is the semantic web. Douligeris and Tilipakis (2006) present a framework of semantic ontologies for knowledge sharing in supply network management sector. Kovacs and Spens (2010) examine different types of communities of Practice (CoPs), as sharing techniques of organised and quality knowledge in the context of relief supply network. Wang et al. (2008) develop a conceptual-based model (SCAPSM) for knowledge sharing in supply network based on the technique of

case-based reasoning (CBR).

In summary, the content analysis of the papers of the fourth area highlights that the diverse contributions focus on specific tools or techniques used by firms but do not emerges a global overview or an interpretative taxonomy. Moreover, there is not distinction between practices and information tools. Finally, some phases of the knowledge management development (such as storage, transfer and application) are neglected.

The content analysis of this area shows that *knowledge management systems to support knowledge management development need a more extensive analysis that highlights the whole set of tools and practices used by firms to improve the different phases in terms of efficiency and effectiveness (fifth gap).*

2.5.2.5 Barriers to the adoption of knowledge management (Area 5)

The fifth area, dealing with the barriers to the adoption of knowledge management includes 2 papers by the same authors. Specifically, the papers included in this category focus on supply network.

Patil and Kant (2014b, 2014c) identify 28 barriers divided into strategic, organizational, cultural, individual and technological. The 50% of obstacles for KM adoption in SC are due these strategic barriers. Organizational barriers are also higher weighted, followed by cultural barriers. The strategic barrier "lack of management commitment" is considered as the most important barrier, "KM not integrated with SC business process" is considered as the second most important barrier, "Lack of organizational structure to create and share knowledge" is the third barrier in the list. These barriers are identified by a literature review and a focus group of experts comprising senior managers, IT representatives, KM project representatives, senior executives of SC members and customers. The perspective of individual companies has not to be considered in the identification of barriers.

In summary, even though the authors analyse a set of specific barriers to the adoption of knowledge management (strategic, organizational, cultural, individual and technological barriers), they don't consider barriers such as financial, tacit or not formalised knowledge, protection of critical information, lack of time and resources, lack of staff skill, lack of confidence in the benefits, lack of a shared language, integrations with existing processing and business culture, etc.

These two papers show the need of a systemic approach (that includes even the individual company point of view) to identify and analyse the whole set of barriers that influences the adoption of knowledge management in supply network and in dyadic relationship. In summary,

this piece of literature highlights that *the barriers to the adoption of knowledge management are not analysed in dyadic relationship and scarcely analysed in supply network (sixth gap).*

2.5.2.6 Knowledge management development and performance (Area 6)

The sixth area dealing with the relationship between knowledge management development process and performance includes 28 papers (even though in table 8, in this area there are 50 papers instead of 28 because some papers deal with more than one phase of the process). This is the most explored area. Specifically, 20 papers deal with dyadic relationship and 8 papers focus on supply network.

As far as dyadic relationship customer-supplier six papers regard knowledge creation phase (Esper et al., 2010; Fletcher and Polychronakis, 2007; Hult et al., 2004; Raisinghani and Meade, 2005; Sambasivan et al., 2009; Tseng, 2014), four papers concern knowledge storage phase (Hult et al., 2004; Hult et al., 2006; Raisinghani and Meade, 2005; Tseng, 2014), four papers focus on knowledge transfer phase (Hernandez-Espallardo et al., 2010; Lu et al., 2014; Raisinghani and Meade, 2005; Tseng, 2014), fifteen papers deal with knowledge sharing phase (Abid and Ali, 2014; Cantor et al. 2014; Dyer and Hatch, 2006; Esper et al., 2010; Fletcher and Polychronakis, 2007; Hult et al., 2004; Lakshman and Parente, 2008; Liu et al., 2012; Paulray et al., 2008; Pedroso and Nakano, 2009; Raisinghani and Meade, 2005; Rollins et al., 2011; Sivakumar and Roy, 2004; Tseng, 2014; Yang et al., 2009), and five papers concern knowledge application phase (Esper et al., 2010; Hult et al., 2006; Raisinghani and Meade, 2005; Sambasivan et al., 2009; Tseng, 2014).

Esper et al. (2010) analyse how the creation of value for customers requires organizations able to integrate strategically demand and supply processes through inter-organizational knowledge management. The authors also show that knowledge sharing capabilities affect costs (inventory costs, transportation cost, lead times, and batch size) and reduction of costs affects the performance. Sambasivan et al. (2009) investigate the impact of knowledge creation and knowledge application on organization performance focusing mainly on the first phase. A key component of knowledge creation is learning. The authors use the construct "supply chain learning" and its antecedents to capture customer-supplier knowledge creation. Fletcher and Polychronakis (2007) demonstrate that knowledge sharing improves the richness of communications between customer and supplier. Consequently performance measurement criteria are necessary to encourage partners to work towards shared goals. Hult et al. (2004) develop a model to link knowledge sharing to the reduction of cycle-time analysing strategic customer-supplier relationships.

Hult et al. (2006) indicate that knowledge application phase is associated with dyadic performance in terms of four factors: speed, quality, cost and flexibility. Raisinghani and Meade (2005) investigate the linkage between knowledge management development and organization performance in terms of cost, time, flexibility and quality.

Lu et al. (2014) develop a model to analyse how knowledge transfer and compliance effort are two factors that impact on customer-supplier performance. Hernandez-Espallardo et al. (2010) explore how upstream knowledge transfer from customers to their suppliers can be governed. Authors investigate the effects of knowledge transfer on learning and performance in the empirical context of the apparel industry.

Rollins et al. (2011) examine how knowledge sharing between logistics service provider and customer increases customer satisfaction and service level. Abid and Ali (2014) describe how knowledge sharing has a positive impact for a market orientation strategy in order to achieve a competitive advantage. Dyer and Hatch (2006) consider "supplier knowledge management" as a key factor in the achievement of a competitive advantage: companies that use the identical supplier network do not always obtain the same benefits. Lakshman and Parente (2008) show that knowledge sharing with supplier (through face-to-face mode or web based tools), is a factor that leads to improve product and financial performances. Liu et al. (2012) investigate how distributive, interpersonal, informational and procedural justice impact on dyadic performance through behaviours of both customer and supplier. Yang et al. (2009) analyse how the information technology as well as an efficient knowledge sharing process with the supplier are key factors for improving performance. Sivakumar and Roy (2004) show that knowledge redundancy can be a value for customer in order to improve knowledge sharing phase and achieve a competitive advantage for both customer and supplier. Paulray et al. (2008) suggest that a long-term relationship orientation can increase collaboration between customers and suppliers, which is necessary for sharing strategically important knowledge for mutual gains. Pedroso and Nakano (2009) analyse how the three phases of communications processes (pre-launch, product launch and continuous marketing) have an impact on customer-supplier relationship in pharmaceutical sector.

As far as the papers focusing on supply network, five papers analyse knowledge creation phase (Dyer and Nobeoka, 2000; Fugate et al., 2012; He et al., 2013; Kanat and Altigan, 2014; Tseng, 2009), one paper focuses on knowledge storage phase (Kanat and Altigan, 2014), three papers deal with knowledge transfer phase (Dyer and Nobeoka, 2000; Fugate et al., 2012; Kanat and Altigan, 2014; Schoenherr, 2014), five papers concern knowledge sharing phase (Briscoe et al., 2001; Dyer and Nobeoka, 2000; Fugate et al., 2012; Halley et al., 2010; Saxena and Wadhwa,

2009), and one paper analyses knowledge application phase (Dyer and Nobeoka, 2000).

Fugate et al. (2012) argue that an efficient process of creation, transfer and sharing of knowledge is a key factor for acquiring competitive advantages in the global market. Authors also stress that knowledge management has a positive impact on strategic and financial performances of the firm. Kanat and Altigan (2014) analyse how three phases of knowledge management (creation, storage and transfer) affect supply network productivity, economy, profitability and efficiency. Authors highlight that knowledge creation is the factor that has the most significant impact on supply network performance. He et al. (2013) show that there is a scarcity of papers analysing how power among actors influences knowledge creation and in turn supply chain partners performance. The authors address this gap and find a positive relationship between knowledge creation and supply chain performance. Tseng (2009) propose a conceptual model to investigate how firms exploit internal knowledge creation activities to gain external knowledge and obtain competitive advantages. This model allows also firms to analyse knowledge creation process and evaluate the impact of customer, supplier, and competitor knowledge in supply network. Dyer and Nobeoka (2000) analyse how knowledge resources affect company performance and show that some firm resources and capabilities are relation-specific not easily transferable to other customers or suppliers. Saxena and Wadhwa (2009) stress that knowledge sharing is very useful to create value for supply network. In this context, knowledge management can be used as an effective approach to achieve knowledge sharing among supply network partners. Briscoe et al. (2001) examine the competencies that are necessary for effective supply chain partnerships. A sample of SMEs are interviewed in order to determine if their emerging knowledge and skills are appropriate for achieving supply chain integration. Halley et al. (2010) describe how the development of meta-competencies affecting knowledge sharing has an impact on supply network performance.

In summary, the literature highlights that the process of knowledge management can have a positive impact on a number of performance, which can be classified into four major topics: *economic and financial performance* (profit, sales growth, cost reduction, etc.), *market performance* (market share, service quality, market flexibility, reputation, etc.), *technical performance* (innovation, growth in core competence, productivity, flexibility technical, etc.) and *organisational performance* (external partner and relationship, diffusion of new ideas, organisational agility, flexibility in resources utilization, etc.).

However, this literature doesn’t consider human performance in terms of creativity, entrepreneurial growth, staff performance, staff satisfaction, etc. This latter is a very important factor since knowledge development is strictly related to human factor. From content analysis of

this area it emerges the necessity to analyse more in deep *the impact of knowledge management development on performance considering the whole set of performance including the human performance that is not analysed in literature, both in dyadic relationship and in supply network (seventh gap).*

2.6 Conclusions and implications

This chapter has proposed a systematic review of the literature on the topic of knowledge management in supply chain context that has allowed to provide a comprehensive framework of the literature and identify some gaps in literature from which derive future research opportunities.

The descriptive analysis offers a helicopter view analysis of the papers included in the literature review. It has allowed to provide a summary view of the papers on the topic of knowledge management in the context of supply chain. In particular, the descriptive analysis has highlighted that knowledge management in supply chain is a crossroad research area that involves a variety of journals that focus on different subject areas. The descriptive analysis has not only confirmed that knowledge management in supply chain is a topic still neglected in literature, but has highlighted that is overlooked even from journals of supply management and journals of knowledge management. The vast majority of papers is based on quantitative methodologies, with few papers using qualitative or conceptual approaches. Moreover, there is a prevalence of papers dealing with dyadic relationship customer-supplier compared with papers focusing on the analysis of supply network. Regarding the topic area, the descriptive analysis has allowed to identify four topic areas: Factors affecting KM; Knowledge management Systems; Barrier to the adoption of KM; KM and performance. The most analysed topic area is that of "knowledge management and performance", whereas "barriers to the introduction of knowledge management" is a relatively unexplored topic area. Concerning the process of knowledge management, the descriptive analysis shows that there are only few papers focusing on "knowledge management adoption", "knowledge storage", and "knowledge application", but there is a variety of papers on topic of "knowledge sharing".

The content analysis of the papers included in the literature review has given us a detailed overview of the main issues covered by research on knowledge management in supply chain context. Specifically, the content analysis of the papers has highlighted six areas of investigation: Factors affecting knowledge management adoption; Factors affecting knowledge management development; Knowledge management systems to support knowledge management adoption; Knowledge management systems to support knowledge management development; Barriers to

the adoption of knowledge management; and Knowledge management development and performance. From these six areas of investigation seven main gaps in the literature are emerged. These gaps represent eight research questions to be investigated.

From the first area it emerges the need of a more comprehensive analysis of the factors affecting the adoption of knowledge management practices both in dyadic relationship and in supply network (first gap). Starting from this gap it is possible to formulate the first research question:
RQ1: What are the factors affecting knowledge management adoption?

The content analysis of the papers dealing with the factors affecting knowledge management development has allowed to point out that there is a lack of papers concerning human, cultural, technical and firm specific factors affecting knowledge management development, both in dyadic relationship and in supply network (second gap). Moreover, there is also a lack of papers regarding the factors affecting knowledge storage and knowledge application both in dyadic relationship and in supply network (third gap). These two gaps allow us to identify the following research questions:
RQ2: What are the factors affecting knowledge management development?
RQ3: How human, cultural, technical and firm specific factors affect knowledge management development?

The third area of investigation (Knowledge management systems to support knowledge management adoption) has highlighted that the issue of knowledge management systems to support knowledge management adoption needs a more extensive analysis, both in supply network and in dyadic relationship (fourth gap). The relevant research question are:
RQ4: How KMSs support knowledge management adoption?
RQ5: What is the degree of alignment between KMSs used by suppliers and the nature of knowledge from the ontological and epistemological perspectives?

From the content analysis of the fourth area (Knowledge management systems to support knowledge management development) emerges that knowledge management systems to support knowledge management development need a more extensive analysis that highlights the whole set of tools and practices used by firms to improve the different phases in terms of efficiency and effectiveness (fifth gap). This gap allows us to identify the following research question:
RQ6: Which are the main tools and practices used by firms to improve the different phases of the process of knowledge management development?

The content analysis of the fifth area (Barriers to the adoption of knowledge management) has

revealed that the barriers to the adoption of knowledge management are not analysed in dyadic relationship and scarcely analysed in supply network (sixth gap). From this gap the following research question may be formulated:
RQ7: What are the barriers to the adoption of knowledge management?

The analysis of the sixth area (Knowledge management development and performance) has pointed out the necessity to analyse more in deep the impact of knowledge management development on performance considering the whole set of performance including the human performance that is not analysed in literature, both in dyadic relationship and in supply network (seventh gap). The research question is:
RQ8: Which is the relationship between knowledge management and firm performance?

These research questions represent some possible areas of investigation to improve the body of knowledge in the field of knowledge management in supply chain context. These areas of investigation need to be analysed considering not only the dyadic relationship customer-supplier but also considering the supplier-supplier relationship within the supply network.

References

Abid, M., Ali, B., 2014. Antecedents and effectiveness of CKM: An empirical study. *Middle - East Journal of Scientific Research*, 19(7), 880-892.

Al-Mutawah, K., Lee, V., Cheung, Y., 2009. A new multi-agent system framework for tacit knowledge management in manufacturing supply chains. *Journal of Intelligent Manufacturing*, 20(5), 593-610.

Blome, C., Schoenherr, T., Eckstein, D., 2014. The impact of knowledge transfer and complexity on supply chain flexibility: A knowledge-based view. *International Journal of Production Economics*, 147 Part B, 307-316.

Breite, R., Koskinen, K.U., 2014. Supply chain as an autopoietic learning system. *Supply Chain Management: An International Journal*, 19(1), 10-16.

Briscoe, G., Dainty, A.R.J., Millett, S., 2001. Construction supply chain partnerships: skills, knowledge and attitudinal requirements. *European Journal of Purchasing & Supply Management*, 7, 243-255.

Cantor, D.E.A., Blackhurst, J.A., Pan, M.B., Crum, M.A., 2014. Examining the role of stakeholder pressure and knowledge management on supply chain risk and demand responsiveness. *International Journal of Logistics Management*, 25(1), 202-223.

Chang, C.W., Chiang, D.M., Pai, F.Y., 2012. Cooperative strategy in supply chain networks. *Industrial Marketing Management*, 41, 1114-1124.

Chen, Y.H.A., Lin, T.P.A. Yen, D.C.B., 2014. How to facilitate inter-organizational knowledge sharing: The impact of trust. *Information and Management*, 51(5), 568-578.

Cheng, J.H., 2011. Inter-organizational relationships and knowledge sharing in green supply chains-Moderating by relational benefits and guanxi. *Transportation Research Part E*, 47, 837-849.

Cheng, J., Yeh, C., Tu, C., 2008. Trust and knowledge sharing in green supply chains. *Supply Chain Management: An International Journal*, 13, 283-295.

Cheng, J.H., Fu, Y.C., 2013. Inter-organizational relationships and knowledge sharing through the relationship and institutional orientations in supply chains. *International Journal of Information Management*, 33, 473-484.

Cheung, M., Myers, M.B., 2008. Managing knowledge sharing networks in global supply chain. *International Journal of Management & Decision Making*, 9, 581-599.

Cheung, M.S., Myers, M.B., Mentzer, J.T., 2010. Does relationship learning lead to relationship value? A cross-national supply chain investigation. *Journal of Operations Management*, 28, 472-487.

Corso, M., Martini, A., Pellegrini, L., Paolucci, E., 2003. Technological and Organizational Tools for Knowledge Management: In Search of Configurations. *Small Business Economics*, 21(4), 397-408.

Desouza, K.C., Chattarai, A., Kraft, G., 2003. Supply chain perspective to knowledge management: research propositions. *Journal of Knowledge Management*, 7, 129-138.

De Vries, E.J., Brijder, H.G., 2000. Knowledge management in hybrid supply channels: a case study. *International Journal of Technology Management*, 20(5-8), 569-587.

Douligeris, C., Tilipakis, N., 2006. A knowledge management paradigm in the supply chain. *EuroMed Journal of Business*, 1, 66-83.

Dyer, J.H., Hatch, N.W., 2006. Relation-specific capabilities and barriers to knowledge transfers: Creating advantage through network relationships. *Strategic Management Journal*, 27(8), 701-719.

Dyer, J.H., Nobeoka, K., 2000. Creating and managing a high-performance knowledge-sharing network: The Toyota case. *Strategic Management Journal*, 21(3), 345-367.

Easterby-Smith, M., Thorpe, R., Jackson, P., 2012. *Management Research*. London: SAGE Publications.

Esper, T.L., Ellinger, A.E., Stank, T.P., Flint, D.J., Moon, M., 2010. Demand and supply integration: A conceptual framework of value creation through knowledge management. *Journal of the Academy of Marketing Science*, 38(1), 5-18.

Fletcher, L., Polychronakis, Y.E., 2007. Capturing knowledge management in the supply chain. *Euromed Journal of Business*, 2, 191-207.

Fugate, B.S., Autry, C.W., Davis-Sramek, B., Germain, R.N., 2012. Does knowledge management facilitate logistics-based differentiation? the effect of global manufacturing reach. *International Journal of Production Economics*, 139(2), 496-509.

Goel, A., Zobel, C.W., Jones, E.C., 2005. A multi-agent system for supporting the electronic contracting of food grains. *Computers and Electronics in Agriculture*, 48, 123-137.

Greenhalgh, T., 1997. How to read a paper: Papers that summarise other papers (systematic reviews and meta-analyses). *British Medical Journal*, 315, 672-675.

Halley, A., Nollet, J., Beaulieu, M., Roy, J., Bigras, Y., 2010. The impact of the supply chain on core competencies and knowledge management: direction for future research. *International Journal of Technology Management*, 49, 297-313.

He, Q., Ghobadian, A., Gallear, D., 2013. Knowledge acquisition in supply chain partnerships: The role of power. *International Journal of Production Economics*, 141(2), 605-618.

Hernandez-Espallardo, M., Rodriguez-Orejuela, A., Sanchez-Perez, M., 2010. Inter-organizational governance, learning and performance in supply chains. *Supply Chain Management: An International Journal*, 15(2), 101-114.

Huang, C.C., Lin, S.H., 2010. Sharing knowledge in a supply chain using the semantic web. *Expert Systems with Applications*, 37, 3145-3161.

Hult, G.T.M., Ketchen, D.J., Slater, S.F., 2004. Information processing, knowledge development, and strategic supply chain performance. *Academy of Management Journal*, 47, 241-253.

Hult, G.T.M., Ketchen, D.J., Cavusgil, T., Calantone, R.J., 2006. Knowledge as a strategic resource in supply chains. *Journal of Operations Management*, 24, 458-475.

Kanat, S., Atilgan, T., 2014. Effects of knowledge management on supply chain management in the clothing sector: Turkish case. *Fibres and Textiles in Eastern Europe*, 103, 9-13.

Ke, W., Wei, K.K., 2007. Factors affecting trading partners' knowledge sharing: Using the lens of transaction cost economics and socio-political theories. *Electronic Commerce Research and Applications*, 6, 297-308.

Kim, K.K., Umanath, N.S., Kim, J.Y., Ahrens, F., Kim, B., 2012. Knowledge complementarity and knowledge exchange in supply channel relationships. *International Journal of Information Management*, 32(1), 35-49.

Kovacs, G., Spens, M.K., 2010. Knowledge sharing in relief supply chain. *International Journal of Networking and Virtual Organizations*, 7, 222-239.

Lakshman, C., Parente, R.C., 2008. Supplier-focused knowledge management in the automobile industry and its implications for product performance. *Journal of Management Studies*, 45(2), 317-342.

Lee, A.H.I., Wang, W.M., Lin, T.Y., 2009. An evaluation framework for technology transfer of new equipment in high technology industry. *Technological Forecasting and Social Change*, 77(1), 135-150.

Li, Y., Liu, Y., Liu, H., 2011. Co-opetition, distributor's entrepreneurial orientation and manufacturer's knowledge acquisition: Evidence from China. *Journal of Operations Management*, 29(1-2), pp. 128-142.

Liu, Y., Huang, Y., Luo, Y., Zhao, Y., 2012. How does justice matter in achieving buyer-supplier relationship performance?, *Journal of Operations Management*, 30, 355-367.

Liu, S., Moizer, J., Megicks, P., Kasturiratne, D., Jayawickrama, U., 2014. A knowledge chain management framework to support integrated decisions in global supply chains. *Production Planning and Control*, 25(8), 639-649.

Loke, S.P., Downe, A.G., Sambasivan, M., Khalid, K., 2012. A structural approach to integrating total quality management and knowledge management with supply chain learning. *Journal of Business Economics and Management*, 13(4), 776-800.

Lu, Q., Meng, F., Goh, M., 2014. Choice of supply chain governance: Self-managing or outsourcing? *International Journal of Production Economics*, 154, 32-38.

Luo, Y.L., Liu, Y., Xue, J.Q., 2009. Relationship Investment and Channel Performance: An Analysis of Mediating Forces. *Journal of Management Studies*, 46(7), 1113-1137.

Mak, K.T., Ramaprasad, A., 2003. Knowledge supply network. *Journal of the Operational Research Society*. 54(2), 175-183.

Malhotra, A.A, Gosain, S.B., El Sawy, O.A.E.C., 2005. Absorptive capacity configurations in supply chains: Gearing for partner-enabled market knowledge creation. *Mis Quarterly*, 29(1), 145-187.

Malhotra, A.A., Gosain, S.B., El Sawy, O.A.E.C., 2007. Leveraging standard electronic business interfaces to enable adaptive supply chain partnerships. *Information Systems Research*, 18(3), 260-279.

Marra, M., Ho, W., Edwards, J.S., 2012. Supply chain knowledge management: A literature review. *Expert Systems with Applications*, 39, 6103-6110.

Martin, K., Papagiannidis, S., Li, F., Bourlakis, M., Cook, S., Hansell, A., 2008. Early challenges of implementing an e-commerce system in a medical supply company: A case experience from a knowledge transfer partnership (KTP). *International Journal of Information Management*, 28, 68-75.

Martin, V., Basnet, C., Childerhouse, P., Foulds, L., 2006. Knowledge management for the sustainable supply chain: A literature review. *Proceedings of the European Conference on Knowledge Management*, 302-309.

Nikabadi, M.S., 2014. A framework for technology-based factors for knowledge management in supply chain of auto industry. VINE, 44(3), 375-393.

Patil, S.K., Kant, R., 2014. A fuzzy AHP-TOPSIS framework for ranking the solutions of Knowledge Management adoption in Supply Chain to overcome its barriers. *Expert Systems with Applications*, 41, 679-693.

Patil, S.K., Kant, R., 2014. Ranking the barriers of knowledge management adoption in supply chain using fuzzy AHP method. *International Journal of Business Innovation and Research*, 8(1), 52-75.

Patil, S.K., Kant, R., 2014. A hybrid approach based on fuzzy DEMATEL and FMCDM to predict success of knowledge management adoption in supply chain. *Applied Soft Computing Journal*, 18, 126-135.

Paton, R.A., McLaughlin, S., 2008. Services innovation: Knowledge transfer and the supply chain. *European Management Journal*, 26, 77-83.

Paulray, A., Lado, A.A., Chen, I.J., 2008. Inter-organizational communication as a relational competency: Antecedents and performance outcomes in collaborative buyer–supplier relationships. *Journal of Operations Management*, 26, 45-46.

Pedroso, M.C., Nakano, D., 2009. Knowledge and information flows in supply chains: A study on pharmaceutical companies. *International Journal of Production Economics*, 122, 376-384.

Petticrew, M., Roberts, H., 2006. *Systematic Reviews in the Social Sciences*, Malden: Blackwell Publishing.

Pittaway, L., Robertson, R., Munir, K., Denyer, D., Neely, D., 2004. Networking and innovation: a systematic review of the evidence. *International Journal of Management Reviews*, 5-6(3-4), 137-168.

Raisinghani, M.S., Meade, L.L., 2005. Strategic decisions in supply-chain intelligence using knowledge management: an analytic-network-process framework. *Supply Chain Management: An International Journal*, 10, 151-170.

Rollins, M., Pekkarinen, S., Mehtala, M., 2011. Inter-firm customer knowledge sharing in logistics services: An empirical study. *International Journal of Physical Distribution and Logistics Management*, 41(10), 956-971.

Sambasivan, M., Loke S. P., Abidin-Mohamed, Z., 2009. Impact of knowledge management in supply chain management: A study in Malaysian manufacturing companies. *Knowledge and Process Management*, 16(3), 111-123.

Samuel, K.E., Goury, M.L., Gunasekaran, A., Spalanzani, A., 2011. Knowledge management in supply chain: An empirical study from France. *Journal of Strategic Information Systems*, 20(3), 283-306.

Saxena, A., Wadhwa, S., 2009. Flexible configuration for seamless supply chains: Directions towards decision knowledge sharing. *Robotics and Computer-Integrated Manufacturing*, 25, 839-852.

Schoenherr, T.A, Griffith, D.A.B., Chandra, A.C., 2014. Knowledge management in supply chains: The role of explicit and tacit knowledge. *Journal of Business Logistics*, 35(2), 121-135.

Shih, S.C., Hsu, S.H.Y., Zhu, Z., Balasubramanian, S.K., 2012. Knowledge sharing-A key role in the downstream supply chain. *Information and Management*, 49(2), 70-80.

Sivakumar, K., Roy, S., 2004. Knowledge redundancy in supply chains: A framework. *Supply Chain Management: An International Journal*, 9(3), 241-249.

Sudhindra, S., Ganesh, L.S., Arshinder, K., 2014. Classification of supply chain knowledge: a morphological approach. *Journal of Knowledge Management*, 18(4), 812-823.

Tatikonda, M.V., Stock, G.N., 2003. Product technology transfer in the upstream supply chain. *Journal of Product Innovation Management*, 20(6), 444-467.

Tseng, S.M., 2009. A study on customer, supplier, and competitor knowledge using the knowledge chain model. *International Journal of Information Management*, 29(6), 488-496.

Tseng, S.M., 2014. The impact of knowledge management capabilities and supplier relationship management on corporate performance. *International Journal of Production Economics*, 154, 39-47.

Wang, C., Fergusson, C., Perry, D., Antony, J., 2008. A conceptual case-based model for knowledge sharing among supply chain members. *Business Process Management Journal*, 14, 147-165.

Wilhelm, M.M., 2011. Managing coopetition through horizontal supply chain relations: Linking dyadic and network levels of analysis. *Journal of Operations Management*, 29(7-8), 663-676.

Wu, D.J., 2001. Software agents for knowledge management: coordination in multi-agent supply chains and auctions. *Expert Systems with Applications*, 20, 51-64.

Yang, J., Wong, C.W.Y., Lai, K.H., Ntoko, A.N., 2009. The antecedents of dyadic quality performance and its effect on buyer-supplier relationship improvement. *International Journal of Production Economics*, 120(1), 243-251.

Zahay, D.L., Handfield, R.B., 2004. The role of learning and technical capabilities in predicting adoption of B2B technologies. *Industrial Marketing Management*, 33(7), 627-641.

Zhang, Q.J., Zhou, K.Z., 2013. Governing interfirm knowledge transfer in the Chinese market: The interplay of formal and informal mechanisms. *Industrial Marketing Management*, 42(5), 783-791.

3. Literature Review on Knowledge Management in SMEs

3.1 Abstract

This chapter provides a systematic review of the literature on knowledge management (KM) in small and medium enterprises (SMEs) and SME networks. The main objective is to highlight the state-of-the-art of KM from the management point of view in order to identify relevant research gaps**.** The review highlights that in recent years the trend of papers on the topic is growing and involves a variety of approaches, methodologies and models from different research areas. The vast majority of papers analysed focus on the topic of knowledge management in the SME while there are only few papers analysing KM in networks populated by SMEs. The content analysis of the papers highlights six areas of investigation from which were derived ten research questions concerning three perspectives: the factors affecting KM; the impact of KM on firm's performance; the knowledge management systems (KMSs).

Keywords - barriers; performance; knowledge management tools; knowledge management practice; knowledge management systems; SMEs; SME networks.

3.2 Introduction

A vast literature underlines that knowledge management (KM) is playing a crucial role in the global economy and is increasingly important for the competitiveness of large companies and small and medium enterprises (SMEs) (Al-Mutawah et al., 2009; Dyer and Hatch, 2006; Esper et al., 2010; Esposito and Passaro, 1994; Esposito and Raffa, 2007; Genovese et al., 2013; Gunasekaran and Ngai, 2007; Lakshman and Parente, 2008; Lee et al., 2010; Samuel et al., 2011).

However, while there are many studies that analyse the processes of dissemination of knowledge and highlight the adoption of KM in large companies, as regards SMEs the framework of knowledge is still fragmented. In particular, while the literature proposes a variety of models concerning KM in large companies, underlining the critical success factors, the knowledge management systems (KMSs) used, the spread of practices of KM and their impact on performance, only in recent years literature has been focusing on KM in SMEs (Frey, 2001; McAdam and Reid, 2001; Pillania, 2006; Pillania, 2008a; Pillania, 2008b; Sparrow, 2001; Wong, 2005; Wong and Aspinwall, 2005).

Part of this literature focuses on the aspects relating to the epistemological and ontological dimensions of knowledge in SMEs. Concerning the epistemological perspective Egbu et al. (2005) highlight that knowledge generated in SMEs is tacit in nature. Regarding the ontological perspective, Desouza and Awazu (2006) underline that in SMEs there is a sort of common knowledge known to all members of the organization, and point out the dominance of the process of socialization in the knowledge creating cycle. These contributions suggest that in SMEs the processes of acquisition and dissemination of knowledge should not prescind from the nature of knowledge that is human embedded. Moreover, even KMSs and the factors that affect the spread of KM practices should be in line with the nature of knowledge of SMEs.

With this in mind, this chapter proposes a systematic review of the literature on KM that deals with the issues of SMEs and SME networks from three perspectives: the KMSs, the factors affecting the spread of KM practices, the impact of KM on firm's performance. This literature review is orthogonal to the interesting literature review of Durst and Edvardsson (2012) that focuses on the process of KM and is also orthogonal to the newsworthy contribution of Thorpe et al. (2005) that provides a systematic review on how SMEs use and acquire knowledge. The main objective of this literature review is to highlight the state-of-the-art on KM in SMEs and SME networks, from a complementary outlook to those of Durst and Edvardsson (2012) and Thorpe et al. (2005), in order to identify further research gaps to be investigated.

3.3 Literature review

The review was carried out using Scopus and Web of Science Academic databases, which include more than 8,000 scientific journals that ensure a comprehensive coverage of the scientific production.

According to Kolbe and Burnett (1991) and Li and Cavusgil (1995), the systematic study of existing body of knowledge on the above topic has been done through the three following phases: sampling; classification; content analysis.

Sampling

This phase aims to identify all relevant scientific output covering the topic of KM in SMEs from 2000 to 2014. The search was performed using the keywords "knowledge management", "KM", "knowledge creation", "knowledge storage", "knowledge transfer", "knowledge sharing", in combination with "SME*" or "small firm*" or "small business*". This allows us to identify 428 papers included in the subject areas of the social sciences and humanities (i.e. business management and accounting, social sciences, decision sciences, computer science, engineering, multidisciplinary). In order to select only the papers concerning the aim of this section, two researchers read the abstract of each paper. The criterion of inclusion/exclusion was the focusing on the managerial aspects. In case of conflicting judgments a third researcher was involved in the selection process. The selection process allowed the exclusion of 334 papers. At the end of this stage 94 papers were selected and analysed.
Figure 1 shows that the trend of papers is growing. In fact the selected sample includes 5 papers from 2000 to 2004, 31 papers from 2005 to 2009, 58 papers from 2010 to 2014.

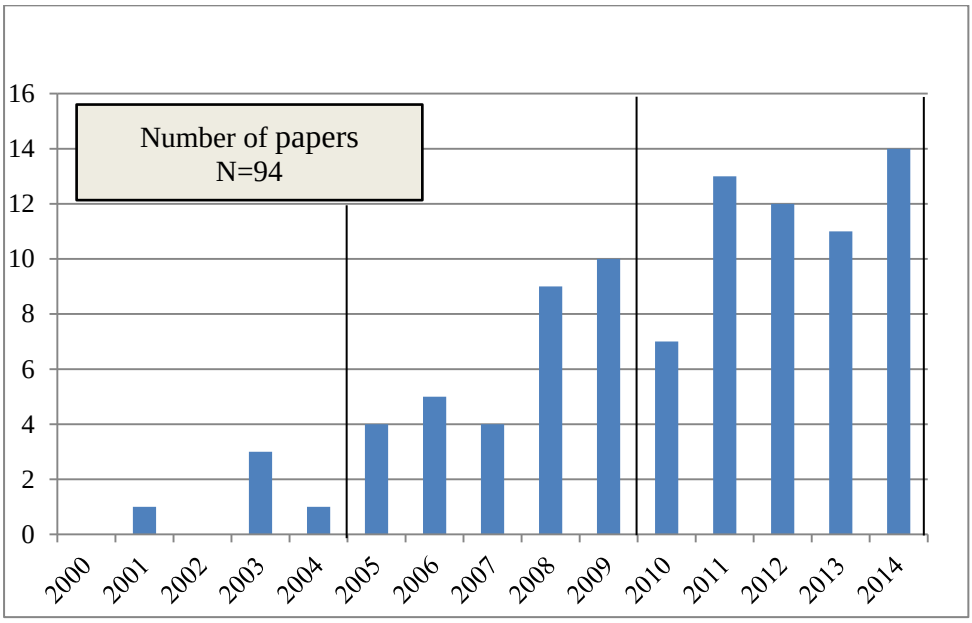


Figure 1. Papers over time

Classification

The papers selected were grouped into four macro areas (table 1): Operations research and management science (60); Information systems and computer science (10); Engineering (8); Multidisciplinary (16).

The distribution of papers by macro-areas testifies that KM involves a variety of approaches, methodologies and models from different research areas.

Table 1. Papers by macro areas

Macro areas	Papers
Operations research and management science	60
Information systems and computer science	10
Engineering	8
Multidisciplinary	16
Total	**94**

3.4 Content analysis: characterisation of research areas

In line with the aim of this paper, the selected sample was analysed considering two outlooks. The first concerns three perspectives: the factors affecting KM; the impact of KM on firm's performance; the knowledge management systems. The second that concerns the unit of analysis was divided into two groups: papers analysing the single SME; papers focusing on SME networks. This partition has identified 6 areas of analysis (table 2):

Area 1: Factors affecting KM in SMEs (41 papers);
Area 2: Factors affecting KM in SME networks (1 paper);
Area 3: KM and SMEs performance (17 papers);
Area 4: KM and SME networks performance (2 papers);
Area 5: KMSs in SMEs (29 papers);
Area 6: KMSs in SME networks (4 papers).

Table 2. Papers by topic area

		UNIT OF ANALYSIS		
		SMEs	NETWORK SMEs	**TOTAL**
PERSPECTIVE	Factors affecting KM	41	1	42
	KM and performance	17	2	19
	KMSs	29	4	33
	TOTAL	87	7	**94**

Area 1: Factors affecting KM in SMEs

Regarding the first area, the analysis of papers points out that it is possible to identify three sub-topics (table 3):

- Contingency factors, that are environmental and historical factors influencing the implementation of KM (9 papers);
- Critical success factors (CSFs), namely factors that may influence the success of KM (28 papers);
- Barriers hindering KM diffusion (4 papers).

Table 3. Papers dealing with factors affecting KM

Factors affecting KM in SMEs	**Authors**	
Contingency factors	Cappellin (2003) Davenport (2005) Edwards (2007) Heavin and Adam (2014) Hsu et al. (2007)	Moffett and McAdam (2006) Purcarea (2013) Roy and Therin (2008) Soto-Acosta et al. (2014)
Critical success factors	Bocquet and Mothe (2010) Boden et al. (2012) Chen et al. (2012) Chen et al. (2013) De Saá-Pérez (2012) Deng (2008) Eze (2013) Gholipour et al. (2010) Hussain et al. (2011) Jones et al. (2010) Lee and Lan (2011) Lin (2014) Martinez-Costa and Jimenez-Jimenez (2009) Migdadi (2008)	Mohannak (2014) Montequín et al. (2006) Patalas-Maliszewska and Hochmeister (2011) Pillania (2008b) Pool et al. (2014) Tan and Hung. (2006) Tseng et al. (2012) Vajjhala and Baghurst (2014) Valmohammadi (2010) Wee and Chua (2013) Wong (2005) Wong and Aspinwall (2005) Zapata Cantù et al. (2009) Zieba and Zieba (2014)
Barriers	Anand (2013) Joshi (2012)	Milosz and Milosz (2010) Nunes et al. (2006)

From the papers regarding the Contingency Factors, it clearly emerges that the KM processes are influenced by a variety of factors that may be grouped into three main sub-categories: *Industrial organisation and industrial characteristics* (Cappellin, 2003; Heavin and Adam, 2014; Hsu et al., 2007; Purcarea, 2013); *Environmental and social factors* (Edwards, 2007; Davenport, 2005; Roy and Therin, 2008; Soto-Acosta et al., 2014); *Firm specific factors* (Davenport, 2005; Moffett and McAdam, 2006; Soto-Acosta et al., 2014).

The papers concerning CSFs may be classified into three main sub-categories: *human and cultural factors* (skill, motivation, training, education, trust, and collaboration), *technical factors* (degree of IT applications, information system, infrastructure), and *managerial factors* (KM strategy, management style, management leadership, organisational infrastructure, team-work, and rewarding).

In particular 12 out of 28 papers deal with all three categories of factors, 7 contributions regard both managerial and human and cultural factors, 1 contribution focuses on both technical and managerial factors, 6 papers concern only human and cultural factors, and 2 papers only managerial factors.

Finally, the 4 papers dealing with the barriers hindering KM diffusion point out two main issues. Anand (2013), Joshi (2012) and Milosz and Milosz (2010) identify the cultural issues, whereas Nunes et al. (2006) highlight the financial issues. They do not consider the managerial issues, the role of human resources, the nature of the knowledge of SMEs that could represent potential barriers.

In summary, as far as the first topic there is a wide literature on the aspects concerning the factors that can influence the success of KM implementation. This literature has also identified a variety of contingency factors (industrial, environmental and firm specific) and a substantial number of CSFs that may be attributed to three main categories (human and cultural, technical, managerial). By contrast, *there are only four papers, which analyse the barriers preventing the adoption of KM practices. Even though these four papers pick out some cultural and financial factors, it seems evident that we need a more detailed analysis and more empirical evidence on this subject.* The analysis of the first topic allows the formulation of the following research question:

- *RQ1: What are the barriers hindering the adoption of KM in SMEs?*

Area 2: Factors affecting KM in SME networks

The second area includes only the contribution of Chang et al. (2012) that identify some important factors affecting the process of knowledge sharing in SME networks (relation-specific assets, knowledge sharing routines, complementary resources and capabilities, and network position). Nevertheless, these conclusions are based on a desk analysis. *Therefore, there is need of a more comprehensive investigation concerning factors and barriers that influence the adoption of KM practices in SME networks*. Starting from this gap it is possible to identify a research question for future research tracks:

- *RQ2: What are the factors affecting the adoption of KM in SME networks?*

According with the main aim of providing an overview on both factors (contingency and CSFs) and barriers, this latter has been subdivided in three research questions:

- *RQ2.1: What are the contingency factors affecting the adoption of KM in SME networks?*
- *RQ2.2: What are the CSFs affecting the adoption of KM in SME networks?*
- *RQ2.3: What are the barriers hindering the spread of KM in SME networks?*

Area 3: KM and SMEs performance

As regards the third area, the analysis of the papers highlights that the KM may impact on the following performance (table 4): *economic and financial performance* (sales growth, revenue growth,

cost reduction, return to investment, profit), *market performance* (market share, service quality, market flexibility, reputation, customer satisfaction, services to clients), *technical performance* (innovation, product quality, competence, productivity, efficiency), *human performance* (creativity, entrepreneurial growth, staff satisfaction) and *organisational performance* (external relationships, diffusion of new ideas, work relationships, flexibility in resources utilization).

Table 4. Papers dealing with KM and SMEs performance

KM and SMEs performance	**Authors**	
Economic and financial performance	Bagnoli and Vedovato (2012) Daud and Yusoff (2011) Delen et al. (2013) Gholami et al. (2013) Hong et al. (2014) Liu and Abdalla (2013)	Omerzel and Antončič (2008) Roxas et al. (2014) Salojärvi et al. (2005) Soon and Zainol (2011) Wei et al. (2011)
Market performance	Beck,and Schenker-Wicki (2014) Daud and Yusoff (2011) Delen et al. (2013) Egbu et al. (2005) Gholami et al. (2013) Gupta et al. (2014)	Hong et al. (2014) Liu and Abdalla (2013) Soon and Zainol (2011) Talebi and Tajeddin (2011) Wei et al. (2011)
Technical performance	Alegre et al. (2011) Bagnoli and Vedovato (2012) Daud and Yusoff (2011) Delen et al. (2013) Egbu et al. (2005) Filippini et al. (2012)	Gholami et al. (2013) Hong et al. (2014) Liu and Abdalla (2013) Soon and Zainol (2011) Talebi and Tajeddin (2011) Wei et al. (2011)
Human performance	Egbu et al. (2005) Gholami et al. (2013) Liu and Abdalla (2013)	Soon and Zainol (2011) Talebi and Tajeddin (2011) Wei et al. (2011)
Organisational performance	Daud and Yusoff (2011) Egbu et al. (2005) Gholami et al. (2013)	Hong et al. (2014) Liu and Abdalla (2013) Wei et al. (2011)

In particular, 3 out of 17 papers indicate that KM supports all five performance, 4 contributions show that KM affects positively four performance, 1 paper points out that KM influences positively three performance, 2 papers highlight two performance, and 7 papers only one performance. This seems highlight that KM contributes to an overall growth of SMEs by enhancing simultaneously more performance. Nevertheless, while it is strongly shared that KM strengthens the technical performance (12 out of 17 papers), it is not otherwise shared the impact on the organisational performance (6 out of 17 papers) and human performance (6 out of 17 papers). *It seems evident that further empirical evidence could strengthen this conclusion and confirm that the impact of KM on SMEs performance is extremely wide and affects simultaneously more performance*. The above literature analysis allows us to formulate the following research question:

- *RQ3: What is the impact of KM on SMEs performance?*

Area 4: KM and SME networks performance

The fourth area dealing with the relationship between KM and SME networks performance includes 2 papers. Briscoe et al. (2001) analyse how knowledge sharing between networks affects SME networks performance. Saxena and Wadhwa (2009) show that knowledge sharing has crucial value for the networks of SMEs.

Although the interesting results, these two papers don't consider how the adoption of KM has an impact on different specific types of performance. Summarising, the analysis of this fourth area highlights that the impact of KM on SME networks requires a deeper investigation. This conclusion allows the formulation of the following research question:

- *RQ4: What is the impact of KM on SME networks performance?*

Area 5: KMSs in SMEs

With reference to the fifth area, the papers were divided into two sub-topics (table 5): *Knowledge management practices* (KM-Practices), defined as the set of methods and techniques to support the organizational processes of knowledge creation, storage, transfer/sharing, and application (18 papers); and *Knowledge management tools* (KM-Tools), namely the specific IT-based systems supporting KM methods and techniques (11 papers).

Table 5. Papers dealing with KMSs by authors

KMSs in SMEs	**Authors**	
KM-Practices	Ambrosini and Bowman (2008)	Levy et al. (2003)
	Chong (2011)	Lin et al. (2012)
	Corso et al. (2003)	Massa and Testa (2011)
	Desouza and Awazu (2006)	Navarro et al. (2010)
	du Plessis (2008)	Noblet and Simon (2012)
	Durst and Wilhelm (2011)	Pillania (2008a)
	Durst and Wilhelm (2012)	Spraggon and Bodolica (2008)
	Fink and Ploder (2009)	Whyte and Classen (2012)
	Hutchinson and Quintas (2008)	Yao et al. (2011)
KM-Tools	Beylier et al. (2009)	Lisanti and Luhukay (2014)
	Choudhary (2013)	Lopez-Nicolas and Soto-Acosta (2010)
	Dotsika and Patrick (2013)	Razmerita and Kirchner (2011)
	Edvardsson (2009)	Rosu et al. (2009)
	Grace (2009)	Zhou (2014)
	Gresty (2013)	

As far as the papers included in the first sub-topic (KM-Practices), they evidence the variety of methods and techniques of KM in relation to the nature of knowledge and/or the process of KM. All papers agree that knowledge in SMEs is mainly human embedded and there is the dominance of socialisation in the SECI cycle (Nonaka, 1994). Then it is not surprising that most of the practices are oriented toward the management of tacit knowledge. Some authors (Chong, 2011; Desouza and Awazu, 2006; du Plessis, 2008; Lin et al., 2012; Massa and Testa, 2011; Navarro et al., 2010; Noblet and

Simon, 2012; Pillania 2008a; Spraggon and Bodolica, 2008; Whyte and Classen, 2012; Yao et al. 2011) suggest a variety of people-centred practices such as: focus groups, formal meetings, seminars, communities of practice, communities of sharing, informal networks, project teams, storytelling, interactions with clients, interactions with suppliers, interactions with partners, job rotation, training. Moreover, even though Hutchinson and Quintas (2008) underline that small firms are more likely to adopt informal processes to manage knowledge, other authors (Ambrosini and Bowman, 2008; du Plessis, 2008; Durst and Wilhelm, 2011, 2012; Fink and Ploder, 2009; Levy et al., 2003) suggest also the importance of more formal techniques and methods (such as: casual mapping, knowledge map, balance scorecard, formal manual), while others suggest to establish a chief knowledge officer (Navarro et al., 2010) or a project team (Corso et al. 2003; Spraggon and Bodolica, 2008).

As far as the second sub-topic (KM-Tools), Grace (2009), and Razmerita and Kirchner (2011), Dotsika and Patrick (2013), Gresty (2013) show the opportunity offered by wikis. Lopez-Nicolas and Soto-Acosta (2010) identified intranet and webpages as KMSs to support organisational learning. Choundary (2013) and Gresty (2013) analyse the use of communication and collaborative tools. Similarly, Dotsika and Patrick (2013) illustrate some specific communication tools (email, blog, content management system), collaborative tools (social media) and management tools (database, document management system, project management system). Edvardsson (2009) and Rosu et al. (2009) suggest a knowledge based applications architecture based on the use of enterprise resource planning, customer relationship management, document management system, data mining and data warehouse. Beylier et al. (2009) analyse a prototype KM-Tool to improve knowledge creation and sharing. Finally, Lisanti and Luhukay (2014) and Zhou et al. (2014) design two different models of SMEs knowledge management system.

In summary, these 29 papers focus on specific KMSs but do not offer a comprehensive overview of the variety of KMSs used by SMEs. Then, *there is a clear need for a more thorough investigation of KM-Tools and KM-Practices employed by SMEs.* The above gap allows us to formulate the following research questions:

- *RQ5.1: What are the main KM-Tools adopted by SMEs?*
- *RQ5.2: What are the main KM-Practices adopted by SMEs?*

Area 6: KMSs in SME networks

The sixth area includes 4 papers focusing on KM-Tools adoption in SME networks. Specifically, Al-Mutawah et al. (2009) analyse the use of a multi-agent system (MAS) for tacit knowledge sharing among firms and perform some experiments to simulate the proposed approach.

Lockett et al. (2009) examine the adoption of knowledge database to facilitate the process of knowledge transfer within SME networks co-located in a higher education institution considered as a

centre of excellence for R&D. Perez-Araos et al. (2007) illustrate the use of an innovative KM-Tool currently at the stage of validation. The adoption of this tool allows SMEs to facilitate the creation of virtual networks and manage efficiently and effectively the created knowledge. Cagnazzo et al. (2014) provide a methodology to establish a knowledge management system in a SME network of 21 Italian firms through an action research approach. Content analysis of this area shows the need of an integrated approach to analyse *KMSs* that *are not analysed considering a set of tools and practices used by SME networks to improve the KM phases in terms of efficiency and effectiveness.* The analysis of the sixth topic allows the formulation of the following research questions:

- *RQ6.1: What are the main KM-Tools adopted by SME networks?*
- *RQ6.2: What are the main KM-Practices adopted by SME networks?*

3.5 Conclusions

This chapter has provided a systematic literature review on KM in SMEs and networks populated by SMEs. The review has been organised into three phases: sampling; classification; and content analysis.
The phase of sampling highlights that in recent years the trend of papers on the topic is growing.
The phase of classification underlines that the topic involves a variety of approaches, methodologies and models from different research areas. The content analysis was carried out considering two outlooks. The first was divided into three perspectives: the factors affecting KM; the impact of KM on firm's performance; and the knowledge management systems. The second concerns the unit of analysis and was divided into two groups: papers analysing the single SME; and papers focusing on SME networks. This partition has allowed us to identify six areas of investigation. The vast majority of papers deals with the single SME compared with papers that focus on the analysis of SME networks. This aspect is important because it highlights that while there is increasing literature on knowledge management in SMEs, is still neglected the issue of knowledge management in SME networks. This gap is particularly relevant considering that in the global economy, networks of SMEs are crucial not only for the competitiveness of individual enterprise, but also for the economic system as a whole. Regarding the three perspectives, it emerges that "Factors affecting KM" is the most analysed perspective while "KM and performance" is less studied. The content analysis highlights six main gaps in the literature from which were derived ten research questions. Four research questions regard the issue of KM in SMEs and six regard the topic of KM in SME networks.
As far as the KM in SMEs, the four research questions concern: the barriers hindering the adoption of KM in SMEs; the impact of KM on SMEs performance; the main KM-Tools adopted by SMEs; the main KM-Practices adopted by SMEs.
Regarding the issue of KM in Networks of SMEs, the six research questions are about: the contingency factors affecting the adoption of KM practices in SME networks; the critical success factors affecting

the adoption of KM in SME networks; the barriers hindering the spread of KM in SME networks; the impact of KM on SME networks performance; the main KM-Tools adopted by SME networks; the main KM-Practices adopted by SME networks.

The variety of gaps that emerges from this literature review points out that the framework of knowledge in the field of KM in SMEs and KM in networks populated by SMEs is still fragmented and many areas are still unexplored. Nevertheless, while in the field of KM in SMEs in the last few years the number of papers is greatly increased and, although fragmented, the framework is in evolution, the issue of KM in SME networks is still considerably unexplored. This finding is in line with what has already been highlighted by Durst and Edvardsson (2012) and Thorpe et al. (2005). However, since this chapter provides a complementary perspective to the two previous contributions, it offers opportunity to integrate their findings and draw a more comprehensive framework on the areas to be investigated in order to improve the body of knowledge in the field of KM in SMEs and in networks populated by SMEs.

References

Alegre J, Sengupta K and Lapiedra R (2011) Knowledge management and innovation performance in a high-tech SMEs industry *International Small Business Journal* 31(4), 454-470.

Ambrosini V and Bowman C (2008) Surfacing tacit sources of success *International Small Business Journal* 26(4), 403-431.

Al-Mutawah K, Lee V and Cheung Y (2009) A new multi-agent system framework for tacit knowledge management in manufacturing supply chains *Journal of Intelligent Manufacturing* 20(5), 593-610.

Anand A, Kant R and Singh MD (2013) Knowledge sharing in SMEs: modelling the barriers *International Journal of Management and Enterprise Development* 12(4-6), 385-410.

Bagnoli C and Vedovato M (2012) The impact of knowledge management and strategy configuration coherence on SME performance *Journal of Management & Governance* 16(4), 1-33.

Beck M and Schenker-Wicki A (2014) Cooperating with external partners: The importance of diversity for innovation performance *European Journal of International Management* 8(5), 548-569.

Beylier C, Pourroy F, Villeneuve F and Mille A (2009) A collaboration-centred approach to manage engineering knowledge: a case study of an engineering SME *Journal of Engineering Design* 20(6), 523-542.

Bocquet R and Mothe C (2010) Knowledge governance within clusters: the case of small firms *Knowledge Management Research & Practice* 8, 229-239.

Boden A, Avram G, Bannon L and Wulf V (2012) Knowledge sharing practices and the impact of cultural factors: reflections on two case studies of offshoring in SME *Journal of Software: Evolution and Process* 24(2), 139-152.

Briscoe G, Dainty ARJ and Millett S (2001) Construction supply chain partnerships: skills, knowledge and attitudinal requirements *European Journal of Purchasing & Supply Management* 7, 243-255.

Cagnazzo L, Tiacci L and Rossi V (2014) Knowledge Management System in SMEs within stable Enterprise Networks *WSEAS Transactions on Business and Economics* 11(1), 155-174.

Cappellin R (2003) Territorial knowledge management: towards a metrics of the cognitive dimension of agglomeration economies, *International Journal of Technology Management* 26(2-4), 303-325.

Chang CW, Chiang DM and Pai FY (2012) Cooperative strategy in supply chain networks *Industrial Marketing Management* 41, 1114-1124.

Chen CW, Chang ML and Tseng CP (2012) Human Factors of Knowledge-Sharing Intention among Taiwanese Enterprises: A Model of Hypotheses *Human Factors and Ergonomics in Manufacturing & Service Industries* 22(4), 362-371.

Chen CW, Chang ML, Tseng CP, Chen BC and Chang YYC (2013) Critical Human Factor Evaluation of Knowledge Sharing Intention in Taiwanese Enterprises *Human Factors and Ergonomics in Manufacturing & Service Industries* 23(2), 95-106.

Chong CW, Chong SC and Gan GC (2011) Inter-organizational knowledge transfer needs among small and medium enterprises *Library Review* 60(1), 37-52.

Choudhary AK, Harding J, Camarinha-Matos LM, Lenny Koh SC and Tiwari MK (2013) Knowledge management and supporting tools for collaborative networks *International Journal of Production Research* 51(7), 1953-1957.

Corso M, Martini A, Pellegrini L and Paolucci E (2003) Technological and Organizational Tools for Knowledge Management: In Search of Configurations *Small Business Economics* 21(4), 397-408.

Daud S and Yusoff WFW (2011) How intellectual capital mediates the relationship between knowledge management processes and organizational performance?" *African Journal of Business Management* 5(7), 2607-2617.

Davenport S (2005) Exploring the role of proximity in SME knowledge-acquisition *Research Policy* 34(5), 683-701.

Delen D, Zaim H, Kuzey C and Zaim S (2013) A comparative analysis of machine learning systems for measuring the impact of knowledge management practices *Decision Support Systems* 54(2), 1150-1160.

Deng PS (2008) Applying a Market-Based Approach to the Development of a Sharing-Enabled KM Model for Knowledge-Intensive Small Firms *Information Systems Management* 25(2), 174-187.

De Saá-Pérez P, Díaz-Díaz NL and Ballesteros-Rodríguez JL (2012) The role of training to innovate in SMEs *Innovation: Management, Policy & Practice* 14(2), 218-230.

Desouza KC and Awazu Y (2006) Knowledge management at SMEs: five peculiarities *Journal of Knowledge Management* 10(1), 32-43.

du Plessis M (2008) The strategic drivers and objectives of communities of practice as vehicles for knowledge management in small and medium enterprises *International Journal of Information Management* 28(1), 61-67.

Dotsika F and Patrick K (2013) Collaborative KM for SMEs: a framework evaluation study *Information Technology & People* 26(4) 368-382.

Durst S and Edvardsson IR (2012) Knowledge management in SMEs: a literature review *Journal of Knowledge Management* 16(6), 879-903.

Durst S and Wilhelm S (2011) Knowledge management in practice: insights into a medium sized enterprise's exposure to knowledge loss *Prometheus: Critical Studies in Innovation* 29(1), 23-38.

Durst S and Wilhelm S (2012) Knowledge management and succession planning in SMEs *Journal of knowledge management* 16(4), 637-649.

Dyer JH and Hatch NW (2006) Relation-specific capabilities and barriers to knowledge transfers: Creating advantage through network relationships *Strategic Management Journal* 27(8), 701-719.

Edvardsson IR (2009) Is knowledge management losing ground? Developments among Icelandic SMEs *Knowledge Management Research & Practice* 7, 91-99.

Edwards T (2007) A critical account of knowledge management: agentic orientation and SME innovation *International Journal of Entrepreneurial Behaviour & Research* 13(2), 64-81.

Egbu CO, Hari S and Renukappa SH (2005) Knowledge management for sustainable competitiveness in small and medium surveying practices, *Structural Survey* 23(1), 7-21.

Esper TL, Ellinger AE, Stank TP, Flint DJ and Moon M (2010) Demand and supply integration: a conceptual framework of value creation through knowledge management *Journal of the Academy of Marketing Science* 38(1), 5-18.

Esposito E and Passaro R (1997) Material Requirement Planning and supply chain at Alenia Aircraft *European Journal of Purchasing and Supply Management* 3(1), 43-51.

Esposito E and Raffa M (1994) The evolution of Italian subcontracting firms: empirical evidence European Journal of Purchasing and Supply Management 1(2), 67-76.

Eze UC, Goh GGG, Goh CY and Tan TL (2013) Perspectives of SMEs on knowledge sharing *VINE* 43(2), 210-236.

Filippini R, Guttel WH and Nosella A (2012) Dynamic capabilities and the evolution of knowledge management projects in SMEs *International Journal Technology Management* 60(3-4), 203-219.

Fink K and Ploder C (2009) Knowledge Management Toolkit for SMEs *International Journal of Knowledge Management* 5(1), 46-60.

Frey RS (2001) Knowledge management, proposal development, and small businesses *The Journal of Management Development* 20(1), 38-54.

Genovese A, Lenny Koh SC and Acquaye A (2013) Energy efficiency retrofitting services supply chains: Evidence about stakeholders and configurations from the Yorskhire and Humber region case *International Journal of Production Economics* 144(1), 20-43.

Gholami MH, Asli MN, Nazari- Shirkouhi S and Noruzy A (2013) Investigating the Influence of Knowledge Management Practices on Organizational Performance: An Empirical Study *Acta Polytechnica Hungarica* 10(2), 205-216.

Gholipour R, Jandaghi G and Hosseinzadeh SAA (2010) Explanation of knowledge management enabler as a latent variable: A case study of SMEs in Iran *African Journal of Business Management* 4(9), 1863-1872.

Grace TPL (2009) Wikis as a knowledge management tool *Journal of Knowledge Management* 13(4), 64-74.

Gresty M (2013) What role do information systems play in the knowledge management activities of SMEs? *Business Information Review* 30(3), 144-151.

Gunasekaran A and Ngai EWT (2007) Knowledge management in 21st century manufacturing *International Journal of Production Research* 45(11), 2391-2418.

Gupta NA, Jaiswal MPA and Pardasani RB (2014) Teaching case: Managing knowledge and going global at FragraAroma *Management Decision* 52(9), 1630-1648.

Heavin CA and Adam FB (2014) From knowledge activities to knowledge scenarios: Cases in five

Irish software SMEs International *Journal of Management and Enterprise Development* 13(1), 37-61.

Hong PA, Park YWB, Choi SBC and Shin GCD (2014) Achieving knowledge management excellence for competitive advantage: An integrative model for empirical research *International Journal of Knowledge Management Studies* 5(3-4), 285-303.

Hsu RG, Lawson D and Liang TP (2007) Factors affecting knowledge management adoption of Taiwan small and medium-sized enterprises *International Journal Management and Enterprise Development* 4(1), 31-51.

Hussain I, Xiaoyu YU, Wang L, Si S and Ahmed S (2011) Organizational knowledge management capabilities and Knowledge management success (KMS) in small and medium enterprises (SMEs) *African Journal of Business Management* 5(22), 8971-8979.

Hutchinson V and Quintas P (2008) Do SMEs do knowledge management? Or Simply Manage what they Know? *International Small Business Journal* 26(2), 131-154.

Jones O, Macpherson A and Thorpe R (2010) Learning in owner-managed small firms: Mediating artefacts and strategic space *Entrepreneurship & Regional Development* 22(7–8), 649-673.

Joshi Y, Parmer S and Chandrawat SS (2012) Knowledge Sharing in Organizations: Modeling the Barriers, an Interpretive Structural Modeling Approach *International Journal of Engineering and Innovative Technology* 2(3), 207-214.

Kolbe RH and Burnett MS (1991) Content-analysis research: an examination of applications with directives for improving research reliability and objectivity *Journal of Consumer Research* 18(2), 243-250.

Lakshman C and Parente RC (2008) Supplier-focused knowledge management in the automobile industry and its implications for product performance *Journal of Management Studies* 45(2), 317-342.

Lee AHI, Wang WM and Lin TY (2010) An evaluation framework for technology transfer of new equipment in high technology industry *Technological Forecasting and Social Change* 77(1), 135-150.

Lee MR and Lan YC (2011) Toward a unified knowledge management model for SMEs *Expert Systems with Applications* 38(1), 729-735.

Levy M, Loebbecke C and Powell P (2003) SMEs, co-opetition and knowledge sharing: the role of information systems *European Journal of Information Systems* 12(1), 3-17.

Li T and Cavusgil ST (1995) A classification and assessment of research streams in international marketing *International Business Review* 4(3), 251-277.

Lin I, Seidel R, Shekar A, Shahbazpour M, and Howell D (2012) Knowledge Sharing Differences Between Engineering Functional Teams: An Empirical Investigation *Journal of Information & Knowledge Management* 11(3), 1-14.

Lin HF (2014) Contextual factors affecting knowledge management diffusion in SMEs I*ndustrial Management and Data Systems* 114(9), 1415-1437.

Lisanti Y and Luhukay D (2014) The design of knowledge management system model for SME (UKM) *Journal of Theoretical and Applied Information Technology* 64(3), 746-755.

Liu Y and Abdalla AN (2013) Evaluating the managerial behavior of managing knowledge in Chinese SMEs *Information Technology and Management* 14(2), 159-165.

Lockett N, Cave F, Kerr R and Robinson S (2009) The influence of co-location in higher education institutions on small firms' perspectives of knowledge transfer *Entrepreneurship & Regional Development* 21(3), 265-283.

Lopez-Nicolas C and Soto-Acosta P (2010) Analyzing ICT adoption and use effects on knowledge creation: An empirical investigation in SMEs *International Journal of Information Management* 30(6), 521-528.

Martinez-Costa M and Jimenez-Jimenez D (2009) The effectiveness of TQM The key role of organizational learning in small businesses *International Small Business Journal* 27(1), 98-125.

Massa S and Testa S (2011) Knowledge domain and innovation behaviour *VINE* 41(4), 483-454.

McAdam R and Reid R (2001) SMEs and large organisation perceptions of knowledge management: comparisons and contrasts *Journal of Knowledge Management* 5(3), 231-241.

Migdadi M (2008) Knowledge management enablers and outcomes in the small-and-medium sized enterprises *Industrial Management & Data Systems* 109(6), 840-858.

Milosz M and Milosz E (2010) Critical success factors and barriers to implementation of knowledge management systems at polish SMEs *Actual Problems of Economics* 6, 309-315.

Moffett S and McAdam R (2006) The effects of organizational size on knowledge management implementation: Opportunities for small firms? *Total Quality Management* 17(2), 221-241.

Mohannak K (2014) Challenges of knowledge integration in small and medium enterprises *Knowledge Management and E-Learning* 6(1), 66-82.

Montequín VR, Fernández FO, Cabal VA and Gutierrez NR (2006) An integrated framework for intellectual capital measurement and knowledge management implementation in small and medium-sized enterprises *Journal of Information Science* 32(6), 525-538.

Navarro JGC, Dewhurst FW and Eldridge S (2010) Linking chief knowledge officers with customer capital through knowledge management practices in the Spanish construction industry *The International Journal of Human Resource Management* 21(3), 389-404.

Noblet JP and Simon E (2012) The role of disseminative capacity in knowledge sharing: which model can be applied to SMEs? *Problems and Perspectives in Management* 10(3), 57-66.

Nonaka I (1994) A Dynamic Theory of Organizational Knowledge Creation *Organization Science* 5(1), 14-37.

Nunes MP, Annansingh F and Eaglestone B (2006) Knowledge management issues in knowledge-intensive SMEs *Journal of Documentation* 62(1), 101-119.

Omerzel DG and Antončič B (2008) Critical entrepreneur knowledge dimensions for the SME performance *Industrial Management & Data Systems* 108(9), 1182-1199.

Patalas-Maliszewska J and Hochmeister M (2011) Modeling Strategic-Knowledge-Resource Management Based on Individual Competencies in SMEs *Contemporary Economics* 5(2), 72-79.

Perez-Araos A, Barber KD, Munive-Hernandez JE and Eldridge S (2007) Designing a knowledge management tool to support knowledge sharing networks *Journal of Manufacturing Technology Management* 18(2), 153-168.

Pillania RK (2006) Leveraging knowledge for sustainable competitiveness in SMEs *International Journal of Globalisation and Small Business* 1(4), 393-406.

Pillania RK (2008a) Creation and categorization of knowledge in automotive components SMEs in India *Management Decision* 46(10), 1452-1464.

Pillania RK (2008b) Strategic issues in knowledge management in small and medium enterprises *Knowledge Management Research & Practice* 6, 334-338.

Pool JK.A, Asadi AA, Forte PB and Ansari MRA (2014) The effect of organisational culture on attitude and intention toward knowledge sharing: A study of Iranian SMEs *International Journal of Management and Decision Making* 13(3), 286-301.

Purcarea I, del Mar Benavides Espinosa M and Apetrei A (2013) Innovation and knowledge creation: perspectives on the SMEs sector *Management Decision* 51(5), 1096-1107.

Razmerita L and Kirchner K (2011) How wikis can be used to manage knowledge in SMEs: A case study *Business Information Review* 28(3), 175-178.

Rosu SM, Dragoi G and Guran M (2009) A Knowledge Management Scenario to Support Knowledge Applications Development in Small and Medium Enterprises *Advances in Electrical and Computer Engineering* 9(1), 8-15.

Roxas BA, Battisti MB and Deakins DB (2014) Learning, innovation and firm performance: Knowledge management in small firms *Knowledge Management Research and Practice* 12(4), 443-453.

Roy MJ and Therin F (2008) Knowledge Acquisition and Environmental Commitment in SMEs *Corporate Social Responsibility and Environmental Management* 15(5), 249-259.

Salojärvi S, Furu P and Sveiby KE (2005) Knowledge management and growth in Finnish SMEs *Journal of Knowledge Management* 9(2), 103-122.

Saxena A and Wadhwa S (2009) Flexible configuration for seamless supply chains: Directions towards decision knowledge sharing *Robotics and Computer-Integrated Manufacturing* 25, 839-852.

Samuel KE, Goury ML, Gunasekaran A and Spalanzani A (2011) Knowledge management in supply chain: an empirical study from France *Journal of Strategic Information Systems* 20(3), 283-306.

Soon TT and Zainol FA (2011) Knowledge Management Enablers, Process and Organizational Performance: Evidence from Malaysian Enterprises *Asian Social Science* 7(8), 186-202.

Soto-Acosta PA, Colomo-Palacios RB and Popa SA (2014) Web knowledge sharing and its effect on innovation: An empirical investigation in SMEs *Knowledge Management Research and Practice* 12(1), 103-113.

Sparrow J (2001) Knowledge management in small firms *Knowledge and Process Management* 8(1), 3-16.

Spraggon M and Bodolica V (2008) Knowledge creation processes in small innovative hi-tech firms *Management Research News* 31(11), 879-894.

Talebi K and Tajeddin M (2011) The adoption of new and innovative knowledge by small and medium enterprises of Iran: Opportunities and constraints for growth *African Journal of Business Management* 5(1), 39-49.

Tan B and Hung H (2006) A knowledge management system introduction model for small- and medium-sized enterprises *International Journal Management and Enterprise Development* 3(1-2), 53-69.

Thorpe R, Holt R, Macpherson A and Pittaway L (2005) Using knowledge within small and medium-sized firms: a systematic review of the evidence *International Journal of Management Reviews* 7(4), 257-281.

Tseng CP, Chang ML and Chen CW (2012) Human Factors of Knowledge Sharing Intention among Taiwanese Enterprises: A Preliminary Study *Human Factors and Ergonomics in Manufacturing & Service Industries* 22(4), 328-339.

Vajjhala NRA and Baghurst TB (2014) Influence of cultural factors on knowledge sharing in medium-sized enterprises within transition economies *International Journal of Knowledge Management Studies* 5(3-4), 304-321.

Valmohammadi C (2010) Investigation and assessment of critical success factors of knowledge management implementation in Iranian small-to-medium sized enterprises *Journal of Applied Sciences* 10(19), 2290-2296.

Wee JCN and Chua AYK (2013) The peculiarities of knowledge management processes in SMEs: the case of Singapore *Journal of Knowledge Management* 17(6), 958-972.

Wei CC, Choy CS and Chew GG (2011) The KM processes in Malaysian SMEs: an empirical validation *Knowledge Management Research & Practice* 9(2), 185-196.

Whyte G, Classen S (2012) Using storytelling to elicit tacit knowledge from SMEs *Journal of Knowledge Management* 16(6), 950-962.

Wong KY and Aspinwall E (2005) An empirical study of the important factors for knowledge-management adoption in the SME sector *Journal of Knowledge Management* 9(3), 64-82.

Wong KY (2005) Critical Success factors for implementing knowledge management in small and medium enterprises *Industrial Management & Data Systems* 105(3), 261-279.

Yao L, Othman A, Abdalla AN and Jing W (2011) A novel sense-making model of effective knowledge management within SMEs *African Journal of Business Management* 5(11), 4423-4431.

Zapata Cantù L, Criado JR and Criado AR (2009) Generation and transfer of knowledge in IT-related SMEs *Journal of Knowledge Management* 13(5), 243-256.

Zieba M and Zieba K (2014) Knowledge management critical success factors and the innovativeness of KIBS companies *Engineering Economics* 25(4), 458-465.

Zhou Y, Zhan H and Zhang Y (2014) Design and development of knowledge management platform for SMEs *Journal of Chemical and Pharmaceutical Research* 6(7), 1035-1041.

4. The Spread of Knowledge Management in SMEs: A Scenario in Evolution

4.1 Abstract

This chapter deals with knowledge management (KM) in small and medium enterprises (SMEs). Through a literature review, three research questions have been identified concerning the barriers hindering the spread of KM practices in SMEs, the main knowledge management systems (KMSs) adopted by SMEs and the impact of the use of KM practices on SME performance. The research questions were subsequently addressed through a field analysis conducted on a sample of SMEs. The empirical evidence highlights that the scenario has changed in the space of a few years. Although SMEs are generally characterized by poor financial and human resources, they are able to overcome the barriers preventing the spread of KM practices. The SMEs investigated perceive the strategic value of KM and consequently adopt a variety of KMSs. Nevertheless, such systems are generally outdated in comparison with cheaper, more recent, and user-friendly applications. Finally, the chapter emphasizes that the use of KM practices can contribute to the overall growth of SMEs by simultaneously and significantly enhancing their performance.

Keywords - barriers; knowledge management systems; literature; performance.

4.2 Introduction

The spread of organizational forms based on intensive collaborative relationships among small and medium enterprises (SMEs) (virtual enterprise, cluster, *etc.*) and between large companies and SMEs (vertical relationships, supply chain, *etc.*) has generated competitive and dynamic environments where knowledge fertilization in SMEs is increasingly crucial in supporting the network of collaboration and the competitiveness of the whole system (Al-Mutawah et al., 2009; Dyer and Hatch, 2006; Esper et al., 2010; Esposito and Passaro, 1997; Esposito and Raffa, 1994; Genovese et al., 2013; Gunasekaran and Ngai, 2007; Lakshman and Parente, 2008; Lee et al., 2010; Samuel et al., 2011). Nevertheless, there is an abundance of studies describing how large companies are successfully exploiting knowledge management (KM) practices, while SMEs show poor use KM practices, and the benefits of KM adoption are not fully exploited by these firms (Alavi and Leidner, 2001; Durst and Edvardsson, 2012; Marra et al., 2012; Thorpe et al., 2005). Although there are many studies that analyze the processes of dissemination of knowledge and highlight the adoption of KM in large companies, as regards SMEs, the framework of knowledge is still fragmented. Moreover, the degree of adoption of KM is not homogeneous and there are still profound differences among various industries (Hung et al., 2011).
Several researches highlight that the factors preventing the adoption of practices and strategies of knowledge management by SMEs are, directly or indirectly, connected to the following three aspects (Desouza and Awazu, 2006; Egbu et al., 2005; Frey, 2001; McAdam and Reid, 2001; Pillania, 2006 and 2008a; Sparrow, 2001; Wong, 2005; Wong and Aspinwall, 2005):

- In SMEs, the nature of knowledge is mainly human embedded;
- In SMEs, there is a sort of common knowledge, which is a knowledge shared by all members of the organization;
- The chronic shortage of human and financial resources that characterizes SMEs.

Even though these three aspects seem to explain the factors that have so far hindered the adoption of practices of KM in SMEs, it should be emphasized that Information and Communication Technologies (ICTs) are increasingly offering SMEs new tools that are (Antonelli et al., 2000; Esposito and Mastroianni, 1998 and 2001; Garrigos-Simon et al., 2012; Matlay and Westhead, 2005):

- low cost. This means knowledge management systems (KMSs) that do not require significant financial investments;
- ease-of-use. ICTs provide KMSs that do not need specific skills;
- more effective. Compared with traditional tools, new ones are able to support the processes of socialization among members of a group.

In summary, on the one hand, the literature highlights the factors that have prevented SMEs adopting KM practices. On the other hand, ICTs are weakening the weight of these factors, reducing the human and financial barriers that hinder their adoption.

This aspect emphasizes that the scenario is in an evolutionary phase, and although the number of papers regarding knowledge management in SMEs is increasing, further research efforts are still needed (Durst and Edvardsson, 2012).

With this in mind, the aim of this chapter is to make a contribution to increasing the body of knowledge in the field of KM in SMEs by investigating three issues that emerge from the literature. The first regards the barriers hindering the spread of KM practices in SMEs, the second concerns the impact of KM practices on SMEs' performance, and the third looks at the adoption of knowledge management systems (KMSs) by SMEs. These three issues have been addressed through a field analysis conducted on a sample of SMEs operating in high-tech and/or complex industries.

The chapter is organized into five sections. Following this introduction, the second section deals with the literature review on KM in SMEs. The third section describes the context of investigation and the methodology. The main findings emerging from the field analysis are presented and discussed in the fourth section. Finally, conclusions and implications are illustrated.

4.3 Literature Review

The main objective of this section is to analyze state-of-the-art of knowledge management in SMEs from the management perspective in order to identify research gaps. For this purpose, we adopt a systematic review approach adapted by Pittaway et al. (2004), Petticrew and Roberts (2006) and Easterby-Smith et al. (2012).

Pittaway et al. (2004) propose a systematic literature review organized into 10 steps: identification of key words; construction of search strings; initial search and identification of further key words; choosing the citation databases; review of the selected citation databases using the search strings; review of the citations identified based on inclusion and exclusion criteria; review of the citation abstracts and separation into different lists; encoding abstracts according to their content; reviewing significant papers; the addition of further papers, based on professional recommendation and references from reviewed papers.

Petticrew and Roberts (2006) define a systematic review process organized into 12 steps: define the question; consider drawing together a steering or advisory group; write a protocol and have it reviewed; carry out the literature search; screen the references; assess the remaining studies against the inclusion/exclusion criteria; data extraction; critical appraisal; synthesis of the primary studies; consider the effects of publication bias, and other internal and external biases; write up the report; wider dissemination.

Easterby-Smith et al. (2012) identify 5 steps in carrying out a systematic review: planning the review; identifying and evaluating studies; extracting and synthesizing data; reporting; utilizing the findings.

Summarizing the above contributions, a systematic study of the existing body of knowledge of the above topic has been carried out along the following the four main phases: (1) material comprehensive search; (2) selection of papers; (3) descriptive analysis; and (4) content analysis.

The review was carried out using Scopus and Web of Science Academic databases, which ensure a wide coverage of scientific output as they contain more than 8000 scientific journals, including the most important high-ranking journals.

4.3.1. Material Comprehensive Search

This phase aimed to identify all relevant scientific output covering the topic of knowledge management in SMEs. The literature review spans the years 1960–2014 and the search was conducted using the keywords "knowledge management", "KM", "knowledge adoption", "knowledge development", "knowledge acquisition", "knowledge creation", "knowledge storage", "knowledge transfer", "knowledge sharing", "knowledge exchange", "knowledge application", "knowledge reuse", "knowledge re-use", in combination with "SME *" or "small firm *" or "small business *". This allowed us to identify 428 papers included in the subject areas of the social sciences and humanities (*i.e.*, business management and accounting, social sciences, decision sciences, computer science, engineering, multidisciplinary).

4.3.2. Selection of Papers

In order to select only the papers concerning the aim of this section, two criteria for the inclusion/exclusion of research products were defined. The first criterion follows the approach proposed by Pittaway et al. (2004). It allowed us to select only those papers whose abstracts focus on knowledge management SMEs. In order to achieve this objective, abstracts of the 428 papers were read in parallel by two different researchers, plus a third one in case of uncertainty.

The second criterion is related to the focus of the paper. For this purpose papers were read in full by two researchers. In the case of conflicting judgements, a third researcher was involved in the selection process. The selection process allowed 341 papers to be excluded. At the end of this stage, 87 papers were selected and studied in detail.

4.3.3. Descriptive Analysis

The descriptive analysis of the papers aims to give an overview of the papers that deal with the topic of knowledge management in SMEs. For the evaluation of the 87 selected papers, two descriptive perspectives were identified:

(1) Papers over time;

(2) Papers by journal subject areas.

According to the distribution of papers over time (Figure 1), thirteen of the selected papers were published in 2011 and 2014. Then a significant percentage of papers belongs to the years 2012 and 2013 with 11 papers. Specifically, there are 13 papers written between 2003 and 2006, 26 papers from 2007 to 2010, and 48 papers from 2011 to 2014.

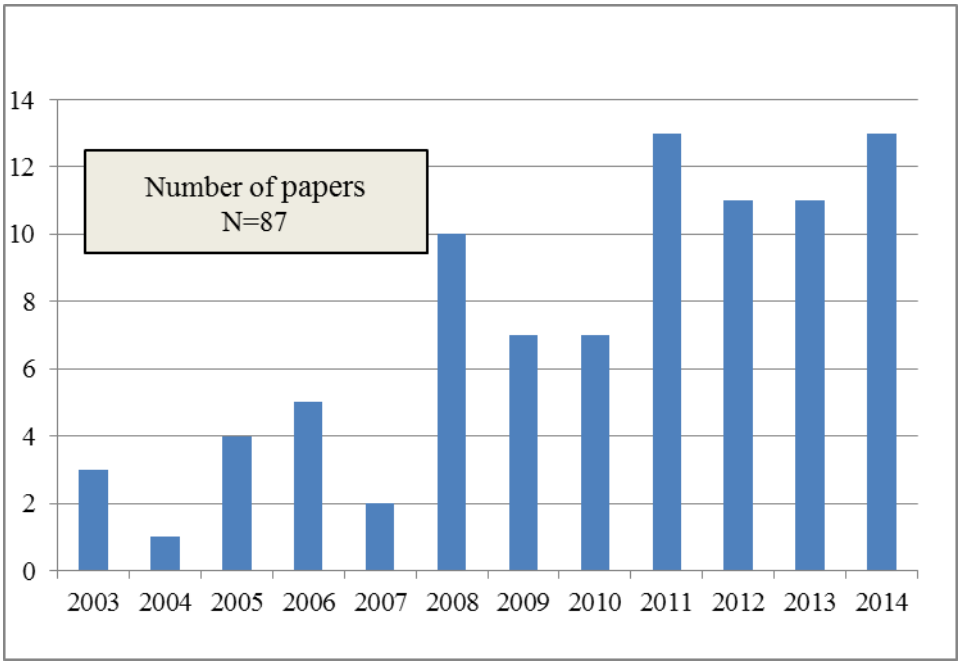


Figure 1. Paper distribution over time

The trend of papers on this topic has thus seen growth over recent years. This conclusion is in line with Serenko (2013), who shows how KM research has progressed through three distinct phases: Initiation (1997–2001), Early Development (2002–2006), and Rigor and Consolidation (2007–2012).
Regarding paper distribution by journal subject areas, the papers identified were grouped into the following four areas: (a) Engineering (6 papers); (b) Computer science and information systems (8 papers); (c) Operations research and business science (59 papers); and (d) Multidisciplinary (14 papers). The distribution of papers by journal subject area testifies that knowledge management involves a variety of approaches, methodologies and models from different research areas.

4.3.4. Content Analysis

In this phase, the papers selected were studied in detail, and the following three main topics were identified (Table 1):

(1) *Factors affecting KM, i.e.*, the set of factors that positively or negatively influence the implementation of KM in SMEs (41 papers - 47.1%)
(2) *Systems supporting KM*; this topic encompasses all the papers included in the sample that highlight how KM is implemented in terms of practices and tools (29 papers - 33.3%)
(3) *KM and performance*; this topic includes papers dealing with the impact of KM on firm performance (17 papers - 19.6%)

In the following paragraphs, the three main topics will be analyzed in detail.

4.3.4.1. Factors Affecting Knowledge Management

As far as the first topic is concerned, analysis of the 41 papers shows that it is possible to identify three sub-topics:

- *Contingency Factors*, *i.e.*, environmental and historical factors influencing the implementation of KM in SMEs (9 papers)
- *Critical Success Factors* (CSFs), namely factors that may influence the success of KM implementation (28 papers)
- *Barriers hindering KM*; factors hindering KM diffusion (4 papers).

From the nine papers regarding the *Contingency Factors*, it clearly emerges that KM processes are influenced by a variety of factors that may be grouped into three main categories: *Industrial organization*, which includes the agglomeration economies (Cappellin, 2003, Heavin and Adam, 2014; Purcarea, 2013) and industrial characteristics (Hsu et al., 2007); *Environmental factors, i.e.*, social

context (Edwards, 2007; Soto-Acosta et al., 2014), environmental commitment (Roy and Therin, 2008), geographic proximity to the knowledge sources (Davenport, 2005), *and Firm specific factors,* namely international interactions and organizational proximity (Davenport, 2005; Soto-Acosta et al., 2014), and organization size (Moffett and McAdam, 2006).

Table 1. Papers by topic and sub-topic

Topic 1: Factors Affecting KM	Topic 2: Systems Supporting KM	Topic 3: KM and Performance
Contingency factors (9 papers)	**KM-Practices (18 papers)**	
Cappellin (2003)	Ambrosini and Bowman (2008)	Alegre *et al.* (2011)
Davenport (2005)	Chong *et al.* (2011)	Bagnoli and Vedovato (2012)
Edwards (2007)	Corso *et al.* (2003)	Beck and Schenker-Wicki (2014)
Heavin and Adam (2014)	Desouza and Awazu (2006)	Daud and Yusoff (2011)
Hsu *et al.* (2007)	du Plessis (2008)	Delen *et al.* (2013)
Moffett and McAdam (2006)	Durst and Wilhelm (2011)	Egbu *et al.* (2005)
Purcarea (2013)	Durst and Wilhelm (2012)	Filippini *et al.* (2012)
Roy and Therin (2008)	Fink and Ploder (2009)	Gholami *et al.* (2013)
Soto-Acosta *et al.* (2014)	Hutchinson and Quintas (2008)	Gupta *et al.* (2014)
Critical success factors (28 papers)	Levy *et al.* (2003)	Hong *et al.* (2014)
Bocquet and Mothe (2010)	Lin *et al.* (2012)	Liu and Abdalla (2013)
Boden *et al.* (2012)	Massa and Testa (2011)	Omerzel and Antončič (2008)
Chen *et al.* (2012)	Navarro *et al.* (2010)	Roxas *et al.* (2014)
Chen *et al.* (2013)	Noblet and Simon (2012)	Salojärvi *et al.* (2004)
De Saá-Pérez (2012)	Pillania (2008a)	Soon and Zainol (2011)
Deng (2008)	Spraggon and Bodolica (2008)	Talebi and Tajeddin (2011)
Eze (2013)	Whyte and Classen (2012)	Wei *et al.* (2011)
Gholipour *et al.* (2010)	Yao *et al.* (2011)	
Hussain *et al.* (2011)	**KM-Tools (11 papers)**	
Jones *et al.* (2010)	Beylier *et al.* (2009)	
Lee and Lan (2011)	Choudhary (2013)	
Lin (2014)	Dotsika and Patrick (2013)	
Martinez-Costa and Jimenez-Jimenez, (2009)	Edvardsson (2009)	
Migdadi (2008)	Grace (2009)	
Mohannak (2014)	Gresty (2013)	
Montequin *et al.* (2006)	Lisanti and Luhukay (2014)	
Patalas-Maliszewska and Hochmeister (2011)	Lopez-Nicolas and Soto-Acosta (2010)	
Pillania (2008 b)	Razmerita and Kirchner (2011)	
Pool *et al.* (2014)	Rosu *et al.* (2009)	
Tan and Hung (2006)	Zhou (2014)	
Tseng *et al.* (2012)		
Vajjhala and Baghurst (2014)		
Valmohammadi (2010)		
Wee and Chua (2013)		
Wong (2005)		
Wong and Aspinwall (2005)		
Zapata Cantù *et al.* (2009)		
Zieba and Zieba (2014)		
Barriers to KMSs adoption (4 papers)		
Anand (2013)		
Joshi (2012)		
Milosz and Milosz (2010)		
Nunes *et al.* (2006)		

The 28 papers concerning *Critical Success Factors* offer a comprehensive framework of the factors that affect KM adoption and show that they may be classified into three main categories: *Human and cultural factors*, which includes human resources, people skill, motivation, training and education, a culture of collaboration and trust (Boden et al., 2012; Chen et al., 2012; Deng, 2008; De Saá-Pérez, 2012; Eze, 2013; Gholipour et al., 2010; Hussain et al., 2011; Lee and Lan, 2011; Migdadi, 2008; Montequin et al., 2006; Patalas-Maliszewska and Hochmeister, 2011; Tan and Hung., 2006; Vajjhala and Baghurst, 2014; Valmohammadi, 2010; Wee and Chua, 2013; Wong, 2005; Wong and Aspinwall, 2005; Zapata Cantù et al., 2009), *Technical factors*, namely the degree of IT applications, the information system, infrastructure, degree of KM adoption, Total Quality Management practices (Eze, 2013; Hussain et al., 2011; Lee and Lan, 2011; Lin, 2014; Migdadi, 2008; Montequin et al., 2006; Tan and Hung., 2006; Valmohammadi, 2010; Wong, 2005; Wong and Aspinwall, 2005) and Managerial factors, *i.e.*, cultivating trust, KM strategy, integrating KMS with staff, management style, management leadership, internal and external network relationships, organizational infrastructure, physical networks, teamwork, and rewarding (Bocquet and Mothe, 2010; Chen et al., 2012; Chen et al., 2013; Deng, 2008; Eze, 2013; Hussain et al., 2011; Jones et al., 2010; Lee and Lan, 2011; Lin, 2014; Martinez-Costa and Jimenez-Jimenez, 2009; Migdadi, 2008; Mohannak, 2014; Montequin et al., 2006; Patalas-Maliszewska and Hochmeister, 2011; Pillania, 2008b; Pool et al. 2014; Tan and Hung, 2006; Tseng et al., 2012; Valmohammadi, 2010; Wee and Chua, 2013; Wong, 200; Wong and Aspinwall , 2005; Zieba and Zieba, 2014).

Finally, the four papers dealing with the barriers hindering KM diffusion highlight just two main issues. Some authors identify the *cultural issues* (knowledge transfer, knowledge sharing, and intellectual property) Anand et al., (2013), Joshi et al., (2012) and Milosz and Milosz (2010), whereas others highlight the *financial issues* (return on investment and long term investments always have lower priority than short term investment) Nunes et al. (2006). It is important to stress that these two papers do not consider the managerial issues, the role of human resources, or the nature of the knowledge that SMEs possess that could represent potential barriers to the spread of KM practices.

In summary, as far as the first topic is concerned, there is a wide literature on the aspects concerning the factors that can influence the success of KM implementation. This literature has also identified a variety of contingency factors (industrial, environmental and firm specific) and a substantial number of CSFs that may be attributed to three main categories (human and cultural, technical, managerial). In contrast, there are only four papers which analyze the barriers preventing the adoption of KM practices. Even though these four papers pick out some cultural and financial factors, it seems evident that we need a more detailed analysis and more empirical evidence on this subject. Analysis of the first topic allows the formulation of the following research question:

- **RQ1**: What are the major barriers hindering the spread of knowledge management practices in SMEs?

4.3.4.2. Systems Supporting Knowledge Management in SMEs

With reference to the second topic (systems supporting KM), the 29 papers were divided into two sub-topics (see Table 1): *Knowledge management practices*, that may be defined as the set of methods and techniques to support and enhance the organizational processes of knowledge creation, storage, transfer/sharing, and application (18 papers), and *Knowledge management tools*, that may be defined as the specific IT-based systems supporting KM methods and techniques (11 papers).

As for the 18 papers included in the first sub-topic (knowledge management practices), these evidence the variety of KM methods and techniques relating to the nature of knowledge (tacit or explicit) and/or the process of knowledge management (e.g., identification, capture, storage, mapping, dissemination and creation). All papers converge towards the fact that knowledge in SMEs is mainly embedded in the human resource and that socialization is dominant in the SECI cycle (Nonaka, 1994). Thus, it is not surprising that most of the practices are oriented toward the management of tacit knowledge. Some authors (Chong et al., 2011; Desouza and Awazu, 2006; du Plessis, 2008; Lin et al., 2012; Massa and Testa, 2011; Navarro et al., 2010; Noblet and Simon, 2012; Pillania 2008a; Spraggon and Bodolica, 2008; Whyte and Classen, 2012; Yao et al. 2011) suggest a variety of people-centered practices such as: Focus groups, formal meetings, communities of sharing, virtual communities, informal networks, project teams, interactions with clients, interactions with suppliers, interactions with partners, communities of practices, job rotation, training. Moreover, even though Hutchinson and Quintas (2008) underline that small firms are more likely to adopt informal processes to manage knowledge, other authors (Ambrosini and Bowman, 2008; Durst and Wilhelm, 2011, 2012; Fink and Ploder, 2009; Levy et al., 2003) also suggest the importance of more formal techniques and methods (such as: casual mapping, knowledge maps, balance scorecards, formal manuals), while others suggest establishing a chief knowledge officer (Navarro et al., 2010) or a project team (Corso et al. 2003; Spraggon and Bodolica, 2008).

As far as the second sub-topic (KM-Tools) is concerned, Grace (2009), Dotsika and Patrick (2013), Gresty (2013), and Razmerita and Kirchner (2011) show the opportunities offered by wikis. Lopez-Nicolas and Soto-Acosta (2010) identified intranet and webpages as KMSs to support organizational learning. Choundary *et al.* (2013) and Gresty (2013) analyze the use of communication and collaborative tools. Similarly, Dotsika and Patrick (2013) illustrate some specific communication tools (email, blog, content management systems), collaborative tools (social media) and management tools (database, document management systems, project management systems). Edvardsson (2009) and Rosu et al. (2009) suggest a knowledge-based applications architecture centered on the use of enterprise resource planning, customer relationship management, a document management system, data mining and the use of data warehouses. Beylier et al. (2009) analyze a prototype KM-Tool to improve knowledge creation and sharing. Finally, Lisanti and Luhukay (2014) and Zhou et al. (2014) design two different models of SME knowledge management system. In summary, these 29 papers focus on specific KMSs, but do not offer a comprehensive overview of the variety of KMSs used by SMEs.

Thus, there is a clear need for a deeper analysis of the KMSs used by SMEs. The above allows us to formulate the following research question:

- **RQ2**: What are the main knowledge management systems adopted by SMEs?

4.3.4.3. Knowledge Management and Performance

As regards the third topic, analysis of the papers highlights that the implementation process of KM in SMEs may impact on the following performance (Table 2): *economic and financial performance* (profit, sales growth, revenue growth, cost reduction, financial performance, return to investment, profitability), *market performance* (market share increase, service quality, market flexibility, reputation, customer satisfaction, services to clients), *technical performance* (innovation, product quality, growth in core competence, productivity, efficiency, flexibility technical), *human performance* (creativity, entrepreneurial growth, staff performance, staff satisfaction) and *organizational performance* (external partner and relationships, diffusion of new ideas, organizational agility, work relationships, learning curve, flexibility in the use of resources).

In detail: three out of 17 papers (Gholami et al., 2013; Liu and Abdalla, 2013; Wei et al., 2011) indicate that KM supports all five performances; four contributions show that KM positively affects four performance types (Daud and Yusoff, 2011; Egbu et al., 2005; Hong et al., 2014; Soon and Zainol, 2011), two papers point out that KM positively influences three performances (Delen et al., 2013; Talebi and Tajeddin, 2011), whereas one paper highlights two performances (Bagnoli and Vedovato, 2012), and seven papers show only one performance (Alegre et al., 2011; Beck and Schenker-Wicki, 2014; Filippini et al., 2012; Gupta et al. 2014; Omerzel and Antončič, 2008; Roxas et al., 2014; Salojärvi et al., 2005). This seems to highlight that KM contributes to an overall growth of SMEs by simultaneously enhancing more performance. Nevertheless, while it is strongly agreed that KM strengthens economic and financial performance (12 out of 17 papers) as well as technical performance (12 out of 17 papers), the impact on the human and organizational performance (both with 6 out of 17) papers is not shared.

It seems evident that further empirical evidence could strengthen this conclusion and confirm that the impact of KM on SME performance is extremely wide and simultaneously affects more performance. The above literature analysis allows us to formulate the following research question:

- **RQ3**: What is the impact of the use of knowledge management practices on SME performance?

In order to provide answers to the three research questions above, a field analysis was carried out on a sample of SMEs. The following section provides an overview of the research context in which the field analysis was conducted.

Table 2. The impact of knowledge management on small and medium enterprises (SME) performance (by author)

Author/Performance	Economic and Financial	Market	Technical and Innovative	Human	Organizational	Performance Number
Alegre et al. (2011)			x			**1**
Bagnoli and Vedovato (2012)	x		x			**2**
Beck and Schenker-Wicki (2014)	x					**1**
Daud and Yusoff (2011)	x	x	x		x	**4**
Delen et al. (2013)	x	x	x			**3**
Egbu et al. (2005)		x	x	x	x	**4**
Filippini et al. (2012)			x			**1**
Gholami et al. (2013)	x	x	x	x	x	**5**
Gupta et al. (2014)		x				**1**
Hong et al. (2014)	x	x	x	x		**4**
Liu and Abdalla (2013)	x	x	x	x	x	**5**
Omerzel and Antončič (2008)	x					**1**
Roxas et al. (2014)	x					**1**
Salojärvi et al. (2004)	x					**1**
Soon and Zainol (2011)	x	x	x	x		**4**
Talebi and Tajeddin (2011)		x	x	x		**3**
Wei et al. (2011)	x	x	x	x	x	**5**
Total	**12**	**10**	**12**	**6**	**6**	**46**

4.4 The Context of the Investigation and Methodology

The field analysis was carried out on a sample of 22 SMEs in 2013. The sample mainly consists of firms with 10-49 employees (63.7%), as shown in Table 3. In the table, the latest EU definition of SMEs proposed by the EU Commission was used (European Commission, 2005).

Table 4 shows that most of the SMEs operate in high-tech industries also characterized by a high level of complexity, such as aerospace, ICT and transport (systems and services); namely, industries in which knowledge management is crucial for firm competitiveness.

The SMEs investigated are part of important SME networks that have a critical impact on the territorial development of an Italian region that is a long-established leader in producing complex components for aerospace and railway industries. The investigation methodology is based on semi-structured interviews. The semi-structured interviews approach has the advantage that does not limit the interview to a set of predetermined responses, but at the same time the use of predetermined questions provides uniformity to investigation (Qu and Dumay, 2011). The investigation has been organized into the following five steps:

(1) *Definition of basic objectives and preparation of the draft semi-structured questionnaire*. In this phase, starting from the basic objectives of the investigation, a draft version of the semi-structured questionnaire was prepared.

(2) *Establishment of a focus group*. In this phase, a focus group involving experts with different competences and professional backgrounds was established. Specifically, the focus group encompassed researchers, entrepreneurs/managers of SMEs, and consultants operating in the field of KM. The focus group was set up in three different phases. Firstly, the topic investigated was presented in order to make focus group participants familiar with it. Secondly, the draft semi-structured questionnaire was submitted to the panelists in order to receive their useful feedback and comments. Finally, panelists' remarks were discussed in a plenary session.

(3) *Re-focusing the objectives and the semi-structured questionnaire. On the basis of the* feedback received during the focus group discussion, objectives were re-focused and the semi-structured questionnaire was revised and finalized.

(4) *Testing the semi-structured interview*. In this step, the final version of the semi-structured questionnaire was tested by means of 3 pilot interviews.

(5) *Field analysis implementation*. The semi-structured questionnaire was submitted during face-to-face interviews involving at least two managers with different skills and roles (e.g., a manager involved in the firm's strategic decision-making process and a manager involved in operations management). This made it possible to obtain both strategic and operational perspectives.

In order to gain a more comprehensive picture of the sample investigated, information from complementary sources (e.g., company websites, company reports and industry magazines) were collected and analysed.

Table 3. SMEs breakdown by employees

Employees Bands	Number of SMEs	%
Micro 0–9	5	22.7
Small 10–49	14	63.7
Medium 50–249	3	13.6
Total	**22**	**100.0**

Table 4. SMEs by industries

Overall Economic Industry	Specific Industry	Number of SMEs	%
Manufacturing	Aerospace	5	22.7
	Engineering	5	22.7
Service	Aerospace (R&D)	1	4.6
	ICT	5	22.7
	Management training and consulting	1	4.6
	Transport (system and services)	5	22.7
Total		**22**	**100.0**

4.5 Results and Discussion

This section describes the preliminary findings emerging from the semi-structured interviews. It is divided into three sub-sections. The first presents the findings related to the major barriers hindering the adoption of practices of knowledge management, the second describes the variety of KMSs used by SMEs, the third highlights the impact of using knowledge management practices on SME performance.

4.5.1 Barriers Hindering Knowledge Management Practices

On the basis of the feedback received during the focus group meetings (step 3 of the methodology) and from the pilot interviews carried out in three SMEs of the sample (step 4 of the methodology), the following 11 barriers hindering the implementation of KM practices have been identified: business culture, financial barriers, integration with existing processing, lack of shared language, lack of confidence in benefits, lack of managerial support, lack of staff skills, lack of time and resources, protection of critical information, tacit and non-formalized knowledge, and technological barriers.
To evaluate the importance of each barrier, a fuzzy set-based approach was used (Watanabe, 1979; Zadeh, 1965). Fuzzy logic gives us the possibility to use the rigor of logic to model natural language and common-sense reasoning (Michellone and Zollo, 2000; Zimmermann, 2001). Furthermore, it is an appropriate methodology to aggregate approximate judgements expressed by managers during the semi-structured interviews (through linguistic variables such as *very poor, poor, medium, important, very important*). In particular, the importance of each barrier was calculated as follows:

(1) The level of importance was defined as a linguistic variable: very poor, poor, medium, important and very important;
(2) Each level was associated with a fuzzy number;
(3) During face-to face meetings, managers of the 22 SMEs were asked to provide a judgement on the level of importance of each barrier;
(4) Each judgement was translated into the corresponding fuzzy number (Figure 2);
(5) The fuzzy mean was calculated for each barrier;
(6) The fuzzy mean of each barrier was de-fuzzified using the well-known mean-of-maxima (MeOM) method (Saletic et al. 2002). The result is a number that ranges from zero to ten representing the level of importance of the barrier (Figure 3).

Figure 3 highlights that the level of importance of barriers hindering the adoption of KM methods and techniques is very low (scores less than 5 out of 10). In fact, they range from 2.2 (lack of managerial support) to 4.8 (protection of critical information), where the mean equals 3.48, variance 0.87, and coefficient of variation 27%. Although SMEs are usually characterized by scarce financial and human resources, the low value of the mean and the coefficient of variation indicate that relevant barriers to the implementation of KM practices do not exist. Moreover, the level of importance attributed by the

investigated SMEs to the "protection of critical information" barrier (score 4.8 out of 10) shows that there are still concerns about preserving intellectual assets from opportunistic behavior. Moreover, the very low score (2.2) attributed to barriers such as "lack of managerial support", "technological barriers" (2.4), and "lack of confidence in the benefits" (2.5) highlights that there are no significant technical and managerial obstacles to the spread of KM. These findings, despite coming from a sample of SMEs operating in high/tech or complex industries, highlight that both the results of Nunes et al. (2006), concerning the financial barriers that hinder the implementation of KM in SMEs, and the conclusions of Milosz and Milosz (2010) that identify the cultural barriers that SMEs have to face, are no longer true. This aspect emphasizes that in the space of a just few years the context has changed. SMEs are proving able to overcome the barriers that hampered the implementation of KM practices yesterday. In summary, with regard to RQ1, this section shows that we are witnessing an evolving scenario. Today, SMEs are able to overcome the barriers that prevent the spread of KM practices. Within this new scenario, there are new opportunities for SMEs and new frontiers to explore in the field of KM.

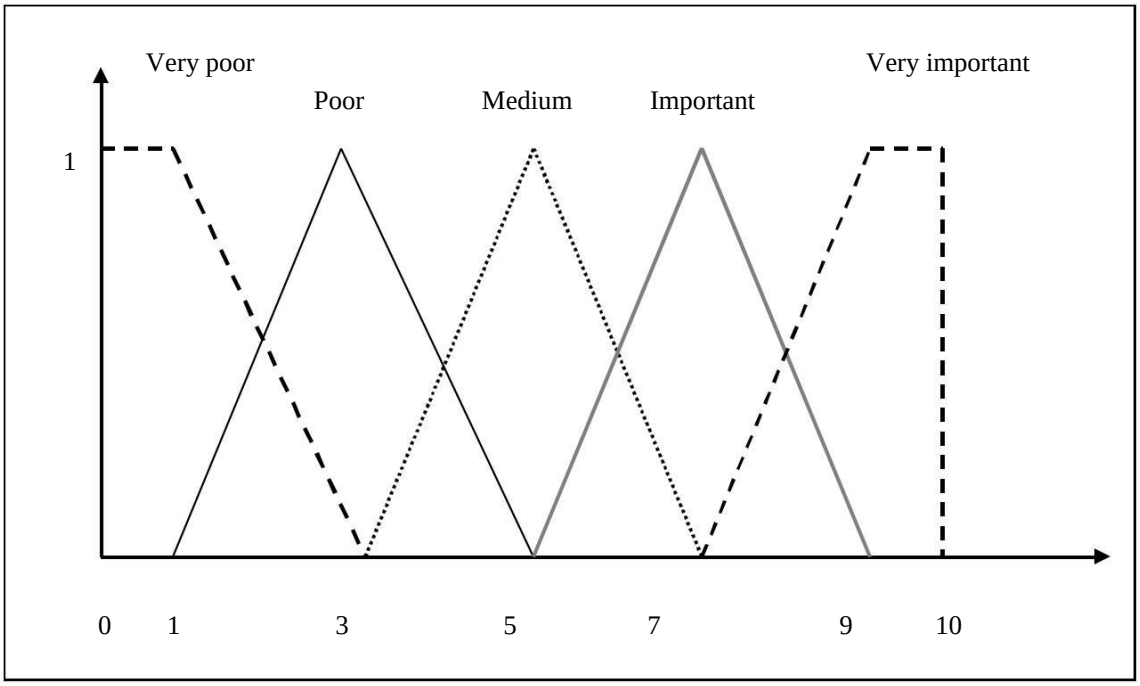


Figure 2. Fuzzy numbers associated to five qualitative levels

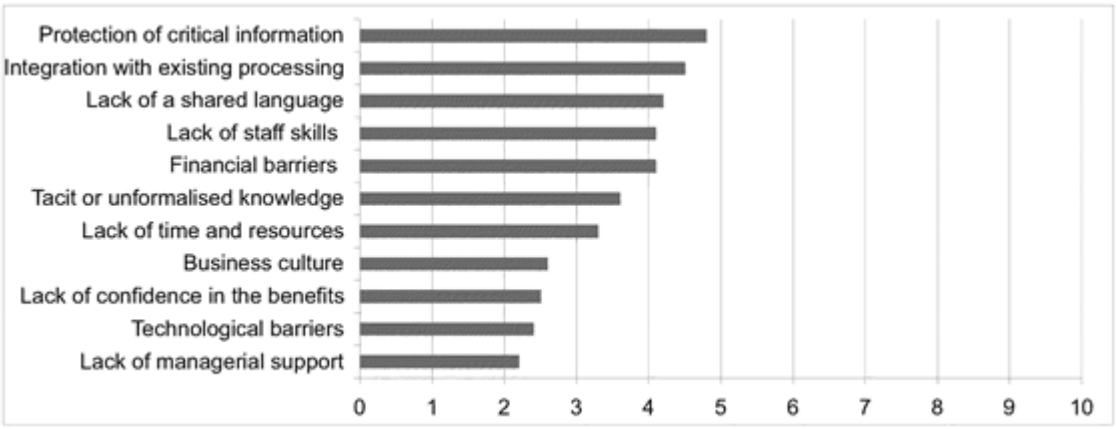


Figure 3. Barriers hindering KMS adoption - Level of importance (from 0 to 10)

4.5.2 The Adoption of Knowledge Management Systems

On the basis of the definition of KMSs used in this chapter (IT-based systems to support methods and techniques of KM) that reflects that provided by Alavi and Leidner (2001), an investigation was carried out to ascertain whether SMEs were using knowledge management systems.

Figure 4 shows the KMSs used by SMEs. The classification of KMSs included in the figure was obtained following a three-step process. In the first step, a draft list of KMSs was obtained adapting those proposed by Alavi and Leidner (2001), Fink and Ploder (2009) and Massa and Testa (2011). Subsequently, this list was submitted to a number of experts in the field of information systems management. The feedback received was used to set up a further list of KMSs that was lastly scrutinised by managers of SMEs in the context of focus group discussion. The final list of KMSs obtained was used during the semi-structured interviews. The field analysis shows that the KMSs used by most of the SMEs investigated are the *database* (95.5%), *document management system* (86.4%), *e-mail and newsletter* (77.3%), *data mining* (72.7%) and *configuration management system* (59.1%). A second group of applications used by 50% of the SMEs includes *data warehouse*, *social media*, *video-conference,* and *content management system*. A third group used by 18%-27% of SMEs includes *podcasting* (27.3%), a *learning management system* (22.7%), and *peer-to-peer* (18.2%). Finally, a fourth group of KMSs with the lower level of usage includes *wiki* (9.1%), *collaborative filtering* (4.5%), *cloud computing* (4.5%) and a *crowd-sourcing system* (4.5%). These results complement and extend the findings of both Lopez-Nicolas and Soto-Acosta (2010), that identified Intranet and webpages as KMSs to support the process of organizational learning, and Rosu et al. (2009), that suggest a knowledge-based applications architecture based on the use of enterprise resource planning, customer relationship management, a document management system, data mining, and a data warehouse. The field analysis highlights that the SMEs investigated do not exploit the opportunities offered by wiki as a tool to share information and knowledge, as suggested, however, by Beylier et al. (2009), Grace (2009), and Razmerita and Kirchner (2011). This latter point seems to highlight that the

SMEs are prone to using older KMSs such as a database and email instead of the newer KMSs, e.g., cloud computing, crowd-sourcing systems, and collaborative filtering.

A similar result emerges when considering KMSs associated with different phases of the KM process. In fact, for the creation phase, 72.7% of the sample firms use data mining and only 4.5% of the firms investigated use collaborative filtering and crowd-sourcing that are newer, cheaper and more user friendly. In the storage phase, a preference emerges for the older database (95.5%) instead of newer content management systems (50.0%). In the distribution phase, SMEs seem to prefer email (87.3%) rather than web 2.0 tools. This aspect is even more significant when considering that the SMEs analyzed operate in high-tech and/or complex industries such as aerospace, telecommunications, transport, *etc.* where large companies adopt the most updated KMSs.

In summary, as far as the RQ2 is concerned, this chapter highlights that the majority of SMEs investigated adopt a variety of KMSs. This finding seems to show that SMEs have a perception of the strategic value of knowledge management and consequently adopt IT systems to support methods and techniques to enhance the organizational processes of knowledge creation, storage, transfer/sharing, and application. Nevertheless, it also emerges that SMEs adopt more traditional KMSs instead of new and more updated tools that are generally cheaper and easier to use. During the interviews, interviewees have underlined that this gap is a consequence of two factors. On the one hand, SMEs typically do not have dedicated resources to monitor the evolution of the ICT market and are not even able to follow the technological dynamic. This forces them to remain in a backward position. On the other hand, ICT vendors generally prefer to deal with large companies rather than SMEs for financial and cultural reasons. Therefore, this gap highlights the difficulties in following rapid technological changes and the lack of support from the system's suppliers (Evangelista et al. 2013).

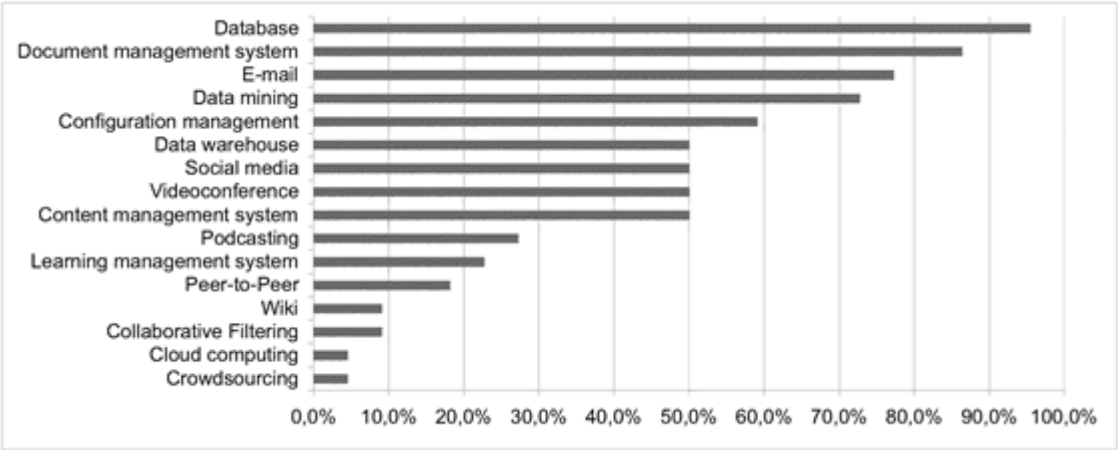


Figure 4. KMSs used by SMEs (%)

4.5.3 Knowledge Management and Performance

The literature analysis shows how the implementation of KM influences a variety of firm performance types, namely: economic and financial performance, market performance, technical performance, human performance, and organizational performance. Starting from these five kinds of performance, during face-to-face meetings, managers were asked to provide a judgement on the impact of KM practices for each type of performance using linguistic variables organized into five qualitative levels (very poor, poor, medium, significant, and very significant). The judgements were aggregated using a fuzzy mean and then de-fuzzified following the six steps illustrated previously. The results are shown in Figure 5.

Figure 5 points out that the impact of KM practices on firm performance ranges from 6.9 (human performance) to 8.1 (organizational performance), with a mean of 7.4, variance 0.21, and coefficient of variation at 6.2%. The values of mean, variance and coefficient of variation underline that the impact of KM practices is very significant and involves all five performance types simultaneously. This conclusion, on the one hand, confirms the results of Gholami et al. (2013), Liu and Abdalla (2013) and Wei et al. (2011) who had already stressed that KM improves all five performances. On the other hand, it reveals that the impact of KM on the performance of SMEs is extremely important.

In summary, regarding RQ3, the empirical evidence of this section highlights that the use of KM practices can contribute to an overall growth of SMEs by enhancing several firm performance types simultaneously and significantly.

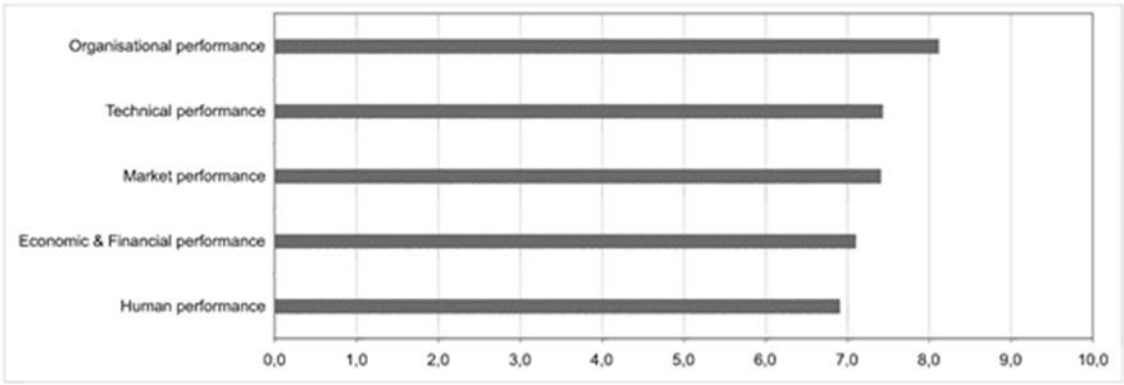


Figure 5. The impact of KM on firm performance - Level of importance (from 0 to 10)

4.6 Conclusions and Implications

The main aim of this chapter was to give a contribution to increase the body of knowledge in the field of KM in SMEs. Through a literature review, three research questions were identified:

- RQ1: What are the major barriers hindering the spread of knowledge management practices in SMEs?
- RQ2: What are the main knowledge management systems adopted by SMEs?
- RQ3: What is the impact of the use of knowledge management practices on SMEs' performance?

These three RQs were addressed through a field analysis carried out on a sample of SMEs operating in high-tech and/or complex industries.

In relation to the first research question, the field analysis results indicate that although SMEs are usually characterized by scarce human and financial resources, they are able to overcome the barriers preventing the spread of KM practices. Thanks to technological innovation in the field of ICTs, cheaper and very easy to use KMSs are available posing reduced financial, technical and cultural barriers. This aspect stresses that the scenario is evolving and is offering SMEs new opportunities and new frontiers to explore in the field of KM.

As for the second research question, empirical evidence shows that the SMEs investigated have perceived the strategic value of KM and consequently adopt a variety of KMSs. Nevertheless, it emerged that they are generally prone to using outdated KMSs rather than the newer ones, which are also cheaper and user friendly. This gap shows the difficulties that SMEs usually have in following rapid technological changes, as well as the lack of support from ICT vendors in the decision-making process regarding the choice of appropriate KM tools and systems.

With regards to the third research question, empirical evidence points out that the impact of the use of practices of KM on firm performance can be extremely significant and at the same time improves a variety of performance. In particular, it emerges that KM contributes positively to the overall growth of SMEs by enhancing financial, market, technical, human and organizational performance.

These results show that we are witnessing an evolving process. Today, SMEs increasingly have access to new knowledge management systems, which do not need significant human and financial investments. This has allowed the reduction of the barriers that have hindered the spread of knowledge management practices in SMEs. Nevertheless, even today, SMEs do not exploit all the opportunities offered by new technologies. In the coming years, overcoming this gap could reduce the distance between SMEs and large companies in the field of knowledge management.

4.6.1 Future Research

The chapter provides guidance for future research. The first research implication derives from the fact that SMEs generally use outdated KMSs rather than newer ones. This issue requires further and in-depth analysis concerning the degree of alignment between KMSs used by SMEs and the nature of knowledge from both the ontological and epistemological perspectives. Secondly, due to the increasing importance of firm networks in the development of SMEs, it seems important to investigate the ways through which knowledge is spread across networks populated by SMEs.

4.6.2 Implications

From the SME point of view, this chapter has highlighted that KM contributes to overall growth by enhancing their performance simultaneously and significantly. However, SMEs could further increase the impact of KM by better exploiting the opportunities offered by the new ICTs (such as cloud computing, crowd-sourcing, collaborative filtering, wiki, etc.).

From the point of view of KMS providers, this chapter has stressed that SMEs typically do not have dedicated resources to monitor the innovation process in the field of KMS. Nevertheless, they could represent a significant market. To seize this opportunity, it is necessary create a new market segment dedicated to SMEs, reducing the cultural distance between demand and supply by developing direct channels of communication (including virtual means) between SMEs and KMS providers.

4.6.3 Limitations

The results highlighted in this chapter can be broadly applied to SMEs operating in high-tech end/or complex industries. Future studies will extend these results, expanding the sample and taking care to include SMEs representing different industries.

References

Alavi, M.; Leidner D.L. Knowledge management and knowledge management systems: Conceptual foundations and research issues. MIS Q. 2001, 25, 107–136.

Alegre, J.; Sengupta, K.; Lapiedra, R. Knowledge management and innovation performance in a high-tech SMEs industry. Int. Small Bus. J. 2011, 31, 454–470.

Al-Mutawah, K.; Lee, V.; Cheung, Y. A new multi-agent system framework for tacit knowledge management in manufacturing supply chains. J. Intell. Manuf. 2009, 20, 593–610.

Ambrosini, V.; Bowman, C. Surfacing tacit sources of success. Int. Small Bus. J. 2008, 26, 403–431.

Anand, A.; Kant, R.; Singh, M.D. Knowledge sharing in SMEs: Modelling the barriers. Int. J. Manag. Enterp. Dev. 2013, 12, 385–410.

Antonelli, C.; Geuna, A.; Steinmueller, W.E. Information and communication technologies and the production, distribution and use of knowledge. Int. J. Technol. Manag. 2000, 20, 72–94.

Bagnoli, C.; Vedovato, M. The impact of knowledge management and strategy configuration coherence on SME performance. J. Manag. Gov. 2012, 16, 1–33.

Beck, M.; Schenker-Wicki, A. Cooperating with external partners: The importance of diversity for innovation performance. Eur. J. Int. Manag. 2014, 8, 548–569.

Beylier, C.; Pourroy, F.; Villeneuve, F.; Mille, A. A collaboration-centred approach to manage engineering knowledge: A case study of an engineering SME. J. Eng. Des. 2009, 20, 523–542.

Bocquet, R.; Mothe, C. Knowledge governance within clusters: the case of small firms. Knowl. Manag. Res. Pract. 2010, 8, 229–239.

Boden, A.; Avram, G.; Bannon, L.; Wulf, V. Knowledge sharing practices and the impact of cultural factors: Reflections on two case studies of offshoring in SME. J. Softw.: Evol. Process 2012, 24, 139–152.

Cappelin, R. Territorial knowledge management: Towards a metrics of the cognitive dimension of agglomeration economies. Int. J. Technol. Manag. 2003, 26, 303–325.

Chen, C.W.; Chang, M.L.; Tseng, C.P. Human Factors of Knowledge-Sharing Intention among Taiwanese Enterprises: A Model of Hypotheses. Hum. Factors Ergon. Manuf. Serv. Ind. 2012, 22, 362–371.

Chen, C.W.; Chang, M.L.; Tseng, C.P.; Chen, B.C.; Chang, Y.Y.C. Critical Human Factor Evaluation of Knowledge Sharing Intention in Taiwanese Enterprises. Hum. Factors Ergon. Manuf. Serv. Ind. 2013, 23, 95–106.

Chong, C.W.; Chong, S.C.; Gan, G.C. Inter-organizational knowledge transfer needs among small and medium enterprises. Libr. Rev. 2011, 60, 37–52.

Choudhary, A.K.; Harding, J.; Camarinha-Matos, L.M.; Lenny Koh, S.C.; Tiwari, M.K. Knowledge management and supporting tools for collaborative networks. Int. J. Prod. Res. 2013, 51, 1953–1957.

Corso, M.; Martini, A.; Pellegrini, L.; Paolucci, E. Technological and Organizational Tools for Knowledge Management: In Search of Configurations. Small Bus. Econ. 2003, 21, 397–408.

Daud, S.; Yusoff, W.F.W. How intellectual capital mediates the relationship between knowledge management processes and organizational performance? Afr. J. Bus. Manag. 2011, 5, 2607–2617.

Davenport, S. Exploring the role of proximity in SME knowledge-acquisition. Res. Policy 2005, 34, 683–701.

De Saá-Pérez, P.; Díaz-Díaz, N.L.; Ballesteros-Rodríguez, J.L. The role of training to innovate in SMEs. Innov.: Manag. Policy Pract. 2012, 14, 218–230.

Delen, D.; Zaim, H.; Kuzey, C.; Zaim, S. A comparative analysis of machine learning systems for measuring the impact of knowledge management practices. Decis. Support Syst. 2013, 54, 1150–1160.

Deng, P.S. Applying a Market-Based Approach to the Development of a Sharing-Enabled KM Model for Knowledge-Intensive Small Firms. Inf. Syst. Manag. 2008, 25, 174–187.

Desouza, K.C.; Awazu, Y. Knowledge management at SMEs: Five peculiarities. J. Knowl. Manag. 2006, 10, 32–43.

Dotsika, F.; Patrick, K. Collaborative KM for SMEs: A framework evaluation study. Inf. Technol. People 2013, 26, 368–382.

Du Plessis, M. The strategic drivers and objectives of communities of practice as vehicles for knowledge management in small and medium enterprises. Int. J. Inf. Manag. 2008, 28, 61–67.

Durst, S.; Edvardsson, I.R. Knowledge management in SMEs: A literature review. J. Knowl. Manag. 2012, 16, 879–903.

Durst, S.; Wilhelm, S. Knowledge management and succession planning in SMEs. J. Knowl. Manag. 2012, 16, 637–649.

Durst, S.; Wilhelm, S. Knowledge management in practice: Insights into a medium sized enterprise's exposure to knowledge loss. Prometh. Crit. Stud. Innov. 2011, 29, 23–38.

Dyer, J.H.; Hatch, N.W. Relation-specific capabilities and barriers to knowledge transfers: Creating advantage through network relationships. Strateg. Manag. J. 2006, 27, 701–719.

Easterby-Smith, M.; Thorpe, R.; Jackson, P. Management Research; SAGE Publications: London, UK, 2012.

Edvardsson, I.R. Is knowledge management losing ground? Developments among Icelandic SMEs. Knowl. Manag. Res. Pract. 2009, 7, 91–99.

Edwards, T. A critical account of knowledge management: Agentic orientation and SME innovation. Int. J. Entrep. Behav. Res. 2007, 13, 64–81.

Egbu, C.O.; Hari, S.; Renukappa, S.H. Knowledge management for sustainable competitiveness in small and medium surveying practices. Struct. Surv. 2005, 23, 7–21.

Esper, T.L.; Ellinger, A.E.; Stank, T.P.; Flint, D.J.; Moon, M. Demand and supply integration: A conceptual framework of value creation through knowledge management. J. Acad. Market. Sci. 2010, 38, 5–18.

Esposito, E.; Mastroianni, M. Information technology and personal computers: The relational life cycle. Technovation 2001, 22, 41–50.

Esposito, E.; Mastroianni, M. Technological Evolution of Personal Computers and Market Implications. Technol. Forecast. Soc. Chang. 1998, 59, 235–254.

Esposito, E.; Passaro, R. Material Requirement Planning and supply chain at Alenia Aircraft. Eur. J. Purch. Supply Manag. 1997, 3, 43–51.

Esposito, E.; Raffa, M. The evolution of Italian subcontracting firms: Empirical evidence. Eur. J. Purch. Supply Manag. 1994, 1, 67–76.

European Commission. The New SME Definition. User Guide and Model Declaration; European Commission, DG Enterprise & Industry: Bruxelles, Belgique, 2005.

Evangelista, P.; Sweeney, E.; McKinnon, A. Technology adoption in small and medium-sized logistics providers. Ind. Manag. Data Syst. 2013, 113, 967–989.

Eze, U.C.; Goh, G.G.G.; Goh, C.Y.; Tan, T.L. Perspectives of SMEs on knowledge sharing. VINE 2013, 43, 210–236.

Filippini, R.; Guttel, W.H.; Nosella, A. Dynamic capabilities and the evolution of knowledge management projects in SMEs. Int. J. Technol. Manag. 2012, 60, 203–219.

Fink, K.; Ploder, C. Knowledge Management Toolkit for SMEs. Int. J. Knowl. Manag. 2009, 5, 46–60.

Frey, R.S. Knowledge management, proposal development, and small businesses. J. Manag. Dev. 2001, 20, 38–54.

Garrigos-Simon, F.J.; Lapiedra Alcami, R.; Barbera Ribera, T. Social networks and Web 3.0: Their impact on the management and marketing of organizations. Manag. Decis. 2012, 50, 1880–1890.

Genovese, A.; Lenny Koh, S.C.; Acquaye, A. Energy efficiency retrofitting services supply chains: Evidence about stakeholders and configurations from the Yorskhire and Humber region case. Int. J. Prod. Econ. 2013, 144, 20–43.

Gholami, M.H.; Asli, M.N.; Nazari-Shirkouhi, S.; Noruzy, A. Investigating the Influence of Knowledge Management Practices on Organizational Performance: An Empirical Study. Acta Polytech. Hung. 2013, 10, 205–216.

Gholipour, R.; Jandaghi, G.; Hosseinzadeh, S.A.A. Explanation of knowledge management enabler as a latent variable: A case study of SMEs in Iran. Afr. J. Bus. Manag. 2010, 4, 1863–1872.

Grace, T.P.L. Wikis as a knowledge management tool. J. Knowl. Manag. 2009, 13, 64–74.

Gresty, M. What role do information systems play in the knowledge management activities of SMEs? Bus. Inf. Rev. 2013, 30, 144–151.

Gunasekaran, A.; Ngai, E.W.T. Knowledge management in 21st century manufacturing. Int. J. Prod. Res. 2007, 45, 2391–2418.

Gupta, N.A.; Jaiswal, M.P.A.; Pardasani, R.B. Teaching case: Managing knowledge and going global at FragraAroma. Manag. Decis. 2014, 52, 1630–1648.

Heavin, C.A.; Adam, F.B. From knowledge activities to knowledge scenarios: Cases in five Irish software SMEs. Int. J. Manag. Enterp. Dev. 2014, 13, 37–61.

Hong, P.A.; Park, Y.W.B.; Choi, S.B.C.; Shin, G.C.D. Achieving knowledge management excellence for competitive advantage: An integrative model for empirical research. Int. J. Knowl. Manag. Stud. 2014, 5, 285–303.

Hsu, R.G.; Lawson, D.; Liang, T.P. Factors affecting knowledge management adoption of Taiwan small and medium-sized enterprises. Int. J. Manag. Enterp. Dev. 2007, 4, 31–51.

Hung, Y.H.; Chou, S.C.T.; Tzeng, G.H. Knowledge management adoption and assessment for SMEs by a novel MCDM approach. Decis. Support Syst. 2011, 51, 270–291.

Hussain, I.; Xiaoyu1, Y.U.; Steven Si, L.V.; Shakeel, A. Organizational knowledge management capabilities and Knowledge management success (KMS) in small and medium enterprises (SMEs). Afr. J. Bus. Manag. 2011, 5, 8971–8979.

Hutchinson, V.; Quintas, P. Do SMEs do Knowledge Management? Or Simply Manage what They Know? Int. Small Bus. J. 2008, 26, 131–154.

Jones, O.; Macphersonb, A.; Thorpe, R. Learning in owner-managed small firms: Mediating artefacts and strategic space. Entrep. Reg. Dev. 2010, 22, 649–673.

Joshi, Y.; Parmer, S.; Chandrawat, S.S. Knowledge Sharing in Organizations: Modeling the Barriers, an Interpretive Structural Modeling Approach. Int. J. Eng. Innov. Technol. 2012, 2, 207–214.

Lakshman, C.; Parente, R.C. Supplier-focused knowledge management in the automobile industry and its implications for product performance. J. Manag. Stud. 2008, 45, 317–342.

Lee, A.H.I.; Wang, W.M.; Lin, T.Y. An evaluation framework for technology transfer of new equipment in high technology industry. Technol. Forecast. Soc. Chang. 2010, 77, 135–150.

Lee, M.R.; Lan, Y.C. Toward a unified knowledge management model for SMEs. Expert Syst. Appl. 2011, 38, 729–735.

Levy, M.; Loebbecke, C.; Powell P. SMEs, co-opetition and knowledge sharing: The role of information systems. Eur. J. Inf. Syst. 2003, 12, 3–17.

Lin, H.F. Contextual factors affecting knowledge management diffusion in SMEs, Industrial Management and Data Systems 2014, 114, 1415–1437.

Lin, I.; Seidel, R.; Shekar, A.; Shahbazpour, M.; Howell, D. Knowledge Sharing Differences between Engineering Functional Teams: An Empirical Investigation. J. Inf. Knowl. Manag. 2012, 11, 1–14.

Lisanti, Y.; Luhukay, D. The design of knowledge management system model for SME (UKM). Theor. Appl. Inf. Technol. 2014, 64, 746–755.

Liu, Y.; Abdalla, A.N. Evaluating the managerial behavior of managing knowledge in Chinese SMEs. Inf. Technol. Manag. 2013, 14, 159–165.

Lopez-Nicolas, C.; Soto-Acosta, P. Analyzing ICT adoption and use effects on knowledge creation: An empirical investigation in SMEs. Int. J. Inf. Manag. 2010, 30, 521–528.

Marra, M.; Ho, W.; Edwards, J.S. Supply chain knowledge management: A literature review. Experts Syst. Appl. 2012, 39, 6103–6110.

Martinez-Costa, M.; Jimenez-Jimenez, D. The effectiveness of TQM. The key role of organizational learning in small businesses. Int. Small Bus. J. 2009, 27, 98–125.

Massa, S.; Testa, S. Knowledge domain and innovation behaviour: A framework to conceptualize KMSs in small and medium enterprises. VINE 2011, 41, 483–454.

Matlay, H.; Westhead, P. Virtual teams and the rise of e-entrepreneurship in Europe. Int. Small Bus. J. 2005, 23, 279–302.

McAdam, R.; Reid, R. SMEs and large organisation perceptions of knowledge management: Comparisons and contrasts. J. Knowl. Manag. 2001, 5, 231–241.

Michellone, G.; Zollo, G. Competences management in knowledge-based firms. Int. J. Technol. Manag. 2000, 20, 134–135.

Migdadi, M. Knowledge management enablers and outcomes in the small-and-medium sized enterprises. Ind. Manag. Data Syst. 2008, 109, 840–858.

Milosz, M.; Milosz, E. Critical success factors and barriers to implementation of knowledge management systems at polish SMEs. Actual Probl. Econ. 2010, 6, 309–315.

Moffett, S.; McAdam, R. The effects of organizational size on knowledge management implementation: Opportunities for small firms? Total Q. Manag. 2006, 17, 221–241.

Mohannak, K. Challenges of knowledge integration in small and medium enterprises. Knowl. Manag. E-Learn. 2014, 6, 66–82.

Montequín, V.R.; Fernández, F.O.; Cabal, V.A.; Gutierrez, N.R. An integrated framework for intellectual capital measurement and knowledge management implementation in small and medium-sized enterprises. J. Inf. Sci. 2006, 32, 525–538.

Navarro, J.G.C.; Dewhurst, F.W.; Eldridge, S. Linking chief knowledge officers with customer capital through knowledge management practices in the Spanish construction industry. Int. J. Hum. Resour. Manag. 2010, 21, 389–404.

Noblet, J.P.; Simon, E. The role of disseminative capacity in knowledge sharing: Which model can be applied to SMEs? Probl. Perspect. Manag. 2012, 10, 57–66.

Nonaka, I. A Dynamic Theory of Organizational Knowledge Creation. Organ. Sci. 1994, 5, 14–37.

Nunes, M.P.; Annansingh, F.; Eaglestone, B. Knowledge management issues in knowledge-intensive SMEs. J. Doc. 2006, 62, 101–119.

Omerzel, D.G.; Antoncic, B. Critical entrepreneur knowledge dimensions for the SME performance. Ind. Manag. Data Syst. 2008, 108, 1182–1199.

Patalas-Maliszewska, J.; Hochmeister, M. Modeling Strategic-Knowledge-Resource Management Based on Individual Competencies in SMEs. Contemp. Econ. 2011, 5, 72–79.

Petticrew, M.; Roberts, H. Systematic Reviews in the Social Sciences; Blackwell Publishing: Malden, MA, USA, 2006.

Pillania, R.K. Leveraging knowledge for sustainable competitiveness in SMEs. Int. J. Glob. Small Bus. 2006, 1, 393–406.

Pillania, R.K. Creation and categorization of knowledge in automotive components SMEs in India. Manag. Decis. 2008, 46, 1452–1464.

Pillania, R.K. Strategic issues in knowledge management in small and medium enterprises. Knowl. Manag. Res. Pract. 2008, 6, 334–338.

Pittaway, L.; Robertson, R.; Munir, K.; Denyer, D.; Neely, D. Networking and innovation: A systematic review of the evidence. Int. J. Manag. Rev. 2004, 5–6, 137–168.

Pool, J.K.A.; Asadi, A.A.; Forte, P.B.; Ansari M.R.A. The effect of organisational culture on attitude and intention toward knowledge sharing: A study of Iranian SMEs. Int. J. Manag. Decis. Mak, 2014, 13, 286–301.

Purcarea, I.; del Mar Benavides Espinosa, M.; Apetrei, A. Innovation and knowledge creation: Perspectives on the SMEs sector. Manag. Decis. 2013, 51, 1096–1107.

Qu, S.Q.; Dumay, J. The qualitative research interview. Qual. Res. Account. Manag. 2011, 8, 238–264.

Razmerita, L.; Kirchner, K. How wikis can be used to manage knowledge in SMEs: A case study. Bus. Inf. Rev. 2011, 28, 175–178.

Rosu, S.M.; Dragoi, G.; Guran, M. A Knowledge Management Scenario to Support Knowledge Applications Development in Small and Medium Enterprises. Adv. Electr. Comput. Eng. 2009, 9, 8–15.

Roxas, B.A.; Battisti, M.B.; Deakins, D.B. Learning, innovation and firm performance: Knowledge management in small firms. Knowl. Manag. Res. Pract. 2014, 12, 443–453.

Roy, M.J.; Therin, F. Knowledge Acquisition and Environmental Commitment in SMEs. Corp. Soc. Responsib. Environ. Manag. 2008, 15, 249–259.

Saletic, D.; Velasevic, D.; Mastorakis, N. Analysis of Basic Defuzzification Techniques. In Recent Advances in Computers, Computing and Communications, Proceedings of the 6th WSES International Multiconference on Circuits, Crete, Greece, 7–14 July 2002.

Salojärvi, S.; Furu, P.; Sveiby, K.E. Knowledge management and growth in Finnish SMEs. Knowl. Manag. 2005, 9, 103–122.

Samuel, K.E.; Goury, M.L.; Gunasekaran, A.; Spalanzani, A. Knowledge management in supply chain: An empirical study from France. J. Strateg. Inf. Syst. 2011, 20, 283–306.

Serenko, A. Meta-analysis of scientometric research of knowledge management: Discovering the identity of the discipline. J. Knowl. Manag. 2013, 17, 773–812.

Soon, T.T.; Zainol, F.A. Knowledge Management Enablers, Process and Organizational Performance: Evidence from Malaysian Enterprises. Asian Soc. Sci. 2011, 7, 186–202.

Soto-Acosta, P.A; Colomo-Palacios, R.B.; Popa, S.A. Web knowledge sharing and its effect on innovation: An empirical investigation in SMEs. Knowl. Manag. Res. Pract. 2014, 12, 103–113.

Sparrow, J. Knowledge management in small firms. Knowl. Process Manag. 2001, 8, 3–16.

Spraggon, M.; Bodolica, V. Knowledge creation processes in small innovative hi-tech firms. Manag. Res. News 2008, 31, 879–894.

Talebi, K.; Tajeddin, M. The adoption of new and innovative knowledge by small and medium enterprises of Iran: Opportunities and constraints for growth. Afr. J. Bus. Manag. 2011, 5, 39–49.

Tan, B.; Hung, H. A knowledge management system introduction model for small- and medium-sized enterprises. Int. J. Manag. Enterp. Dev. 2006, 3, 53–69.

Thorpe, R.; Holt, R.; Macpherson, A.; Pittaway, L. Using knowledge within small and medium-sized firms: A systematic review of the evidence. Int. J. Manag. Rev. 2005, 7, 257–281.

Tseng, C.P.; Chang, M.L.; Chen, C.W. Human Factors of Knowledge Sharing Intention among Taiwanese Enterprises: A Preliminary Study. Hum. Factors Ergon. Manuf. Serv. Ind. 2012, 22, 328–339.

Vajjhala, N.R.A.; Baghurst, T.B. Influence of cultural factors on knowledge sharing in medium-sized enterprises within transition economies. Int. J. Knowl. Manag. Stud. 2014, 5, 304–321.

Valmohammadi, C. Investigation and assessment of critical success factors of knowledge management implementation in Iranian small-to-medium sized enterprises. J. Appl. Sci. 2010, 10, 2290–2296.

Watanabe, N. Statistical Methods for Estimating Membership Functions. Jpn. J. Fuzzy Theory Syst. 1979, 5, 833–846.

Wee, J.C.N.; Chua, A.Y.K. The peculiarities of knowledge management processes in SMEs: The case of Singapore. J. Knowl. Manag. 2013, 17, 958–972.

Wei, C.C.; Choy, C.S.; Chew, G.G. The KM processes in Malaysian SMEs: An empirical validation. Knowl. Manag. Res. Pract. 2011, 9, 185–196.

Whyte G.; Classen, S. Using storytelling to elicit tacit knowledge from SMEs. J. Knowl. Manag. 2012, 16, 950–962.

Wong, K.Y. Critical Success factors for implementing knowledge management in small and medium enterprises. Ind. Manag. Data Syst. 2005, 105, 261–279.

Wong, K.Y.; Aspinwall, E. An empirical study of the important factors for knowledge-management adoption in the SME sector. J. Knowl. Manag. 2005, 9, 64–82.

Yao, L.; Othman, A.; Abdalla, A.N.; Jing, W. A novel sensemaking model of effective knowledge management within SMEs. Afr. J. Bus. Manag. 2011, 5, 4423–4431.

Zadeh, L.A. Fuzzy Sets. Inf. Control 1965, 8, 338–353.

Zapata Cantù, L.; Criado, J.R.; Criado, A.R. Generation and transfer of knowledge in IT-related SMEs. J. Knowl. Manag. 2009, 13, 243–256.

Zhou, Y.; Zhan, H.; Zhang, Y. Design and development of knowledge management platform for SMEs. J. Chem. Pharm. Res. 2014, 6, 1035–1041.

Zieba, M.; Zieba, K. Knowledge management critical success factors and the innovativeness of KIBS companies. Eng. Econ. 2014, 25, 458–465.

Zimmermann, H. Fuzzy Set Theory and Its Applications; Kluwer Academic Publishers: Boston, MA, USA, 2001.

5. Knowledge Management Systems: The Hallmark of SMEs

5.1 Abstract

This chapter provides an overview on the knowledge management systems (KMSs) adopted by small and medium enterprises (SMEs). KMSs are divided into two categories: knowledge management tools (KM-Tools) and knowledge management practices (KM-Practices). On the base of the analysis of the literature two research questions (RQs) were identified and addressed through semi-structured interviews carried out in a sample of 35 SMEs operating in high-tech industries. The first RQ concerns the degree of adoption of KMSs by SMEs. The second RQ regards the relationship between KM-Tools and KM-Practices. As far as the degree of adoption of KMSs, the chapter highlights that SMEs are not a homogeneous world but there are a variety of approaches and behaviours. As far as the relationship between the degree of adoption of KM-Tools and KM-Practices, the chapter identifies three groups of SMEs that seem to point out the stages of the process of adoption of KMSs: Introduction, SMEs that deal with the process of knowledge management exploiting practices and tools that already know; Growth, SMEs that adopt specialist practices of knowledge management acquiring new organizational and managerial competence in the field of knowledge management; Maturity, SMEs that invest in new technology and that acquire new technological competence in the field of knowledge management.

Keywords - knowledge management systems; knowledge management tools; knowledge management practices; small and medium enterprises.

5.2 Introduction

In the last few years there is an increasing number of papers dealing with the topic of KMSs (Damodaran and Olphert, 2000; Huber, 2001; Hung et al., 2005; Poston and Speier, 2005; Nevo and Chan, 2007; Lin and Huang, 2008). Nevertheless, this literature focuses mainly on KMSs adopted by large firms, whereas in the field of SMEs this topic is still neglected and there is not yet a structured framework (Antonelli et al., 2000; Esposito and Mastroianni, 2001; Garrigos-Simon et al., 2012; Matlay and Westhead, 2005; Cerchione et al., 2015). This aspect is crucial since the adoption of KMSs represents a crucial step towards the adoption of strategies of knowledge management. Moreover, in the literature there is not a common definition of KMSs, but there is a variety of definitions that ranges between two extremes: 1) IT-based systems to support methods and techniques of KM (Alavi and Leidner, 2001); 2) information systems or managerial practices adopted to support firms to improve knowledge management processes (Corso et al., 2003).

The literature on the topic identifies specific practices to support the process of knowledge management in SMEs (e.g. casual mapping, knowledge mapping, balance scorecard, formal manual, chief knowledge officer, communities of practice, communities of sharing, informal networks, project teams, storytelling) and highlights the IT-based tools to support the knowledge management practices (e.g. data mining, data warehouse - DW, document management systems - DMS, enterprise resource planning systems – ERP systems), but does not offer an exhaustive framework of the whole set of KMSs used by SMEs. However, the literature focuses on the KMSs used by SMEs but not focuses on the SMEs that use KMSs. In other words, from the literature does not emerge the point of view of SMEs. Specifically, the literature does not highlight if the individual SMEs use few or many KMSs, namely it does not show out the degree of adoption of KMSs by SMEs. In addition, it does not emerge if there is a relationship between the use of KM-Practices and the use of KM-Tools by SMEs. These issues are particularly significant as SMEs are not entity without a own strategy to deal with the knowledge management process.

This gap is also aggravated by the scarcity of empirical papers on the subject. Starting from this literature gap this chapter identifies two research questions concerning the degree of adoption of KMSs by SMEs and the relationship between KM-Practices and KM-Tools used by SMEs. These two research questions are addressed through semi-structured interviews carried out in a sample of 35 SMEs operating in high-tech industries.

The chapter is structured in six sections. After the introduction, in the second section the framework is described. The methodology is analysed in the third section. In the fourth section

the context of investigation is presented. The main findings of field analysis are illustrated in the fifth section. Finally, conclusions and implications.

5.3 Framework

Starting from the two definitions of knowledge management systems provided by Alavi and Leidner (2001) and Corso et al. (2003), our definition of KMSs include: knowledge management practices (KM-Practices), defined as the set of methods and techniques to support the organizational processes of knowledge creation, storage, transfer; and knowledge management tools (KM-Tools), namely the specific IT-based systems supporting KM-Practices (Figure 1). This definition is more comprehensive and includes both the IT-based tools and the organisation practices identified in the two previous definitions.

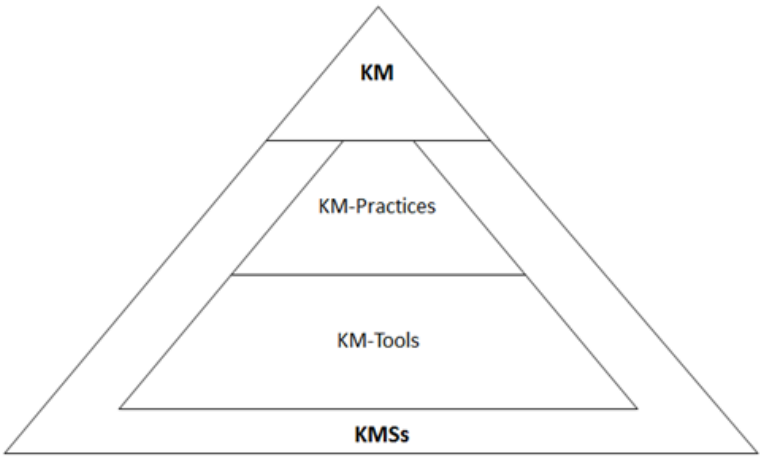


Figure 1. Knowledge management systems

Starting from the above definition, to illustrate the state-of-the-art on knowledge management systems in SMEs, we used two academic databases (Scopus and Web of Knowledge), which guarantee a comprehensive coverage of papers published in the most important high-ranking journals. Thirty-two papers concerning the adoption of KMSs by SMEs were identified and studied in detail. Specifically, 19 papers focus on KM-Practices and 13 deal with KM-Tools (Table 1).

Table 1. Papers by unit of analysis

KMSs in SMEs	Authors	
KM-Practices	Ambrosini and Bowman (2008)	Lin et al. (2012)
	Chong (2011)	Massa and Testa (2011)
	Corso et al. (2003)	Navarro et al. (2010)
	Desouza and Awazu (2006)	Noblet and Simon (2012)
	du Plessis (2008)	Pillania (2008)
	Durst and Wilhelm (2011)	Shih et al. (2010)
	Durst and Wilhelm (2012)	Spraggon and Bodolica (2008)
	Fink and Ploder (2009)	Whyte and Classen (2012)
	Hutchinson and Quintas (2008)	Yao et al. (2011)
	Levy et al. (2003)	
KM-Tools	Beylier et al. (2009)	Lockett et al. (2009)
	Choudhary (2013)	Lopez-Nicolas and Soto-Acosta (2010)
	Dotsika and Patrick (2013)	Perez-Araos et al. (2007)
	Edvardsson (2009)	Razmerita and Kirchner (2011)
	Grace (2009)	Rosu et al. (2009)
	Gresty (2013)	Zhou (2014)
	Lisanti and Luhukay (2014)	

As far as the 19 papers focusing on KM-Practices, Shih et al. (2010) analyse the adoption of brainstorming as a very usual team-oriented KM-Practice improving knowledge creation phase. Hutchinson and Quintas (2008) underline that SMEs are more likely to adopt informal processes to manage knowledge. Conversely other authors (Ambrosini and Bowman, 2008; du Plessis, 2008; Durst and Wilhelm, 2011, 2012; Fink and Ploder, 2009; Levy et al., 2003) suggest the importance of more formal practices and methods (e.g. casual mapping, knowledge mapping, balance scorecard, formal manual), while Navarro et al. (2010) suggest to establish a chief knowledge officer. Moreover, Chong (2011), Corso et al. (2003), Desouza and Awazu (2006), du Plessis (2008), Lin et al. (2012), Massa and Testa 2011), Navarro et al. (2010), Noblet and Simon (2012), Pillania (2008), Spraggon and Bodolica (2008), Whyte and Classen (2012), and Yao et al. (2011) suggest a variety of people-centred practices such as: focus groups, meetings, seminars, communities of practice, communities of sharing, informal networks, project teams, storytelling, interactions with customers, interactions with suppliers, interactions with partners, job rotation, training.

With regards to the 13 papers dealing with KM-Tools, Perez-Araos et al. (2007) illustrate the use of an innovative KM-Tool currently at the stage of validation. The adoption of this tool allows SMEs to facilitate the creation of networks and manage efficiently and effectively the created knowledge. Lockett et al. (2009) examine the adoption of knowledge database to facilitate the process of knowledge storage. Edvardsson (2009) and Rosu et al. (2009) suggest a knowledge based applications architecture based on the use of enterprise resource planning system (ERP), customer relationship management (CRM), document management systems (DMS), data mining and data warehouse (DW). Grace (2009), Razmerita and Kirchner (2011), Dotsika and Patrick

(2013), and Gresty (2013) show the opportunity offered by wikis. Lopez-Nicolas and Soto-Acosta (2010) identified intranet and webpages as KMSs to support organisational learning. Choudary (2013) analyses the use of communication and collaborative tools. Similarly, Dotsika and Patrick (2013) illustrate some specific communication tools (email, blog, content management system), collaborative tools (social media). Finally, Beylier et al. (2009) analyse a prototype collaboration tool to improve knowledge transfer phase.

Summarising, these 32 papers analyse specific IT-based tools (data mining, DW, DMS, CRM, ERP systems), formal practices (casual mapping, knowledge mapping, balance scorecard, formal manual, chief knowledge officer), or people-centred practices (brainstorming, focus groups, formal meetings, seminars, communities of practice, communities of sharing, informal networks, project teams, storytelling, interactions with customers, interactions with suppliers, interactions with partners, job rotation, training). However, they do not point out the hallmark of SMEs, since they do not highlight if the individual SMEs use few or many KMSs, namely they do not show out the degree of adoption of KMSs by individual SMEs. In addition, it does not emerge if there is a relationship between the use of KM-Practices and the use of KM-Tools by SMEs. These issues are particularly significant as SMEs located in the different stages of development of the process of diffusion of knowledge management may adopt different approaches and use different KM-Tools and KM-Practices.

Starting from the above *literature gaps* it is possible to formulate the following two research questions:

RQ1: What is the degree of adoption of KMSs by SMEs?

RQ2: What is the relationship between KM-Practices and KM-Tools used by SMEs?

In order to address these two research question an empirical research has been conducted on the base of semi-structured interviews that have involved a sample of SMEs operating in the high-tech industry. The following paragraph provides an overview of the methodology.

5.4 Methodology

The methodology has been organised into the following six phases:

Phase 1) Desk analysis. In this phase a draft list of KM-Tools and KM-Practices has been identified through the analysis of the literature on the topic presented in the framework section;

Phase 2) Focus groups with experts. Two IT senior consultants and a researcher have provided a

list of KM-Tools and KM-Practices, integrating the draft list identified in *phase 1* with some innovative tools and practices not analysed in the current literature on the topic;

Phase 3) Definition of field analysis objectives and preparation of the draft questionnaire. In this phase, using the list of KMSs identified (*Phase 2*), a first version of the questionnaire for semi-structured interviews has been prepared according to basic research objectives;

Phase 4) Test of the questionnaire. In this step, the first version of the questionnaire has been tested through 3 pilot semi-structured interviews carried out in three SMEs of the surveyed sample;

Phase 5) Definition of final questionnaire. In this phase, the research objectives have been re-focused and the questionnaire has been revised on the basis of the feedbacks received during the pilot tests;

Phase 6) Field analysis. This phase consists in a face-to-face distribution of the questionnaire to two managers with different skills and roles. This allowed us to obtain different strategic and operational perspectives. The total number of respondents was 35 firms. The output of field analysis allows us to answer to the research questions (*RQ1 and RQ2*).

The following paragraph provides an overview of the context of investigation in which the field analysis has been conducted.

5.5 Context of investigation

The field analysis has been carried out in a sample of 35 SMEs belonging to three consortia located in the south of Italy. The SAM consortium was established in 1998 and currently comprises 11 firms. The ALI consortium was established in 2006 and comprises 12 firms. The CHAIN consortium is a network comprising 23 firms and established in October 2008. The total employment is about 3000 people and the total turnover is around 300 million Euros in 2013. The consortia carry out a number of activities to support the associated firms. In particular, they provide services to develop technologies and products, know-how exchanges, high education programs, services to improve the internationalisation and the collaboration among the associated firms. They mainly comprises small firms as shown in table 2. In this table, the latest EU definition of SMEs proposed by the EU Commission has been used for the classification of the surveyed SMEs (European Commission, 2005).

Table 2. ALI-CHAIN-SAM consortia: SMEs breakdown by employees' bands

	Employees band	Number of SMEs	%
ALI-CHAIN-SAM	Micro (0-9)	7	20
	Small (10-49)	18	51
	Medium (50-249)	10	29
Total		35 SMEs	

Table 3 shows that the majority of SMEs belonging to the ALI-CHAIN-SAM consortia operates in high-tech industries even characterized by a high level of complexity, such as aerospace, engineering, R&D, ICT, consulting.

Table 3. ALI-CHAIN-SAM consortia: SMEs industries

	Overall economic industry	Specific industry	Number of SMEs	%
ALI-CHAIN-SAM	Manufacturing	Aerospace	12	34
		Engineering	5	14
	Service	R&D	5	14
		ICT	11	32
		Consulting	2	6
Total			35 SMEs	

The following paragraph presents the main findings emerging from the field analysis.

5.6 Main findings of field analysis

This section presents the main findings about the use of knowledge management systems (KM-Tools and KM-Practices) by individual SMEs. It is divided into three parts. The first identifies the set of KM-Practices and KM-Tools adopted by the surveyed SMEs. The second shows the variety of KM-Practices and KM-Tools adopted by individual SMEs. Finally, the third points out the relationship between the use of KM-Practices and the use of KM-Tools by SMEs.

5.6.1 The identification of KM-Tools and KM-Practices

This paragraph presents the three steps used to identify the KM-Tools and KM-Practices adopted by the surveyed SMEs: 1) desk analysis (*phase 1* of the methodology); 2) focus group with experts (*phase 2* of the methodology); and 3) field analysis (*phase 6* of the methodology).
Firstly, the desk analysis of the literature allowed to select a first list of KM-Tools and KM-Practices adopted by SMEs. Secondly, the feedbacks provided by the experts during the focus group allowed to identify the following KM-Tools and KM-Practices:

- **KM-Tools:** Audio conference/Video conference, Blogs, Business Process Management

Systems, Chat, Cloud Computing, Collaborative Filtering, Configuration Management Systems, Content Management Systems, Conversational Technologies, Crowdsourcing Systems, Database, Data Management Systems, Data Mining, Data Visualization, Data Warehouse, Decision Support Systems, Document Management Systems, E-mail, ERP Systems, Expert Systems, Learning Management Systems, Mash-up, Peer-to-Peer Resource Sharing, Podcasting/Videocasting, Prediction and Idea Markets, Product Data Management Systems, Product Lifecycle Management Systems, Social Data Mining, Social Media, Syndication Systems, Text Mining, Trust and Reputation Systems, Wiki;

- **KM-Practices:** After Action Review, Balance Scorecard, Benchmarking, Best Practice, Brainstorming, Case Based Reasoning, Casual mapping, Coaching/Mentoring, Communities of Practice, Communities of Sharing, Contextual Inquiry, Facilitated Discussion, Focus Groups, Ideas Competition, Informal Networks, Job Rotation, Knowledge Cafes, Knowledge Elicitation Interview, Knowledge Filtering, Knowledge Mapping, Knowledge Modelling, Knowledge Office, Learning by doing, Lesson Learned, Meeting/Task Force, Problem Solving, Process Mapping, Project Teams Training, Rating, Seminars, Storytelling, Social Network Analysis, Work Groups;

Finally, the field analysis allowed to exclude from the above list the KM-practices and KM-Tools do not used by surveyed SMEs. The final list of KM-Tools and KM-Practices, which includes exclusively those adopted by the sample of investigated SMEs, is reported respectively in Table 4 and Table 5.

Table 4. KM-Tools adopted by surveyed SMEs

KM-TOOLS	
Audio Conference/Video Conference	Document Management Systems
Cloud Computing	E-mail
Collaborative Filtering	ERP Systems
Configuration Management Systems	Expert Systems
Content Management Systems	Learning Management Systems
Conversational Technologies	Mash-up
Crowdsourcing Systems	Peer-to-Peer Resource Sharing
Data Mining	Podcasting/Videocasting
Data Warehouse	Social Media
Databases	Syndication Systems

Table 5. KM-Practices adopted by surveyed SMEs

KM-PRACTICES	
After Action Review	Knowledge Mapping
Benchmarking	Learning by doing
Best Practice	Meeting/Task Force
Brainstorming	Problem Solving
Coaching/Mentoring	Process Mapping
Communities of Practice	Social Network Analysis
Job Rotation	Storytelling
Knowledge Filtering	Work Groups

5.6.2 The adoption of KM-Tools and KM-Practices

To analyse the degree of adoption of KM-Tools by individual SMEs, the index of adoption of KM-Tools was introduced. It is defined as the number of KM-Tools adopted by the individual SMEs divided by twenty, which is the total number of tools adopted by the surveyed sample (see Table 4). The index ranges from 0.0 (if the SME does not use any KM-Tool) to 1.0 (if the SME uses all the twenty KM-Tools identified in Tab.4). Figure 2 highlights that this index calculated for the surveyed SMEs ranges from 0.10 (firm A7) to 1.00 (firm A8), with mean equal to 0.49 and coefficient of variation 46%. The value of the mean shows that each SME uses on average ten out of twenty KM-Tools, while the value of the coefficient of variation indicates that SMEs have a wide variety of behaviours. Some SMEs use many KM-Tools (A16, A23, A17, A28, A2, A27, A8), while others focus on a few KM-Tools (A24, A25, A6, A5, A10, A3, A7).

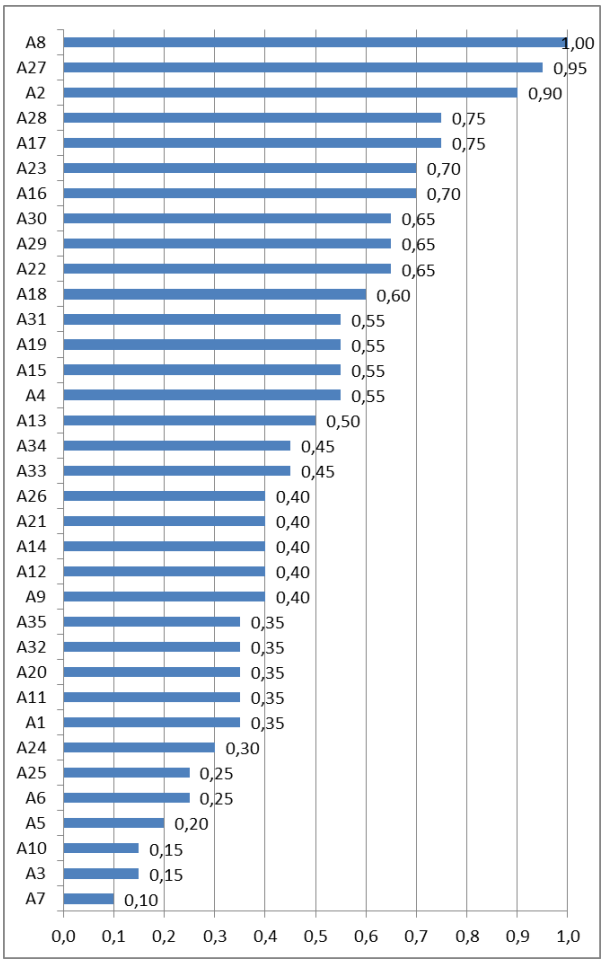


Figure 2. Index of adoption of KM-Tools

To analyse the variety of KM-Practices adopted by individual SMEs, the index of adoption of KM-Practices was used. The index was defined as the number of KM-Practices adopted by the

firm divided sixteen, that is the total number of practices adopted by the surveyed sample (see Table 5). The index ranges from 0.0 (if the SME does not use any KM-Practice) to 1.0 (if the SME uses all the sixteen KM-Practices). Figure 3 highlights that this index calculated for the surveyed SMEs ranges from 0.25 (firm A7) to 1.00 (firms A22), with mean equal to 0.73 and coefficient of variation 25%. The high value of the mean highlights that SMEs use on average 11-12 KM-Practices out of 16. The low value of the coefficient of variation indicates that SMEs investigated have a quite homogeneous behaviour. Except five SMEs (A35, A34, A10, A3 and A7) that use 4-8 KM-Practices, the remaining SMEs (30 out of 35) use 10-16 KM-Practices out of 16.

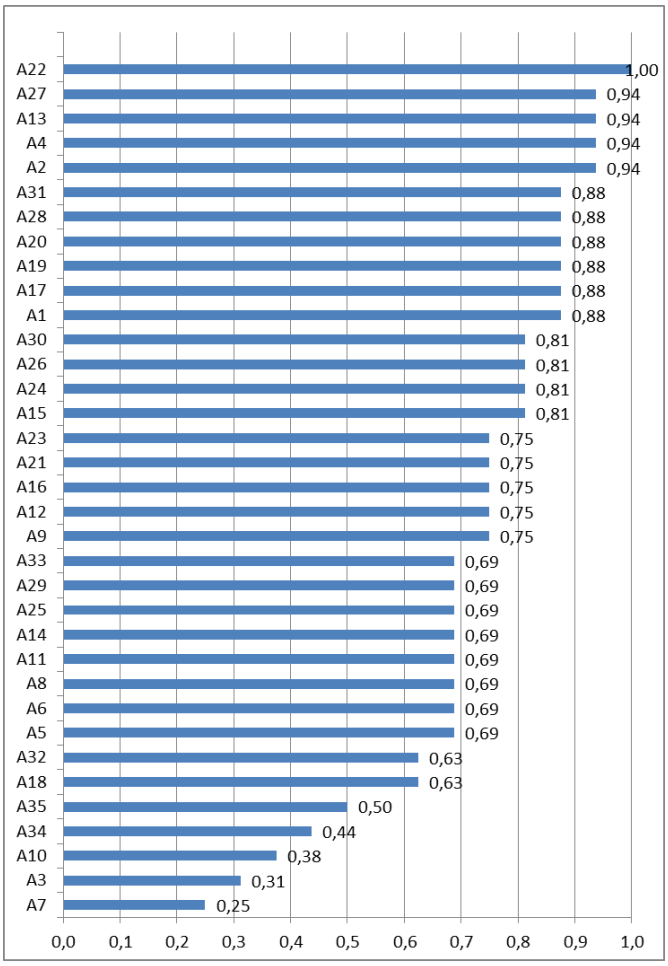


Figure 3. Index of adoption of KM-Practices

The indexes of adoption of KM-Tools and KM-Practices emphasises that, as regards the degree of adoption of KMSs, SMEs are not a homogeneous world that makes indistinctly the same choices and adopts the same solutions. It is no longer sufficient to point out that SMEs are not a scaled-down replica of the experiences of large firms, but it needs to highlight the distinctive features of SMEs to underline the variety of approaches and behaviours. In order to deal with

this issue, in the next section the two indexes of adoption are compared.

5.6.3 SMEs are not an indistinct world

The comparison between the index of adoption of KM-Tools and the index of adoption of KM-Practices, highlights a significant and positive correlation (see Table 6). Namely, the higher the number of KM-Practices adopted, the higher the number of KM-Tools used (see Figure 4). The correlation coefficient (r) was calculated using a power regression function:

$$y = 1{,}0032x0{,}4221$$

To investigate whether the correlation coefficient between the two indexes is statistically significant t-test has been applied. Specifically, to test null hypothesis (H0) that the couples of the indexes are not correlated, the test statistic is calculated using Student's t-distribution with n - 2 degrees of freedom. Specifically the correlation coefficient is 0.72. The calculated t value is 5.96. Since the acceptance region is $-1.65 < t < 1.65$, the null hypothesis (H0) is rejected for surveyed SMEs.

Figure 4 also shows that there are three groups of SMEs. The first group is characterised by SMEs that have a low index of adoption of KM-Practices and KM-Tools. These SMEs use exclusively generalist KM-Practices, that are practices not specifically dedicated to the knowledge management (e.g. Brainstorming, Problem Solving, Process Mapping, After Action Review, Job Rotation, Work Groups, Meeting, Learning by doing) and traditional KM-Tools (e.g. Database, Video conference, ERP System, E-mail, Document Management System). The fact that they have not yet invested to acquire specialist KM-Practices or innovative KM-Tools highlights that with regard to the knowledge management they are still in the phase of introduction and consequently seek to exploit practices and tools that already know. These SMEs are moving the first steps in the field of knowledge management.

The second group identifies SMEs that have a high index of adoption of KM-Practices but a lower index of adoption of KM-Tools. This asymmetry is due to the fact that these SMEs, unlike those of the first group, along with generalist KM-Practices also use specialist KM-Practices, such as: Best Practices, Community of Practices, Knowledge Filtering, Knowledge Mapping, Social Network Analysis, Storytelling. The process of knowledge management involves various departments and consequently are introduced a set of specialist practices to deal with specific issues. However, there is a gap in terms of KM-Tools since these SMEs have not still invested in new technology to support the process of knowledge management. They are SMEs which, as regards the knowledge management, are in a growing phase.

The third group encompasses SMEs that present a high index of adoption of KM-Practices and KM-Tools. The high index of adoption of KM-Tools is due to the use of innovative tools (along with traditional ones), such as: Data Mining, Crowdsourcing Systems, Peer to Peer, Podcasting, Collaborative Filtering, Syndication System, Mash-up, Content Management System, Social Media, Cloud Computing, Learning Management Systems. So these SMEs have invested in new technology to support the KM-Practices, thus promoting a synergistic symbiosis between KM-Practices and KM-Tools. They are SMEs that have reached a full maturity in the field of knowledge management.

These results seem to point out three stages of the process of adoption of KMSs (Figure 5). In the first stage (Introduction), SMEs deal with the process of knowledge management exploiting practices and tools that already know and use generalist KM-Practices and traditional KM-Tools. They do not make a new investment but exploit the flexibility of the technological and organizational solutions already used.

In the second stage (Growth), SMEs adopt new specialist practices for knowledge management but continue to use traditional tools. In this stage, SMEs acquire new organizational and managerial competence in the field of knowledge management. However, it creates a gap between KM-Practices and KM-Tools, since SMEs use new practices but old tools.

In third stage (Maturity), SMEs invest in new technology. They adopt innovative KM-Tools to support the variety of KM-Practices used. In this stage, SMEs acquire new technological competence in the field of knowledge management. In this way, it reduces the gap between practices and tools.

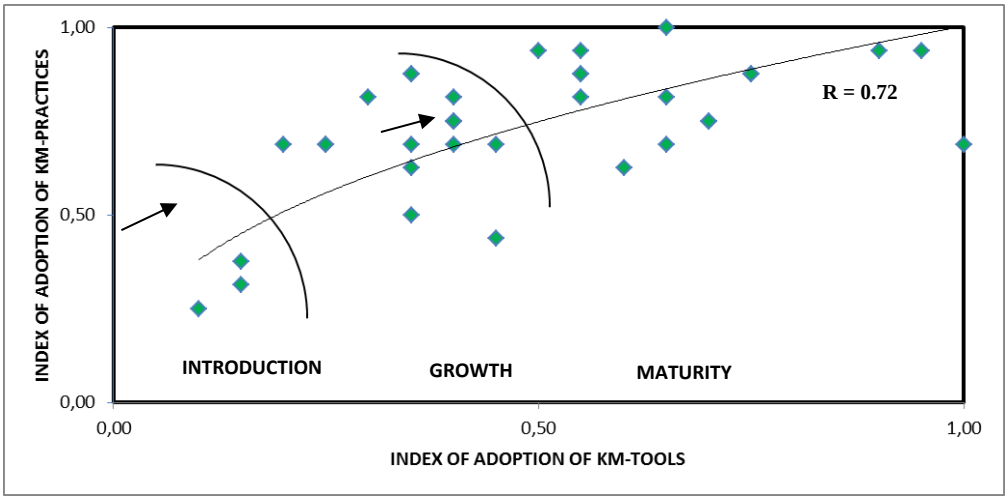


Figure 4. Relation between index of adoption of KM-Tools and KM-Practices

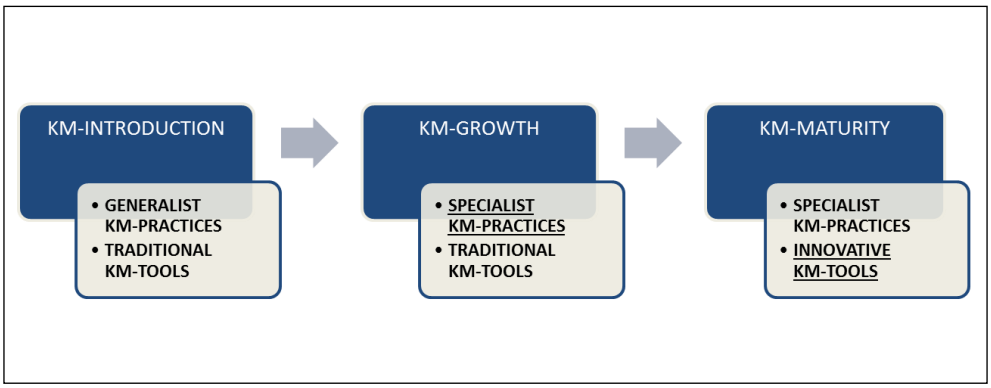
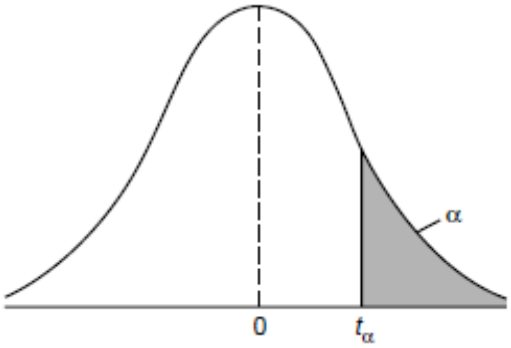


Figure 5. Process of adoption of KMSs

Table 6. *t*-test correlation coefficient

	Index of adoption		t-test			
SMEs	KM-Tools	KM-Practices	ν = 33	$r = 0.72$	$t = 5.96$	$t_{\alpha;0.05} = 1.65$
A1	0.35	0.88				
A2	0.90	0.94				
A3	0.15	0.31				
A4	0.55	0.94				
A5	0.20	0.69				
A6	0.25	0.69				
A7	0.10	0.25				
A8	1.00	0.69				
A9	0.40	0.75				
A10	0.15	0.38				
A11	0.35	0.69				
A12	0.40	0.75				
A13	0.50	0.94				
A14	0.40	0.69				
A15	0.55	0.81				
A16	0.70	0.75				
A17	0.75	0.88				
A18	0.60	0.63				
A19	0.55	0.88				
A20	0.35	0.88				
A21	0.40	0.75				
A22	0.65	1.00				
A23	0.70	0.75				
A24	0.30	0.81				
A25	0.25	0.69				
A26	0.40	0.81				
A27	0.95	0.94				
A28	0.75	0.88				
A29	0.65	0.69				
A30	0.65	0.81				
A31	0.55	0.88				
A32	0.35	0.63				
A33	0.45	0.69				
A34	0.45	0.44				
A35	0.35	0.50				



Null hypothesis (H_0): the index of adoption of KM-Tools and KM-Practices are not correlated.

$t > t_\alpha \Rightarrow H_0$ *rejected*: the difference between the sample correlation coefficient and zero is statistically significant.

5.7 Conclusions

The analysis of the literature has allowed us to identify the following two research questions:

RQ1: What is the degree of adoption of KMSs by SMEs?

RQ2: What is the relationship between KM-Practices and KM-Tools used by SMEs?

To address the first research question, this chapter has first divided KMSs into two categories, i.e. knowledge management tools (KM-Tools) and knowledge management practices (KM-Practices), and then has identified twenty KM-Tools and sixteen KM-Practices used by SMEs. Successively, it has been identified the degree of adoption of KM-Tools and the degree of adoption of KM-Practices. As far as the KM-Tools, the chapter has shown that SMEs have a strong variety of behaviours, which ranges between two extremes. Some SMEs use many KM-Tools, while others focus on a few KM-Tools. SMEs adopting many KM-Tools use both traditional and innovative ones. By contrast, SMEs that adopt few KM-Tools use exclusively traditional ones. As far as the KM-Practices, the chapter has highlighted a quite homogeneous behaviour. Apart from a few SMEs, the majority of SMEs investigated uses a wide range of practices. To sum up, as regards the adoption of KMSs, the chapter highlights that SMEs are not a homogeneous world that replays indistinctly the same choices and adopts the same solutions but there are a variety of approaches and behaviours.

As far as the second research question, the comparison between the degree of adoption of KM-Tools and KM-Practices has pointed out a significant and positive correlation: the higher the use of KM-Practices, the higher the adoption of KM-Tools. Moreover, the chapter has highlighted three groups of SMEs. The first, encompasses SMEs that have a low level of adoption of KM-Practices and KM-Tools. These SMEs use exclusively generalist KM-Practices and traditional KM-Tools. The second group includes SMEs that have a high index of adoption of KM-Practices and a low index of adoption of KM-Tools. These SMEs adopt traditional KM-Tools and use specialist KM-Practices (along with generalist KM-Practices). The third group encompasses SMEs that have a high degree of adoption of KM-Practices and KM-Tools. These SMEs use innovative tools (along with traditional ones) and specialist KM-Practices (along with generalist ones).

These three groups of SMEs seem to point out the various stages of the process of adoption of KMSs: Introduction, SMEs that deal with the process of knowledge management exploiting practices and tool that already know; Growth, SMEs that adopt specialist practices of knowledge management acquiring new organizational and managerial competence in the field of knowledge management; Maturity, SMEs that invest in new technology and that acquire new technological competence in the field of knowledge management.

References

Alavi M and Leidner DL (2001) Review: knowledge management and knowledge management systems: conceptual foundations and research issues. MIS Quarterly, 25(1), 107-136.

Al-Mutawah K, Lee V and Cheung Y (2009) A new multi-agent system framework for tacit knowledge management in manufacturing supply chains. *Journal of Intelligent Manufacturing*, 20(5), 593-610.

Ambrosini V and Bowman C (2008) Surfacing tacit sources of success. *International Small Business Journal*, 26(4), 403-431.

Antonelli C, Geuna A and Steinmueller WE (2000) Information and communication technologies and the production, distribution and use of knowledge. *International Journal of Technology Management*, 20(1-2), 72-94.

Beylier C, Pourroy F, Villeneuve F and Mille A (2009) A collaboration-centred approach to manage engineering knowledge: a case study of an engineering SME. *Journal of Engineering Design*, 20(6), 523-542.

Boden A, Avram G, Bannon L and Wulf V (2012) Knowledge sharing practices and the impact of cultural factors: reflections on two case studies of offshoring in SME. *Journal of Software: Evolution and Process*, 24(2), 139-152.

Cappellin R (2003) Territorial knowledge management: towards a metrics of the cognitive dimension of agglomeration economies. *International Journal of Technology Management*, 26(2-4), 303-325.

Cerchione R, Esposito E and Spadaro MR (2015) The Spread of Knowledge Management in SMEs: A Scenario in Evolution. *Sustainability*, 7, 10210-10232.

Chen CW, Chang ML and Tseng CP (2012) Human Factors of Knowledge-Sharing Intention among Taiwanese Enterprises: A Model of Hypotheses. *Human Factors and Ergonomics in Manufacturing & Service Industries*, 22(4), 362-371.

Chong CW, Chong SC and Gan GC (2011) Inter-organizational knowledge transfer needs among small and medium enterprises. *Library Review*, 60(1), 37-52.

Choudhary AK, Harding J, Camarinha-Matos LM, Lenny Koh SC and Tiwari MK (2013) Knowledge management and supporting tools for collaborative networks. *International Journal of Production Research*, 51(7), 1953-1957.

Corso M, Martini A, Pellegrini L and Paolucci E (2003) Technological and Organizational Tools for Knowledge Management: In Search of Configurations. *Small Business Economics*, 21(4), 397-408.

Damodaran L and Olphert W (2000) Barriers and facilitators to the use of knowledge management systems. *Behaviour and Information Technology*, 19(6), 405-413.

Davenport S (2005) Exploring the role of proximity in SME knowledge-acquisition. *Research Policy*, 34(5), 683-701.

Desouza KC and Awazu Y (2006) Knowledge management at SMEs: five peculiarities. *Journal of Knowledge Management*, 10(1), 32-43.

Dotsika F and Patrick K (2013) Collaborative KM for SMEs: a framework evaluation study. *Information Technology & People*, 26(4), 368-382.

du Plessis M (2008) The strategic drivers and objectives of communities of practice as vehicles for knowledge management in small and medium enterprises. *International Journal of Information Management*, 28(1), 61-67.

Durst S and Edvardsson IR (2012) Knowledge management in SMEs: a literature review. Journal of Knowledge Management, 16(6), 879-903.

Durst S and Wilhelm S (2011) Knowledge management in practice: insights into a medium sized enterprise's exposure to knowledge loss. *Prometheus: Critical Studies in Innovation*, 29(1), 23-38.

Durst S and Wilhelm S (2012) Knowledge management and succession planning in SMEs. *Journal of knowledge management*, 16(4), 637-649.

Dyer JH and Hatch NW (2006) Relation-specific capabilities and barriers to knowledge transfers: Creating advantage through network relationships. *Strategic Management Journal*, 27(8), 701-719.

Edvardsson IR (2009) Is knowledge management losing ground? Developments among Icelandic SMEs. *Knowledge Management Research & Practice*, 7, 91-99.

Edwards T (2007) A critical account of knowledge management: agentic orientation and SME innovation. *International Journal of Entrepreneurial Behaviour & Research*, 13(2), 64-81.

Egbu CO, Hari S and Renukappa SH (2005) Knowledge management for sustainable competitiveness in small and medium surveying practices. *Structural Survey*, 23(1), 7-21.

Esper TL, Ellinger AE, Stank TP, Flint DJ and Moon M (2010) Demand and supply integration: a conceptual framework of value creation through knowledge management. *Journal of the Academy of Marketing Science*, 38(1), 5-18.

Esposito E and Mastroianni M (2001) Information technology and personal computers: The relational life cycle. *Technovation*, 22(1), 41-50.

Esposito E and Raffa M (1994) The evolution of Italian subcontracting firms: empirical evidence. *European Journal of Purchasing and Supply Management*, 1(2), 67-76.

European Commission (2005) *The New SME Definition. User Guide and Model Declaration*. European Commission, DG Enterprise & Industry, Bruxelles.

Fink K and Ploder C (2009) Knowledge Management Toolkit for SMEs. *International Journal of Knowledge Management*, 5(1), 46-60.

Garrigos-Simon FJ, Lapiedra Alcami R and Barbera Ribera T (2012) Social networks and Web 3.0: their impact on the management and marketing of organizations. *Management Decision*, 50(10), 1880-1890.

Gholipour R, Jandaghi G, Hosseinzadeh SAA (2010) Explanation of knowledge management enabler as a latent variable: A case study of SMEs in Iran African. *Journal of Business Management*, 4(9), 1863-1872.

Grace TPL (2009) Wikis as a knowledge management tool. *Journal of Knowledge Management*, 13(4), 64-74.

Gunasekaran A and Ngai EWT (2007) Knowledge management in 21st century manufacturing. *International Journal of Production Research*, 45(11), 2391-2418.

Hsu RG, Lawson D and Liang TP (2007) Factors affecting knowledge management adoption of Taiwan small and medium-sized enterprises. *International Journal Management and Enterprise Development*, 4(1), 31-51.

Huber GP (2001) Transfer of knowledge in knowledge management systems: Unexplored issues and suggested studies. *European Journal of Information Systems*, 10(2), 72-79.

Hung YC, Huang SM, Lin QP and Tsai ML (2005) Critical factors in adopting a knowledge management system for the pharmaceutical industry. *Industrial Management and Data Systems*, 105(2), 164-183.

Hussain I, Xiaoyu YU, Wang L, Si S and Ahmed S (2011) Organizational knowledge management capabilities and Knowledge management success (KMS) in small and medium enterprises (SMEs). *African Journal of Business Management*, Vol. 5, No. 22, pp. 8971-8979.

Hutchinson V and Quintas P (2008) Do SMEs do knowledge management? Or Simply Manage what they Know? *International Small Business Journal*, 26(2), 131-154.

Kanat S and Atilgan T (2014) Effects of knowledge management on supply chain management in the clothing sector: Turkish case. *Fibres and Textiles in Eastern Europe*, 103, 9-13.

Lakshman C and Parente RC (2008) Supplier-focused knowledge management in the automobile industry and its implications for product performance. *Journal of Management Studies*, 45(2), 317-342.

Lee AHI, Wang WM, Lin TY (2010) An evaluation framework for technology transfer of new equipment in high technology industry. *Technological Forecasting and Social Change*, 77(1), 135-150.

Lee MR and Lan YC (2011) Toward a unified knowledge management model for SMEs. *Expert Systems with Applications*, 38(1), 729-735.

Levy M, Loebbecke C and Powell P (2003) SMEs, co-opetition and knowledge sharing: the role of information systems. *European Journal of Information Systems*, 12(1), 3-17.

Lin I, Seidel R, Shekar A, Shahbazpour M and Howell D (2012) Knowledge Sharing Differences Between Engineering Functional Teams: An Empirical Investigation. *Journal of Information & Knowledge Management*, 11(3), 1-14.

Lin TC and Huang CC (2008) Understanding knowledge management system usage antecedents: An integration of social cognitive theory and task technology fit. *Information and Management*, 45(6), 410-417.

Lockett N, Cave F, Kerr R and Robinson S (2009) The influence of co-location in higher education institutions on small firms' perspectives of knowledge transfer. *Entrepreneurship & Regional Development*, 21(3), 265-283.

Massa S and Testa S (2011) Knowledge domain and innovation behaviour. *VINE*, 41(4), 483-454.

Matlay H and Westhead P (2005) Virtual teams and the rise of e-entrepreneurship in Europe. *International Small Business Journal*, 23(3), 279-302.

Michellone G and Zollo G (2000) Competences management in knowledge-based firms. *International Journal of Technology Management*, 20(1), 134-135.

Moffett S and McAdam R (2006) The effects of organizational size on knowledge management implementation: Opportunities for small firms? *Total Quality Management*, 17(2), 221-241.

Navarro JGC, Dewhurst FW, Eldridge S (2010) Linking chief knowledge officers with customer capital through knowledge management practices in the Spanish construction industry. *The International Journal of Human Resource Management*, 21(3), 389-404.

Nevo D and Chan YE (2007) A Delphi study of knowledge management systems: Scope and requirements. *Information and Management*, 44(6), 583-597.

Noblet JP and Simon E (2012) The role of disseminative capacity in knowledge sharing: which model can be applied to SMEs? *Problems and Perspectives in Management*, 10(3), 57-66.

Patalas-Maliszewska J and Hochmeister M (2011) Modeling Strategic-Knowledge-Resource Management Based on Individual Competencies in SMEs. *Contemporary Economics*, 5(2), 72-79.

Perez-Araos A, Barber KD, Munive-Hernandez JE and Eldridge S (2007) Designing a knowledge management tool to support knowledge sharing networks. *Journal of Manufacturing Technology Management*, 18(2), 153-168.

Pillania RK (2008) Creation and categorization of knowledge in automotive components SMEs in India. *Management Decision*, 46(10), 1452-1464.

Poston RS and Speier C (2005) Effective use of knowledge management systems: A process model of content ratings and credibility indicators. *MIS Quarterly: Management Information Systems*, 29(2), 221-244.

Razmerita L and Kirchner K (2011) How wikis can be used to manage knowledge in SMEs: A case study. *Business Information Review*, 28(3), 175-178.

Rosu SM, Dragoi G, Guran M (2009) A Knowledge Management Scenario to Support Knowledge Applications Development in Small and Medium Enterprises. *Advances in Electrical and Computer Engineering*, 9(1), 8-15.

Roy MJ and Therin F (2008) Knowledge Acquisition and Environmental Commitment in SMEs. *Corporate Social Responsibility and Environmental Management*, 15(5), 249-259.

Samuel KE, Goury ML, Gunasekaran A and Spalanzani A (2011) Knowledge management in supply chain: an empirical study from France. *Journal of Strategic Information Systems*, 20(3), 283-306.

Shih KH, Chang CJ, Lin B (2010) Assessing knowledge creation and intellectual capital in banking industry. *Journal of Intellectual Capital*, 11(1), 74-89.

Sparrow J (2001) Knowledge management in small firms. *Knowledge and Process Management*, 8(1), 3-16.

Spraggon M and Bodolica V (2008) Knowledge creation processes in small innovative hi-tech firms. *Management Research News*, 31(11), 879-894.

Valmohammadi C (2010) Investigation and assessment of critical success factors of knowledge management implementation in Iranian small-to-medium sized enterprises. *Journal of Applied Sciences*, 10(19), 2290-2296.

Watanabe N (1979) Statistical Methods for Estimating Membership Functions. *Japanese Journal of Fuzzy Theory and Systems*, 5(4).

Whyte G and Classen S (2012) Using storytelling to elicit tacit knowledge from SMEs. *Journal of Knowledge Management*, 16(6), 950-962.

Wong KY (2005) Critical Success factors for implementing knowledge management in small and medium enterprises. *Industrial Management & Data Systems*, 105(3), 261-279.

Wong KY and Aspinwall E (2005) An empirical study of the important factors for knowledge-management adoption in the SME sector. *Journal of Knowledge Management*, 9(3), 64-82.

Yao L, Othman A, Abdalla AN and Jing W (2011) A novel sense-making model of effective knowledge management within SMEs. *African Journal of Business Management*, 5(11), 4423-4431.

Zadeh LA (1965) Fuzzy Sets. Information and Control, 8(3), 338-353.

Zimmermann H (2001) *Fuzzy set theory and its applications*. Kluwer Academic Publishers, Boston.

6. Using Knowledge Management Systems: A Taxonomy of SME Strategies

6.1 Abstract

The chapter aims to highlight the degree of diffusion and the intensity of use of knowledge management systems (KMSs) among small and medium enterprises (SMEs) and to propose a taxonomy that synthesises the strategies of using KMSs on the part of SMEs. Starting from a literature review on KMSs used by SMEs and from a focus group with consultants/researchers operating in the field of information technology in SMEs, an empirical investigation was designed, developed and conducted through semi-structured interviews involving 61 selected SMEs operating in high tech industries. The chapter highlights three main issues regarding the use of KMSs. Firstly, SMEs adopt and use more intensively traditional tools (KM-Tools) rather than new and more updated ones that are generally cheaper and easier to use. Secondly, SMEs adopt and make more intensive use of practices (KM-Practices) that do not exclusively focus on the knowledge management process, but seek to adapt practices they already know to the requirements of knowledge management. Finally, the chapter points out that there is a relationship of reciprocity between KM-Tools and KM-Practices: one reinforces the other and vice versa. The chapter proposes a taxonomy bringing together SME strategies for using KMSs. Specifically, four strategies are identified: guidepost, explorer, exploiter, and latecomer.

Keywords - field analysis; fuzzy logic; knowledge management systems; practices; tools.

6.2 Introduction

A wide range of literature highlights the pivotal role now played by knowledge management (KM) in the competitiveness of large firms and small and medium enterprises (Al-Mutawah et al., 2009; Dyer and Hatch, 2006; Esper et al., 2010; Gunasekaran and Ngai, 2007; Gottschalk, 2000; Lakshman and Parente, 2008; Lee et al., 2010; Samuel, 2011). Regarding the introduction of knowledge management in small and medium enterprises (SMEs), practitioners and academics agree that SMEs follow in the wake of large companies in developing KM practices. This is reflected in the literature on the topic, where little research and, most notably, few empirical studies have been carried out on SMEs. Nevertheless, papers on the topic have been increasing in recent years, and the scenario is rapidly evolving (Durst and Edvardsson, 2012).

Within this scenario, Information and Communication Technologies (ICTs) are playing a vital role in the development of knowledge management (Bolisani and Scarso, 1999; Benbya et al., 2004; Chua, 2004; Adamides and Karacapilidis, 2006). On the one hand, the literature highlights that ICTs are reducing the weight of the human and financial barriers hindering the spread of knowledge management (Milosz and Milosz, 2010; Nunes et al., 2006). This issue is crucial, as nowadays the technological and innovation trend in ICTs is driving the development and the introduction of new knowledge management systems, which are creating new opportunities for SMEs as they are cheaper, more user-friendly and more effective than the traditional ones (Antonelli et al., 2000; Esposito and Mastroianni, 2001; Garrigos-Simon et al., 2012; Matlay and Westhead, 2005). On the other hand, the literature on KM in SMEs shows that small and medium enterprises are not simply a scaled-down replica of large firms (Egbu et al., 2005; Desouza and Awazu, 2006; Sparrow, 2001; Wong, 2005; Wong and Aspinwall, 2005). Nevertheless, it is not clear what makes the SME different. It seems that the SME is an entity without a strategy of its own for addressing the processes of knowledge management, and furthermore it is not clear what knowledge management systems they use.

Within this context, the chapter has a dual aim. Firstly, to identify an exhaustive taxonomy of knowledge management systems used by SMEs, evaluating how intensively they are used, and secondly, to propose a taxonomy of SME strategies addressing the processes of knowledge management. These results are obtained through desk analysis and semi-structured interviews carried out on a sample of selected SMEs.

The chapter is organised into seven sections. Following this introduction, the second section deals with the literature review on KM in SMEs and three research questions are suggested. In the third section, a taxonomy of KM-Tools and a taxonomy of KM-Practices are identified. The fourth section describes the research methodology and the context of investigation. The degree

of diffusion and the intensity of use of KM-Tools and KM-Practices are illustrated and discussed in the fifth section. The sixth section proposes a taxonomy of SME strategies. Finally, the conclusions and implications are illustrated.

6.3 Literature review

This section proposes a systematic review to analyse the state of the art of the literature on the subject of KMSs in SMEs. A systematic review is an overview of primary studies that use explicit and reproducible methods (Greenhalgh, 1997). According to Greenhalgh, Pittaway et al. (2004) propose a systematic literature review organised into ten steps. Petticrew and Roberts (2006) define a systematic review as a "review that strives to comprehensively identify, appraise and synthesize all relevant studies on a given topic" and suggest a review process organised into 12 steps. Easterby-Smith et al. (2012) identify two main processes in a systematic review. The first consists in defining the review protocol and mapping the field by accessing, retrieving and judging the quality and the relevance of studies in the research field under investigation. The second describes findings to identify gaps in the existing body of knowledge.
According to this approach, it is possible to identify two main phases:

1. A paper selection phase
2. A content analysis phase

The first phase includes the identification of key words, the construction of search strings, the choice of databases to be investigated (Scopus, Web of Science, etc.), a review of the databases using the search strings, the selection of papers to be analysed in detail, the definition of criteria for inclusion/exclusion, and the process of selection according to the inclusion/exclusion criteria.
In the second phase, the selected papers are reviewed and studied in depth in order to highlight strengths and weaknesses in the literature, evidence research gaps, and identify appropriate research questions to be investigated.

6.3.1 Papers selection

In order to ensure a high level of rigorousness, the search was conducted using two academic databases (Scopus and Web of Science) from 1960 until 2014 and a set of selected keywords such as "KMS*", "knowledge management system*" "knowledge management tool*", "knowledge management practice*" was used in combination with "SME*", "small firm*", "small business*", "small and medium enterprise*". Initially, a total of 243 hits were found, as

shown in table 1.

Table 1. Material search

Keywords used	TITLE-ABS-KEY ("KMS*" OR ("knowledge management" AND ("tool*" OR "practice*" OR "system*") AND TITLE-ABS-KEY ("SME*" OR "small firm*" OR "small business*" OR "small and medium enterprise*")
Date range	The literature review spans the years 1960-2014.
Number of hits retrieved in databases	**243**

In order to focus on the research products closer to the topic under investigation, three criteria for the inclusion/exclusion of research products were defined as reported in table 2.

Table 2. Inclusion/exclusion criteria

First criterion: focus of the abstracts	Abstracts focusing on knowledge management systems and SMEs are included
Second criterion: focus of the papers	Papers focusing on knowledge management systems and SMEs are included
Third criterion: cited references	Papers not included in Scopus and Web of Science but cited in the literature on knowledge management are included

The *first criterion* follows the approach proposed by Pittaway et al. (2004). It makes it possible to only select papers whose abstracts focus on knowledge management systems in the context of SMEs. In order to meet this objective, the abstracts of the 243 papers were read in parallel by two researchers, plus a third in the event of uncertainty. In line with Petticrew and Roberts (2006), Easterby-Smith et al. (2012) and Pittaway et al. (2004), the papers were categorised into the following two lists as shown in table 3:

- List A includes papers with a focus on knowledge management systems and SMEs
- List B includes papers with a prevalent focus on knowledge management systems but scarce or insignificant reference to SMEs or papers with a prevalent focus on SMEs but scarce or inconsiderable reference to KMSs.

Table 3. First step selection

List	Description	Number of papers
B	"Papers with a predominant focus on KMSs but scarce or inconsiderable reference to SMEs" OR "Papers with a prevalent focus on SMEs but scarce or inconsiderable reference to KMSs"	144
A	"Papers with a focus on both KMSs and SMEs"	99
Total		**243**

The papers contained in List B (144 papers) were excluded as they were beyond the scope of the research. The 99 papers contained in List A were fully considered and subjected to the second criterion to be analysed in detail.

The *second criterion* is related to the focus of the paper. For this purpose, papers were read in full by two researchers. In the event of conflicting judgements, a third researcher was involved in the selection process. The in-depth reading phase allowed us to exclude 50 papers (out of 99) as they did not focus on the research topic.

The *third criterion* relates to the references cited in the literature analysed, but not identified during the previous process of selection or not included in Scopus and Web of Science databases. This third criterion did not disclose any further additional documents. 49 papers were thus selected for the subsequent phase of descriptive analysis.

6.3.2 Content analysis

Content analysis of the 49 papers aims to give a detailed overview of the issues covered by the literature on knowledge management systems in SMEs. Two content perspectives are identified: the knowledge management process and the knowledge management systems.

In accordance with Kanat and Atilgan (2014), the knowledge management process was subdivided into 3 different phases: 1) the creation phase, in which knowledge is acquired and validated, 2) the storage phase, in which knowledge is retained and organised, and 3) the transfer phase, in which several actors exchange and share knowledge.

In line with Alavi and Leidner (2001), Corso et al. (2003), and Cerchione and Esposito (2015), the KMSs were divided into two categories, i.e., 1) Knowledge management practices (KM-Practices), defined as the set of methods and techniques to support the organisational processes of knowledge creation, storage, and transfer, and 2) Knowledge management tools (KM-Tools), namely the specific IT-based systems supporting KM-Practices.

By overlapping the two perspectives, the papers were classified into 6 areas and analysed in detail (Table 4):

1) KM-Tools supporting the knowledge creation phase
2) KM-Tools supporting the knowledge storage phase
3) KM-Tools supporting the knowledge transfer phase
4) KM-Practices supporting the knowledge creation phase
5) KM-Practices supporting the knowledge storage phase
6) KM-Practices supporting the knowledge transfer phase

Table 4. Papers by unit of analysis and process perspectives

		THE KM-PROCESS			
		Creation Phase	Storage Phase	Transfer Phase	**TOTAL**
OBJECT OF ANALYSIS	KM-Tools	3	9	13	**25**
	KM-Practices	3	10	17	**30**
TOTAL		**6**	**19**	**30**	**55**

* Since some papers deal with more than one phase of the knowledge management process, the total shown in the table is 55 but the number of papers analysed is 49

6.3.*2.1 KM-Tools supporting the knowledge creation phase*

The first area includes 3 papers (Hari et al., 2005; Perez-Araos et al., 2007; Tan and Hung, 2006) focusing on KM-Tools improving the knowledge creation phase. Hari et al. (2005), Perez-Araos et al. (2007) and Tan and Hung (2006) illustrate the use of innovative knowledge creation tools. These authors underline that the adoption of these tools allows SMEs to facilitate the creation of networks and manage the created knowledge efficiently and effectively.

6.3.*2.2 KM-Tools supporting the knowledge storage phase*

The second area includes 9 papers dealing with KM-Tools that support the knowledge storage phase (Adisa and Rose, 2013; Edvardsson, 2009; Fargnoli et al., 2011; Heavin, 2011; Huang et al., 2009; Lin et al., 2011; Lockett et al., 2009; Rosu et al., 2009; Tan and Hung, 2006). Heavin (2011) and Lin et al. (2012) show the opportunity offered by decision support systems for knowledge storage in SMEs. Adisa and Rose (2013) and Huang et al. (2009) analyse the use of *enterprise resource planning (ERP).* Lockett et al. (2009) examine the adoption of a knowledge *database* to facilitate the process of knowledge storage. Edvardsson (2009) and Rosu et al. (2009) suggest a knowledge-based applications architecture based on the use of *enterprise resource planning (ERP), customer relationship management (CRM), document management systems (DMS), and data warehouses (DW).*

6.3.*2.3 KM-Tools supporting the knowledge transfer phase*

The third area includes 13 papers (Aziz and Poorsartep, 2010; Beylier et al., 2009; Cagnazzo et al., 2014; Choudary, 2013; Dotsika and Patrick, 2013; Grace, 2009; Gresty, 2013; Lopez-Nicolas and Soto-Acosta, 2010; Majors and Stale, 2010; Razmerita and Kirchner, 2011; Soto-Acosta et al., 2014; Tan and Hung, 2006; Taticchi et al., 2009) dealing with KM-Tools improving the knowledge transfer phase. Grace (2009), Gresty (2013) and Razmerita and Kirchner (2011) show the opportunity offered by *wikis*. Lopez-Nicolas and Soto-Acosta (2010) identified *intranet* and

webpages as KMSs to support organisational learning. Choudary (2013) analyses the use of *communication and collaborative tools*. Similarly, Dotsika and Patrick (2013) illustrate some specific communication tools (*email, blog, content management system*), and collaborative tools (*social media*). Finally, Beylier et al. (2009) analyse a prototype collaboration tool to improve the knowledge transfer phase.

6.3.*2.4 KM-Practices improving the knowledge creation phase*

The fourth area includes three papers (Delen et al., 2013; Sandhu and Naaranoja, 2009; Shih et al., 2010). Shih et al. (2010) analyse the adoption of *brainstorming* as a very common team-oriented KM-Practice improving the knowledge creation phase.

6.3.*2.5 KM-Practices improving the knowledge storage phase*

The fifth area includes 10 papers (Ambrosini and Bowman, 2008; Delen et al., 2013; du Plessis, 2008; Durst and Wilhelm, 2011; Fink and Ploder, 2009; Hutchinson and Quintas, 2008; Levy et al., 2003; Navarro et al., 2010; Phusavat and Manaves, 2008; Villar et al., 2014). Even though Hutchinson and Quintas (2008) underline that SMEs are more likely to adopt informal processes to manage knowledge, other authors (Ambrosini and Bowman, 2008; du Plessis, 2008; Durst and Wilhelm, 2011, 2012; Fink and Ploder, 2009; Levy et al., 2003) also suggest the importance of more formal practices and methods (such as: *casual mapping, knowledge mapping, balance scorecards, formal manuals*), while others suggest establishing a *chief knowledge officer* (Navarro et al., 2010).

6.3.*2.6 KM-Practices improving the knowledge transfer phase*

The sixth area includes 17 papers concerning KM-Practices improving the knowledge transfer phase. Some authors (Chong, 2011; Corso et al. 2003; Delen et al., 2013; Desouza and Awazu, 2006; du Plessis, 2008; Lin et al., 2012; Massa and Testa, 2011; Navarro et al., 2010; Nguyen and Mohamed, 2011; Nicholls and Cargill, 2008; Noblet and Simon, 2012; Pillania 2008; Sandhu and Naaranoja, 2009; Spraggon and Bodolica, 2008; Whyte and Classen, 2012; Villar et al., 2014; Yao et al., 2011) suggest a variety of people-centred practices such as *focus groups, meetings, seminars, communities of practice, communities of sharing, informal networks, project teams, storytelling, interactions with customers, interactions with suppliers, interaction with partners, job rotation, training*.

Putting together the content analysis of the forty-nine papers presented in the above six areas, it

emerges that the literature on KMSs in SMEs focuses only on specific IT-based tools (*decision support systems, DW, DMS, CRM, ERP*), formal practices (*casual mapping, knowledge mapping, balance scorecards, formal manuals, chief knowledge officer*), people-centred practices (*brainstorming, focus groups, formal meetings, seminars, communities of practice, communities of sharing, informal networks, project teams, storytelling, interaction with customers, interaction with suppliers, interaction with partners, job rotation, training*). Nevertheless, it does not take into consideration web-based tools (*Ariba, WEEKS, RosettaNet B2B, SEBIs, EDI*), multi-agent systems (*LivingFactory, DragonChain,, StrategyFinder, eBAC, Farm Smart 2000, Heifer Management System, Casa*), on-line auctions applications (*Agriculture.com, Comdaq.net, Agex.com, Team.com, eBay.com*), semantic ontologies, knowledge transfer practices (*CoPs, CBR, etc*.).

In summary, the literature does not provide a complete overview of KM-Tools and KM-Practices used by SMEs to support the different phases in the knowledge management process; it does not highlight their degree of diffusion and their intensity of use. Moreover, although the literature focuses on the knowledge management systems used by SMEs, the point of view of the individual SMEs does not emerge. This issue is particularly significant as SMEs may have different strategies in dealing with knowledge management. These literature gaps allow us to formulate the following three research questions:

RQ1: Which KM-tools and KM-Practices are used by SMEs?

RQ2: What is the degree of diffusion and the intensity of use of KM-Tools and KM-Practices among SMEs?

RQ3: What are the strategies for using KM-Tools and KM-Practices among SMEs?

In order to provide an answer to the first research question, a taxonomy of KMSs is proposed in the next section.

6.4 Taxonomy of KM-Tools and KM-Practices

Knowledge management systems have been identified through a three-phase process in order to provide an answer to the first research question.

Firstly, a list of knowledge management systems was obtained by integrating KMSs analysed in the literature and those proposed by Alavi and Leidner (2001), Fink and Ploder (2009), and Massa and Testa (2011).

Secondly, the list was submitted to a focus group of senior IT consultants/researchers operating

in the field of SMEs. The result was a new list of KMSs. Moreover, on the basis of the feedback received, the list of KMSs was divided into KM-Tools and KM-Practices.

Thirdly, KM-Tools and KM-Practices were categorised according to the phases of the knowledge management process identified by Kanat and Atilgan (2014) (creation, storage, transfer). On the basis of the above three phases, table 5 and table 6 present a taxonomy of KM-Tools and KM-Practices respectively.

Table 5. Taxonomy of KM-Tools

KM-PHASE	TOOLS	
KNOWLEDE CREATION	Data Mining	Crowdsourcing Systems
	Data Visualization	Mash-up
	Expert Systems	Prediction and Idea Markets
	Social Data Mining	Syndication Systems
	Text Mining	Trust and Reputation Systems
	Collaborative Filtering	
KNOWLEDGE STORAGE	Business Process Management Systems	Databases
	Configuration Management Systems	Data Management Systems
	Content Management Systems	Data Warehouse
	Product Data Management Systems	Document Management Systems
	Product Lifecycle Management Systems	Decision Support Systems
	ERP Systems	
KNOWLEDGE TRANSFER	Cloud Computing	Audio conference/Video conference
	Learning Management Systems	Blogs
	Peer-to-Peer Resource Sharing	Chat
	Podcasting/Videocasting	Conversational Technologies
	Social Media	E-mail
	Wiki	

Table 6. Taxonomy of KM-Practices

KM-PHASE	PRACTICES	
KNOWLEDE CREATION	Brainstorming	Benchmarking
	Ideas Competition	Knowledge Filtering
	Knowledge Elicitation Interview	Rating
KNOWLEDGE STORAGE	Casual Mapping	After Action Review
	Knowledge Mapping	Balance Scorecard
	Knowledge Modelling	Best Practice
	Problem Solving	Contextual Inquiry
	Process Mapping	Knowledge Office
	Social Network Analysis	Lesson Learned
KNOWLEDGE TRANSFER	Case Based Reasoning	Work Groups
	Coaching/Mentoring	Facilitated Discussion
	Communities of Practice	Meeting/Task Force
	Communities of Sharing	Informal Networks
	Focus Groups	Knowledge Cafes
	Job Rotation	Seminars
	Learning by doing	Storytelling
	Project Teams Training	

These two taxonomies offer an extensive overview of the set of KM-Tools and KM-Practices that support the process of knowledge management in the field of SMEs and represent the answer to the first research question.
In order to provide answers to the second and third research question, a field analysis was carried out in a sample of small and medium enterprises.

6.5 Context of investigation and field analysis methodology

The field analysis was carried out on a sample of 61 SMEs located in the south of Italy. They mainly comprise small firms as shown in table 7. For this table, the latest EU definition of SMEs proposed by the EU Commission is used (European Commission, 2005).

Table 7. Breakdown of SMEs by employee bands

Employees band	**Number of SMEs**	**%**
Micro (0-9)	9	15
Small (10-49)	30	49
Medium (50-249)	22	36
Total	61 SMEs	

Table 8 shows that the 61% of SMEs operates in high-tech and complex manufacturing industries, such as aerospace, automotive and engineering. The 39% in service industry, such as information and communications technology, research and development, and management consulting.

Table 8. SME industries

Overall economic industry	**Specific industry**	**Number of SMEs**	**%**
Manufacturing	Aerospace	12	20
	Automotive	20	33
	Engineering	5	8
Service	Research and Development	7	11
	Information and Communications Technology	14	23
	Management Consulting	3	5
Total		61 SMEs	

The investigation methodology used for the field analysis is based on semi-structured interviews. The semi- structured interview approach has the advantage that it does not limit the interview to a set of predetermined responses, but at the same time the use of predetermined questions gives uniformity to the investigation (Qu and Dumay, 2011). The investigation has

been organised into the following five steps:

1) Definition of basic research objectives and preparation of the draft semi-structured questionnaire. In this phase, a first version of the semi-structured questionnaire was prepared starting from the basic objectives of the investigation

2) Testing the semi-structured questionnaire. In this step, the semi-structured questionnaire was tested through 3 pilot interviews carried out in three SMEs from the surveyed sample. The semi-structured questionnaire was revised on the basis of the feedback received.

3) Field analysis. This phase consists in a face-to-face distribution of the questionnaire to two managers with different skills and roles. This allowed us to obtain different strategic and operational perspectives. The total number of respondents was 61 firms.

The output from the field analysis allowed us to identify the degree of diffusion and the intensity of use of KM-Tools and KM-Practices by the surveyed SMEs.

6.6 The degree of diffusion and intensity of use of KM-Tools and KM-Practices

This section is divided into two parts. The first analyses the main results regarding the degree of diffusion of KM-Tools and KM-Practices among SMEs. The intensity of their use is examined in the second part.

6.6.1 Degree of diffusion of KM-Tools and KM-Practices among SMEs of the sample investigated

The degree of diffusion of KM-Tools (KM-Practices) was defined as the number of SMEs adopting the specific KM-Tool (KM-Practice) divided by the total number SMEs of the sample (61). It shows the percentage of SMEs using a specific KM-Tool (KM-Practice). The degree of diffusion ranges from zero, if no SME uses the specific KM-Tool (KM-Practice) to 100, if all the SMEs use the specific KM-Tool (KM-Practice).

As far as KM-Tools, figure 1 highlights the degree of diffusion of KM-Tools (DT) adopted by SMEs ranges from 9.84 (mash up, syndication systems) to 93.44 (e-mail), with a mean of 26.28 and a coefficient of variation of 111.86%. The mean and coefficient of variation were calculated considering that the total number of KM-Tools is 33 as identified in section 3 (Table 5). The high value of the coefficient of variation shows that there is a focus on a group of KM-Tools used by more than 50% of the SMEs investigated (e-mail, databases, document management systems, audio conference/video conference, cloud computing, peer-to-peer resource sharing, ERP systems, data warehouse). Other KM-Tools are used by few SMEs (mash-up, syndication

systems, crowdsourcing systems, collaborative filtering, expert systems, data mining, learning management systems, podcasting/videocasting, conversational technologies) or not used at all (data visualization, social data mining, text mining, prediction and idea markets, trust and reputation systems, business process management systems, product data management systems, product lifecycle management systems, data management systems, decision support systems, wiki, blogs, and chat). Moreover, it emerged that SMEs are generally inclined to adopt out-dated KM-Tools (e-mail, databases, document management systems, audio conference/video conference, ERP systems, data warehouse, configuration management systems) rather than the newer ones, which are also cheaper and user friendly (podcasting/videocasting, data mining, social media, mash-up, syndication systems, collaborative filtering, crowdsourcing systems).

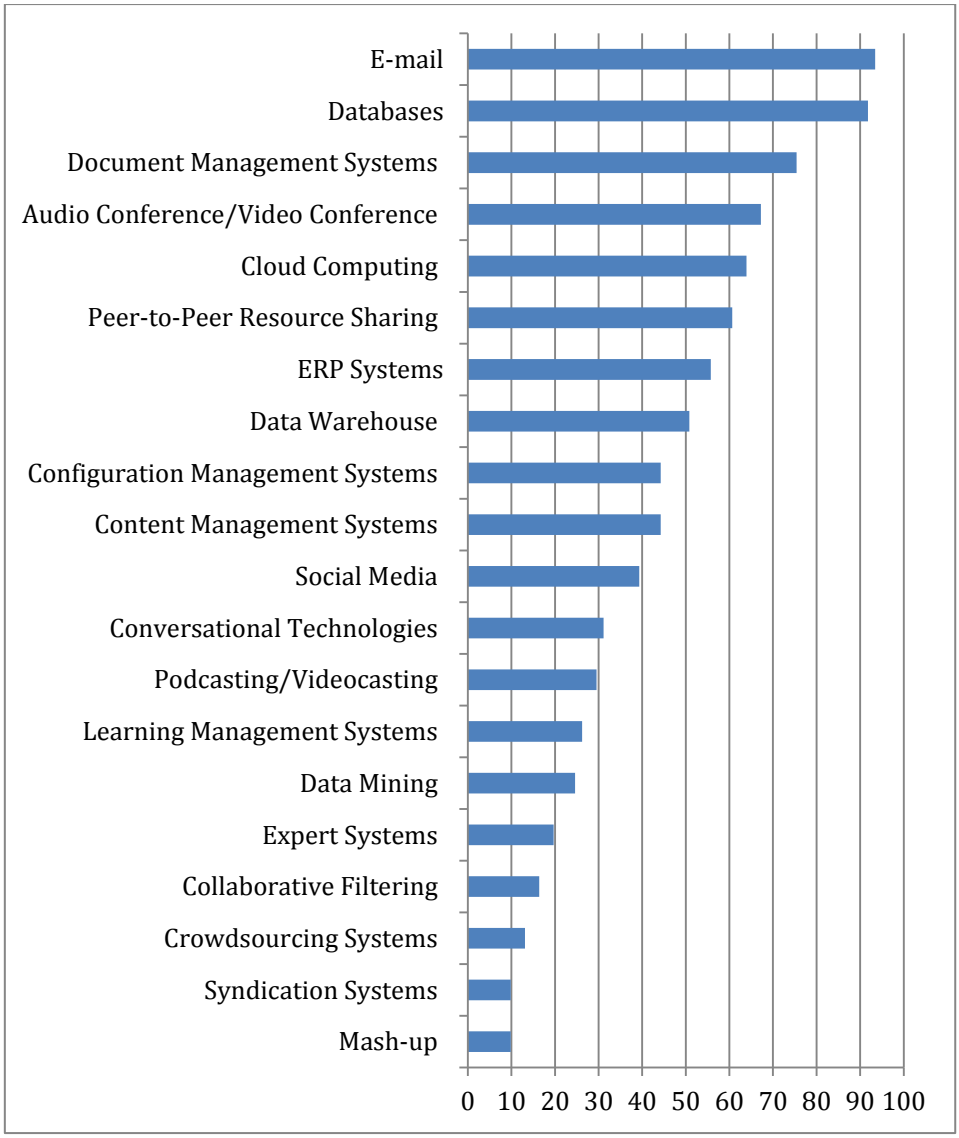


Figure 1. KM-Tools - Levels for the degree of diffusion

As far as KM-Practices adopted by SMEs are concerned, figure 2 highlights that the degree of

diffusion (DP) is higher than that of the KM-Tools. Specifically, it ranges from 18.03 (social network analysis) to 93.44 (problem solving), with a mean of 32.19 and a coefficient of variation of 113.64%. The mean and coefficient of variation were calculated considering that the total number of KM-Practices is 33, as ascertained in section 3 (Table 6).

The high value of the coefficient of variation indicates that there is a dichotomy between a group of twelve KM-Practices adopted by more than 60% of the SMEs investigated (problem solving, brainstorming, work groups, learning by doing, meeting/task force, process mapping, after action review, coaching/mentoring, knowledge mapping, benchmarking, best practice, job rotation), and a group of seventeen KM-Practices not adopted by any SME (ideas competition, knowledge elicitation interview, rating, casual mapping, knowledge modelling, balance scorecard, contextual inquiry, knowledge office, lesson learned, case based reasoning, communities of sharing, focus groups, project teams training, facilitated discussion, informal networks, knowledge cafes, seminars). Moreover, the results show that the degree of diffusion of the KM-Practices that do not focus exclusively on knowledge management issues (problem solving, learning by doing, meeting/task force, work groups) is higher than the ones more oriented to knowledge management (knowledge elicitation interview, knowledge modelling, knowledge office, knowledge cafes, communities of practice, knowledge filtering).

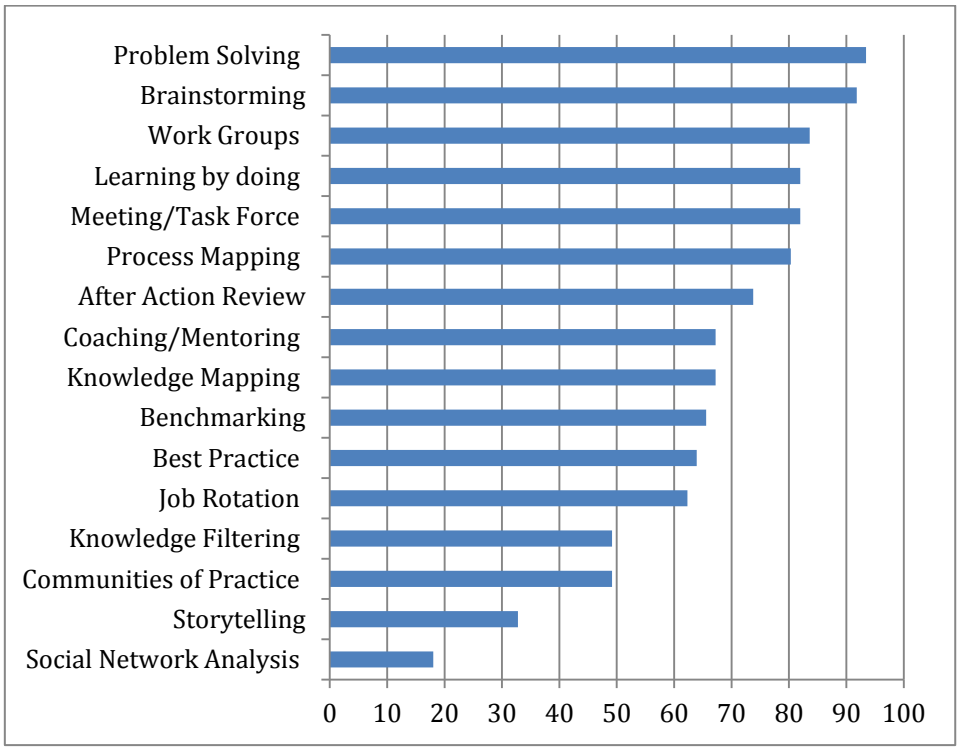


Figure 2. KM-Practices - Levels for the degree of diffusion

6.6.2 Intensity of use of KM-Tools and KM-Practices

While the degree of diffusion shows the percentage of SMEs using the specific KM-Tool (KM-Practice), the intensity of use underlines if SMEs make of it scarce or intensive use. The fuzzy set theory-based approach was used (Zadeh, 1965; Watanabe, 1979) to evaluate the intensity of use of each KM-Tool and KM-Practice adopted by SMEs. The fuzzy set theory allows us to use the rigor of logic to model natural language and common-sense reasoning (Michellone and Zollo, 2000; Zimmermann, 2001). Therefore, it is an adequate methodology to aggregate approximate judgments expressed by managers during semi-structured interviews. In particular, the intensity of use of KM-Tools (KM-Practices) was calculated as described in the following 6 steps:

I. The intensity of use was defined as a linguistic variable on five qualitative levels: very poor, poor, medium, significant and very significant
II. Each qualitative level was associated with a fuzzy number (Figure 3)
III. During the semi-structured interviews, managers provided a qualitative judgment about the intensity of use of KM-Tools (KM-Practices) by their firms
IV. Each qualitative judgment was codified into the correspondent fuzzy number
V. For each KM-Tool (KM-Practice) the fuzzy mean was calculated
VI. The fuzzy mean was defuzzified using the mean-of-maxima (MeOM) technique (Saletic et al., 2002). The result represents the intensity of use of an individual KM-Tool (KM-Practice).

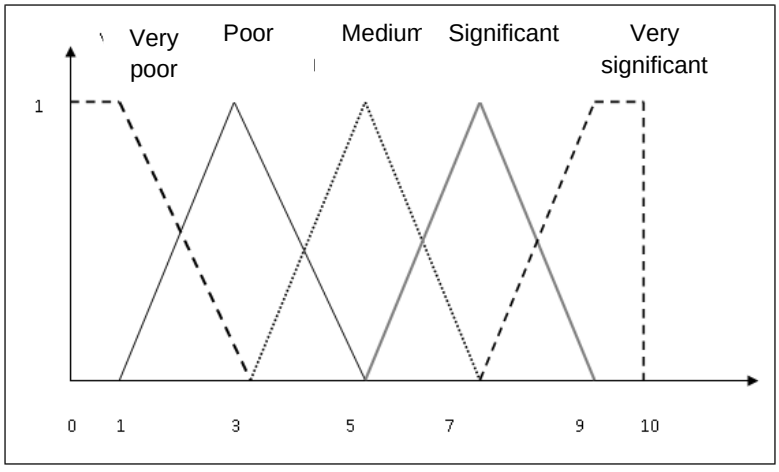


Figure 3. Fuzzy sets representing qualitative judgements for the intensity of use of KMSs

As for KM-Tools, figure 4 highlights that the intensity of use of KM-Tools (IT) ranges from 30.83 (podcasting/videocasting) to 87.81 (e-mail), with a mean of 53.44 and coefficient of variation of 27.75%. The low value of the coefficient of variation indicates that the intensity of use of KM-Tools is quite homogeneous. Most KM-Tools have an intensity of use around the mean whereas few of them have high or low intensity of use.

Figure 4. KM-Tools - Levels for the intensity of use

The first group of KM-Tools, with a high intensity of use includes e-mail (87.81), databases (78.13), configuration management systems (70.56), ERP systems (64.85), document management systems (63.04), content management systems (61.44). The second group of KM-Tools, with an around average intensity of use includes audio conference/video conference (59.27), data warehouse (56.94), conversational technologies (55.26), cloud computing (54.74), peer-to-peer resource sharing (51.22), learning management systems (48.44), social media

(46.25), syndication systems (45.83), data mining (42.25), crowdsourcing systems (41.25). Finally, a third group of KM-Tools with a low intensity of use includes mash-up (38.33), expert systems (37.50), collaborative filtering (34.50), and podcasting/videocasting (30.83).

These findings show that the KM-Tools with a greater degree of diffusion also show a higher intensity of use among the SMEs investigated. They are also more traditional KM-Tools (e-mail, databases, configuration management systems, ERP systems, document management systems). This conclusion confirms that the SMEs investigated are generally inclined to use more traditional KM-Tools intensely rather than new and more updated tools (podcasting/videocasting, collaborative filtering, mash-up, crowdsourcing systems, syndication systems) which, as stressed above, are cheaper and easier to use.

Concerning KM-Practices, figure 5 highlights that the intensity of use of KM-Practices (IP) is tends to be higher than KM-Tools. Specifically, the intensity of use of KM-Practices ranges from 42.37 (job rotation) to 68.95 (problem solving), with a mean of 55.39 and a coefficient of variation of 14.20%. The low value of the coefficient of variation indicates that the intensity of use of the different KM-Practices is quite homogeneous. In fact, with the exception of a group of KM-Practices with a high IP value (problem solving, meeting/task force, learning by doing, process mapping, work groups) and a few KM-Practices with a low IP value (job rotation, storytelling, social network analysis), most KM-Practices have an intensity of use similar to the average value.

These results also show that the SMEs surveyed make more intense use of KM-Practices that are not exclusively dedicated to knowledge management issues, such as problem solving, learning by doing, meeting/task force, or work groups. By contrast, the more specific KM-Practices and those geared to knowledge management (such as communities of practice, knowledge filtering, knowledge mapping) present a lower intensity of use.

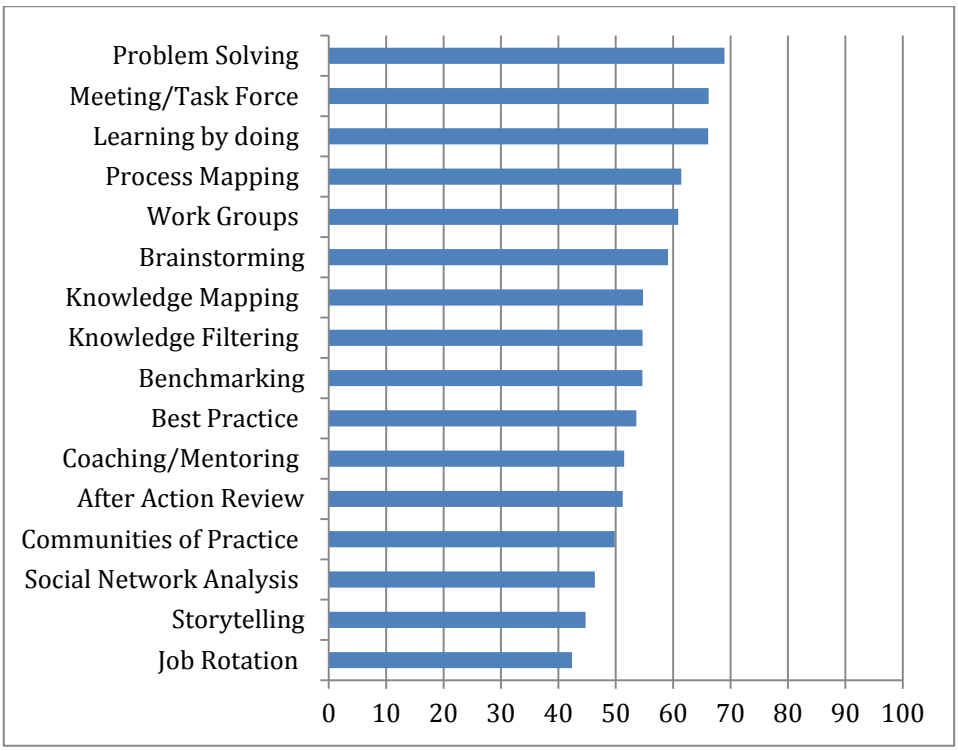


Figure 5. KM-Practices - Levels for intensity of use

By bringing together the conclusions emerging from the analysis of the degree of diffusion and the intensity of use of KM-Tools and KM-Practices, it is possible to formulate an answer to the second research question.

Concerning KM-Tools, this chapter highlights that the SMEs surveyed adopt and make more intense use of traditional KM-Tools rather than new and more updated ones that are generally cheaper and easier to use. Specifically, collaborative technologies belonging to Web 2.0 are scarcely adopted and not intensively used to improve the knowledge management process in terms of efficiency and effectiveness. This aspect is even more significant when considering that the SMEs analysed operate in high-tech and/or complex industries such as aerospace, telecommunications, transport, etc. where large companies adopt the most updated KM-Tools. This gap could be explained by the rapid technological changes in the ICT industry represented by Web 2.0. SMEs typically do not have dedicated resources to monitor and follow the evolution of Web 2.0. They are not even able to be responsive to technology dynamics. This forces them to remain backward. Therefore, this gap highlights the difficulties in following rapid technological changes and the lack of support from ICT providers.

Regarding KM-Practices, this chapter shows that the SMEs surveyed adopt and make more intensive use of KM-Practices that do not focus exclusively on the KM issue. From the semi-structured interviews, it emerged that this trend is due to two aspects. First, SMEs have scarce

resources and so instead of adopting new practices oriented to the knowledge management that specific investments need, they seek to adapt the practices they already know to the new requirements of knowledge management. The second aspect is connected with the nature of knowledge, that in these firms is prevalently human embedded and does not promote a large diffusion of formal KM-Practices.

6.7 A taxonomy of SME strategies

The previous sections highlighted the spread of KM-Tools and KM-Practices as well as their intensity of use in the sample of SMEs investigated. This section focuses on individual SMEs. The aim is to stress difference and homogeneity among SMEs and highlight their strategies with respect to the use of KM-Tools and KM-Practices. To analyse the specificity of each SME, two indices were used: the SME differentiation index and the SME intensity of use index.

The index of differentiation is defined as the number of KM-Tools (KM-Practices) adopted by the SME divided by the total number of KM-Tools (KM-Practices) identified in Table 5 (Table 6). It ranges from zero, if no KM-Tool (KM-Practice) is used by the SME, to one hundred, if the SME uses all the KM-Tools (KM-Practices).

For each SME, the index of differentiation of KM-Tools (IDT) and the index of differentiation of KM-Practices (IDP) were calculated. Table 9 shows that the index of differentiation of KM-Tools ranges from 6.06 (an SME that adopts only 2 out of 33 KM-Tools) to 60.61 (an SME that adopts 20 KM-Tools), whereas the index of differentiation of KM-Practices ranges from 12.12 (an SME that adopts 4 out of 33 KM-Practices) to 48.48 (an SME that adopts 16 KM-Practices). The comparison between the two indices shows that an SME adopting many (few) KM-Practices also uses many (few) KM-Tools. Figure 6 highlights a significant correlation (r=0.70) between the two indices and evidences that the higher the number of KM-Practices adopted, the higher the number of KM-Tools used (and vice versa). To investigate whether the correlation coefficient (r=0.70) between the index of differentiation of KM-Tools and KM Practices is statistically significant, the t-test was applied with n - 2 degrees of freedom. The calculated t value was 7.55. Our acceptance range was $-1.65 < t < 1.65$. The null hypothesis (H0) was thus rejected.

Table 9. The index of differentiation of KM-Tools and KM-Practices

Index of differentiation					
SMEs	**KM-Tools**	**KM-Practices**	**SMEs**	**KM-Tools**	**KM-Practices**
A1	21.21	42.42	**A32**	21.21	30.30
A2	54.55	45.45	**A33**	27.27	33.33
A3	9.09	15.15	**A34**	27.27	21.21
A4	33.33	45.45	**A35**	21.21	24.24
A5	12.12	33.33	**A36**	24.24	24.24
A6	15.15	33.33	**A37**	36.36	36.36
A7	6.06	12.12	**A38**	27.27	27.27
A8	60.61	33.33	**A39**	27.27	33.33
A9	24.24	36.36	**A40**	21.21	24.24
A10	9.09	18.18	**A41**	27.27	30.30
A11	21.21	33.33	**A42**	36.36	36.36
A12	24.24	36.36	**A43**	21.21	27.27
A13	30.30	45.45	**A44**	42.42	30.30
A14	24.24	33.33	**A45**	9.09	27.27
A15	33.33	36.36	**A46**	6.06	21.21
A16	60.61	48.48	**A47**	15.15	27.27
A17	36.36	42.42	**A48**	21.21	30.30
A18	33.33	36.36	**A49**	21.21	30.30
A19	33.33	30.30	**A50**	18.18	21.21
A20	21.21	42.42	**A51**	24.24	30.30
A21	9.09	15.15	**A52**	9.09	21.21
A22	12.12	33.33	**A53**	36.36	48.48
A23	6.06	12.12	**A54**	21.21	33.33
A24	24.24	36.36	**A55**	21.21	27.27
A25	21.21	33.33	**A56**	24.24	21.21
A26	24.24	39.39	**A57**	21.21	24.24
A27	57.58	45.45	**A58**	30.30	33.33
A28	45.45	42.42	**A59**	12.12	27.27
A29	39.39	33.33	**A60**	39.39	48.48
A30	39.39	39.39	**A61**	36.36	39.39
A31	33.33	42.42			

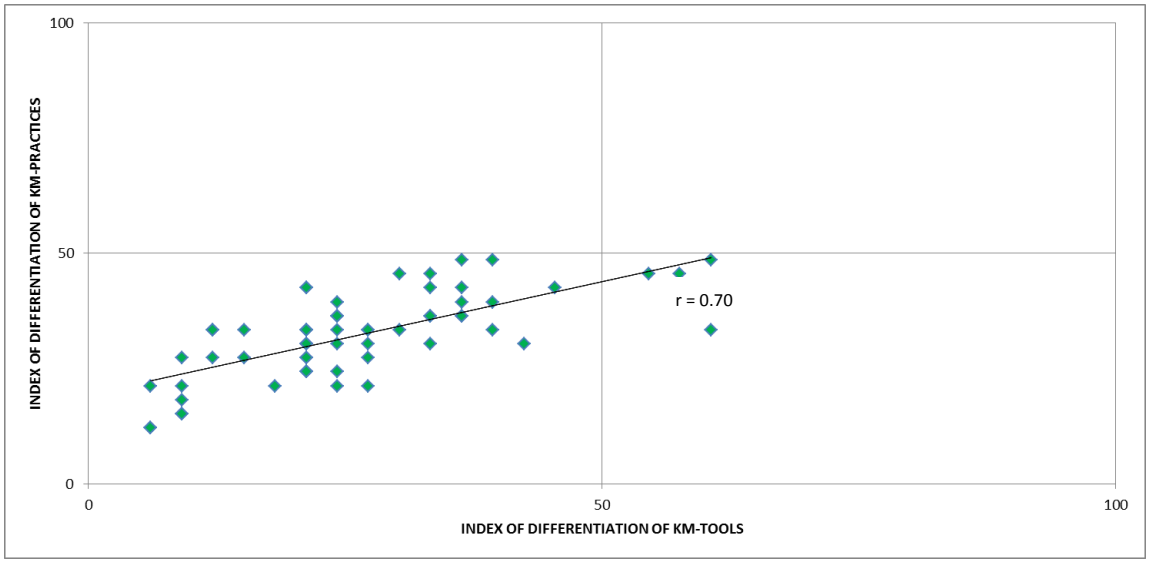


Figure 6. Correlation between the index of differentiation of KM-Tools and KM-Practices

The index of the intensity of use defined as the fuzzy mean (defuzzified) of the intensity of use of all the KM-Tools (KM-Practices) adopted by the SME (see the six steps described in §5.2).

The index of intensity of use of KM-Tools (IUT) and the index of intensity of use of KM-

Practices (IUP) were calculated for each SME. Table 10 shows that the index of intensity of use of KM-Tools ranges from 27.75 (the SME uses KM-Tools, but not assiduously) to 95.00 (the SME uses KM-Tools assiduously), whereas the index of intensity of use of KM-Practices ranges from 31.00 (the SME does not use KM-Practices assiduously) to 86.00 (the SME does not use KM-Practices assiduously). Even in this case there is a significant correlation (r=0.48) between the two indices (Figure 7), which highlights that the higher the intensity of use of KM-Practices, the higher the intensity of use of KM-Tools (and vice versa). To investigate whether the correlation coefficient (r=0.48) between the index of intensity of use of KM-Tools and KM-Practices is statistically significant, the t-test has been applied with n - 2 degrees of freedom. The calculated t value is 4.17. Our acceptance range is $-1.65 < t < 1.65$. Therefore the null hypothesis (H0) is rejected.

Table 10. The intensity of use of KM-Tools and KM-Practices

Intensity of use					
SMEs	**KM-Tools**	**KM-Practices**	**SMEs**	**KM-Tools**	**KM-Practices**
A1	65.71	50.36	**A32**	82.14	78.50
A2	62.50	54.67	**A33**	57.78	40.91
A3	86.67	86.00	**A34**	52.78	65.00
A4	61.82	45.00	**A35**	68.57	57.50
A5	72.50	47.73	**A36**	53.10	65.70
A6	82.00	64.55	**A37**	57.00	53.30
A7	72.50	55.00	**A38**	39.40	64.40
A8	55.25	65.45	**A39**	59.40	57.50
A9	60.63	50.00	**A40**	48.10	50.00
A10	58.33	67.50	**A41**	74.20	70.00
A11	65.00	54.09	**A42**	61.80	64.00
A12	55.63	53.33	**A43**	71.40	60.00
A13	54.00	50.33	**A44**	67.00	56.70
A14	39.38	41.82	**A45**	87.00	56.70
A15	78.18	79.17	**A46**	95.00	70.00
A16	27.75	37.81	**A47**	68.00	62.00
A17	65.42	67.50	**A48**	68.00	61.70
A18	68.18	62.50	**A49**	58.00	31.00
A19	75.45	54.00	**A50**	74.20	45.50
A20	65.71	50.36	**A51**	65.00	66.50
A21	86.67	86.00	**A52**	86.70	57.20
A22	72.50	47.73	**A53**	54.60	50.00
A23	72.50	55.00	**A54**	65.70	71.50
A24	60.63	50.00	**A55**	49.30	50.00
A25	65.00	54.09	**A56**	50.00	54.00
A26	64.38	79.23	**A57**	84.30	67.00
A27	28.95	55.00	**A58**	37.00	41.90
A28	68.00	71.79	**A59**	62.50	55.00
A29	68.08	55.91	**A60**	61.00	60.00
A30	65.38	65.00	**A61**	56.70	63.60
A31	82.27	54.29			

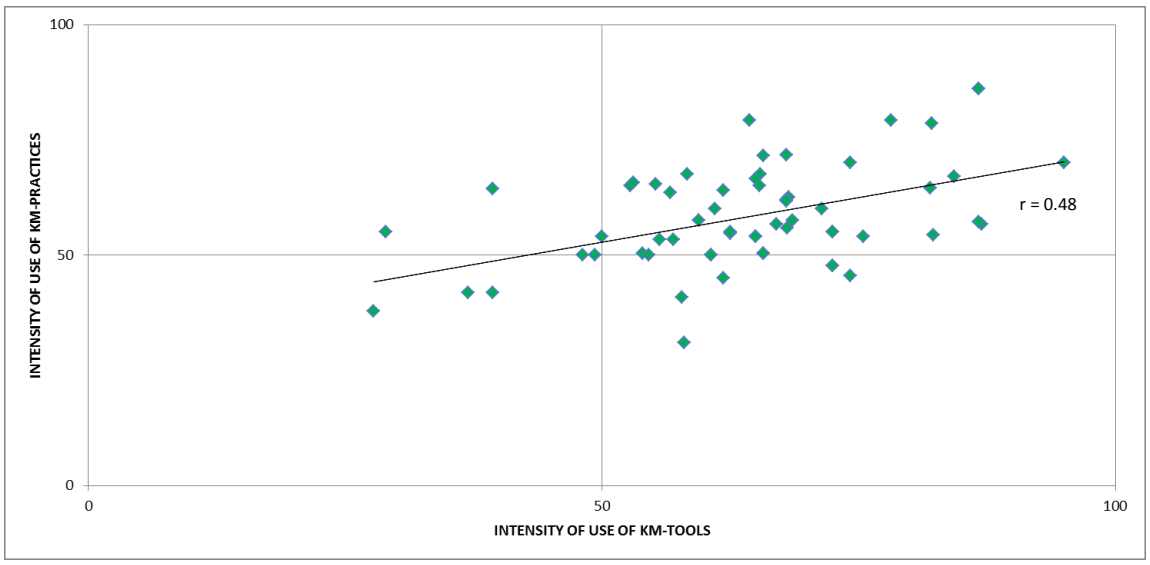


Figure 7. Correlation between the intensity of use of KM-Tools and KM-Practices

In sum, the empirical evidence shows that there is a relationship of reciprocity between KM-Tools and KM-Practices: one reinforces the other, and vice versa. The higher the number of KM-Practices used by SMEs, the higher the number of KM-Tools used by SMEs, but also the higher the intensity of use of KM-Practices by an SME, the higher the intensity of use of KM-Tools by SMEs (Figure 8).

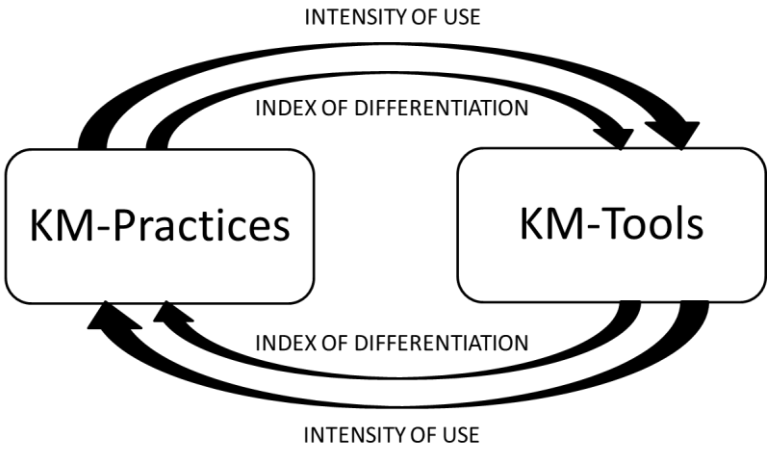


Figure 8. Relationship of reciprocity between KM-Tools and M-Practices

To highlight the relationship between the number of KM-Practices/KM-Tools adopted by an SME and their intensity of use, two more indices were introduced: the index of global differentiation (IGD) of SMEs and the index of global intensity of use (IGI) of SMEs.

$$IGD = \frac{\sqrt{IDP^2 + IDT^2}}{\sqrt{2}}$$

$$IGI = \frac{\sqrt{IUP^2 + IUT^2}}{\sqrt{2}}$$

The two indices were calculated for each SME. They range from 0 to 100. Figure 9 shows that the IGD ranges from 9.58 to 54.88 (mean of 29.78), whereas the IGI ranges from 33.17 to 86.33 (mean of 61.74). Figure 9 also shows that there is a negative correlation between the index of global differentiation and the index of global intensity of use of SMEs. To investigate whether the correlation coefficient (r= -0.42) between IGD and IGI is statistically significant, the t-test has been applied with n - 2 degrees of freedom. The calculated t value is -3.59. Our acceptance range is $-1.65 < t < 1.65$. The null hypothesis (H0) is therefore rejected. This aspect underlines that the higher the variety of KMSs (KM-Tools and KM-Practices) used by an SME, the lower their intensity of use. Moreover, it is possible to identify four areas limited by the average value of the two indices. High-right located SMEs make intensive use of many KM-Tools and KM-Practices (A1). High-left located SMEs make intensive use of few KM-Tools and KM-Practices (A2). Low-left located SMEs do not use the few resources at their disposal intensively (A3). Low-right located SMEs do not use the many KM-Practices and KM-Tools at their disposal intensively (A4).

These four areas identify different strategies for SMEs using KM-Practices and KM-Tools (Figure 10).

The A1 area is particularly important, considering, as seen above, that the variety of KMSs used is negatively correlated to their intensity of use. This area regards SMEs that have a perception of the strategic value of knowledge management and so explore the potentiality of a variety of KM-Tools and KM-Practices, exploiting them intensively. These SMEs invest in order to improve their process of knowledge management through the adoption of innovative KM-Tools (cloud computing, content management system, data mining, social media, learning management systems, peer to peer, podcasting) and KM-Practices specifically dedicated to KM (best practices, community of practices, knowledge filtering, knowledge mapping, social network analysis). This is the *Guideposts* area.

The SMEs that exploit the few KM-Practices and KM-Tools at their disposal intensively are located in the A2 area. The SMEs in this area use mainly traditional KM-Tools (such as: databases, video conference, ERP systems, e-mail, document management system) and KM-Practices not specifically dedicated to knowledge management (such as: brainstorming, problem solving, process mapping, after action review, job rotation, work groups, meeting, learning by doing). The fact that these SMEs do not use innovative KM-Tools and KM-Practices specifically

dedicated to KM highlights that they exploit what they already have, but do not actually invest in the field of KM. To shift towards Area 1, these SMEs need to acquire awareness of the importance of investing resources in the field of KM. This is the area of the *Exploiters*.

Area 3 regards SMEs that have still to acquire awareness of the strategic value of knowledge management. They have still not invested in resources such as to be competitive in the field of knowledge management. This is the area of the *Latecomers*.

Area A4 contains the SMEs that despite exploring the opportunity of a variety of KM-Practices and KM-Tools are not still able to exploit them in full. Nevertheless, from field analysis it emerges that these SMEs use innovative KM-Tools (such as: data mining, crowdsourcing systems, collaborative filtering, syndication systems, mash-up, content management systems, social media, cloud computing, learning management systems, podcasting, peer to peer) and KM-Practices specifically dedicated to KM (knowledge filtering, knowledge mapping, social network analysis, best practices, community of practices, storytelling). They are SMEs that are investing in the field of KM and have great potential for growth. Through learning and training, they can shift towards area A1.This is the area of the *Explorers*.

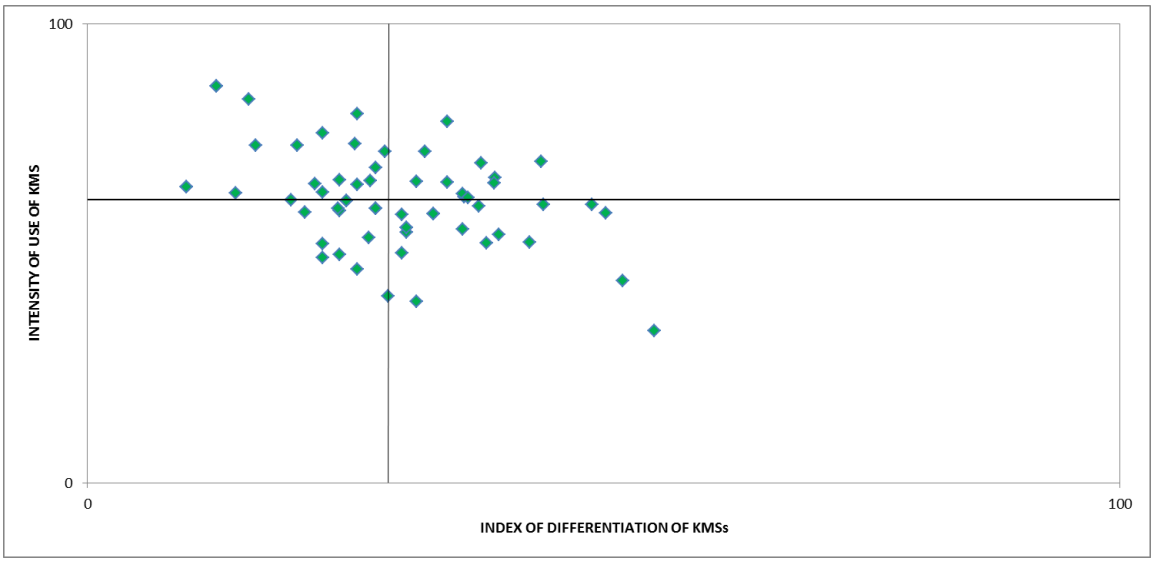


Figure 9. Correlation between the intensity of use and the index of differentiation of KMSs

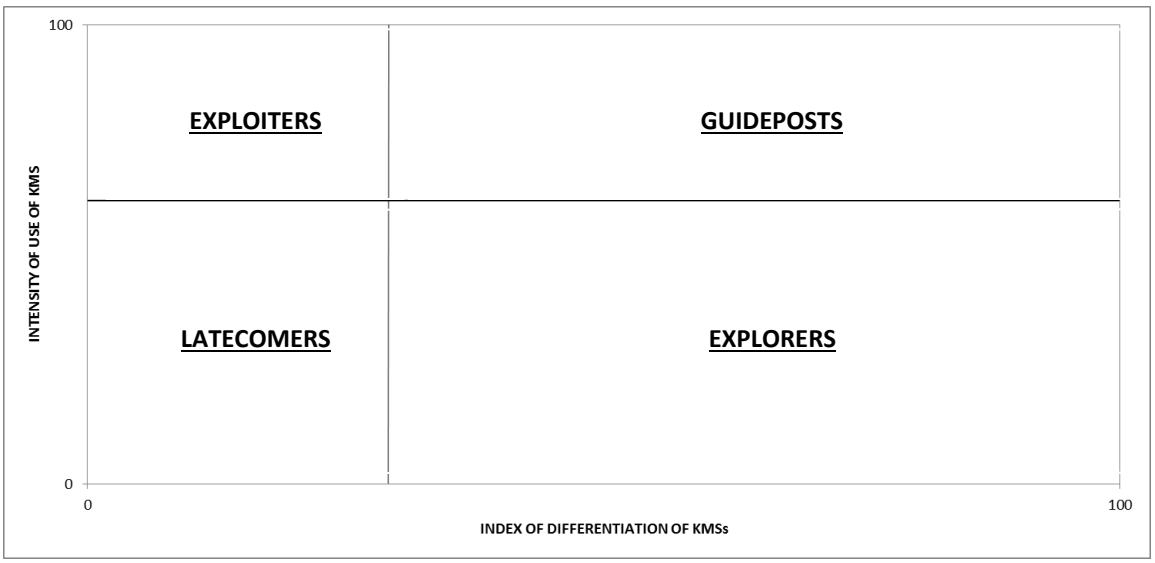


Figure 10. Taxonomy of KM strategies

6.8 Conclusions and implications

The main aim of this chapter is to contribute to increasing the body of knowledge in the field of knowledge management systems used by SMEs. KMSs were divided into two categories, i.e., KM-Practices (defined as the set of methods and techniques to support the organisational processes of knowledge management) and KM-Tools (namely the specific IT-based systems supporting KM-Practices).

The literature review allowed us to identify three research questions:

RQ1: Which KM-Tools and KM-Practices are used by SMEs?

RQ2: What is the degree of diffusion and the intensity of use of KM-Tools and KM-Practices among SMEs?

RQ3: What are the strategies of use of KM-Tools and KM-Practices by SMEs?

As for *RQ1*, on the base of a study of the literature and a focus group that involved senior IT consultants/researchers operating in the field of SMEs, a taxonomy of KM-Tools and KM-Practices was identified. These two taxonomies offer SMEs the opportunity to identify a set of tools and practices that could be used to improve the different phases of the knowledge management process (creation, storage, transfer).

Regarding *RQ2*, using semi-structured interviews with 61 SMEs, this chapter highlights that the SMEs surveyed adopt and make more intensive use of traditional KM-Tools rather than new and more updated ones that are generally cheaper and easier to use. This gap could be the result of the rapidity of technological changes in the field of ICTs. Moreover, considering that SMEs

generally do not have dedicated resources to monitor and follow technological evolution, this forces them to remain in a backward position. The chapter also shows that the SMEs surveyed adopt KM-Practices use more intensively those that do not focus exclusively on the KM process. From the semi-structured interviews it emerged that this trend is due to two characteristics of SMEs. Firstly, SMEs have scarce resources and so instead of investing in new practices geared to knowledge management, they seek to adapt the practices they already know to the new requirements of knowledge management. The second peculiarity is connected to the nature of knowledge. Knowledge of SMEs is mainly embedded in human resources, and this does not promote a wide diffusion of formal KM-Practices. In summary, these results seem to show that SMEs tend to use more traditional tools and adapt practices already used for knowledge management.

Regarding *RQ3*, the chapter points out *a relationship of reciprocity* between KM-Tools and KM-Practices: one reinforces the other and vice versa. The higher the number of KM-Practices used by SMEs, the higher the number of KM-Tools they use. This result is in line with the previous study by Carayannis (1999) in which it is assumed that KM plays a crucial role in fostering a synergistic symbiosis between ICTs and managerial/organizational practices.

Moreover, the higher the intensity of use of KM-Practices by SMEs, the higher the intensity of their use of KM-Tools. Moreover, the chapter highlights a negative relationship between the number of KMSs (KM-Tools and KM-Practices) used by SMEs and their intensity of use. Finally, the chapter proposes a taxonomy that synthesises the strategies of using KM-Practices and KM-Tools on the part of SMEs. Specifically, four strategies were identified: *guidepost*, *exploiter*, *explorer*, and *latecomer*.

The *guidepost* is an SME with a perception of the strategic value of knowledge management and that explores the potential of a number of KM-Tools and KM-Practices, intensively exploiting them. *Guidepost* SMEs invest in order to improve the knowledge management process by adopting innovative KM-Tools and KM-Practices specifically dedicated to KM.

The *exploiter* is an SME that intensively exploits the few KM-Practices and KM-Tools at its disposal. The *SME exploiter* has yet to become aware of the importance of investing resources in the field of KM. In fact, it uses mainly traditional KM-Tools and KM-Practices not specifically dedicated to KM.

The *explorer* is an SME that, despite exploring the opportunities of a variety of KM-Practices and KM-Tools, is still not able to exploit them in full. *Explorer* SMEs use innovative KM-Tools and KM-Practices specifically dedicated to KM. They invest in the field of KM and through learning and training processes could become guidepost SMEs.

The *latecomer* is an SME that is still unaware of the strategic value of knowledge management and still does not have the resources necessary to be competitive in the field of knowledge management.

Future research

The above results provide guidance for future research.

The first research implication derives from the fact that tools are aligned with practices (relationship of reciprocity), but SMEs seem to prefer not to use updated KM-Tools rather than the newer ones and KM-Practices that are not exclusively focussed on the KM process. This issue requires further and in-depth analysis concerning the degree of alignment between KM-Tools, KM-Practices and the nature of knowledge of SMEs from both the ontological and epistemological perspectives.

The second research implication is a consequence of the taxonomy of the strategies of SMEs (*Guideposts, Explorers, Exploiters, Latecomers*). This issue requires an in-depth analysis to verify whether the strategy used affects the performance of an SME.

Implications

From the SMEs' point of view, this chapter highlights that they could further increase the impact of KM by better exploiting the opportunity offered by the new ICTs (such as: cloud computing, crowdsourcing systems, collaborative filtering, wiki).

From the KMS providers' point of view, this chapter stresses that SMEs typically do not have dedicated resources to monitor the process of innovation in the field of KMSs. Nevertheless, they may well represent a significant market. To seize this opportunity, it is necessary create not only a new market segment dedicated to SMEs, but also direct channels of communication (even virtual) between SMEs and KM providers.

References

Adamides, E.D., & Karacapilidis, N. (2006). Information technology support for the knowledge and social processes of innovation management. *Technovation*, 26(1), 50-59.

Alavi, M., & Leidner D.L. (2001). Review: knowledge management and knowledge management systems: conceptual foundations and research issues. *MIS Quarterly*, 25(1), 107-136.

Al-Mutawah, K., Lee, V., & Cheung, Y. (2009). A new multi-agent system framework for tacit knowledge management in manufacturing supply chains. *Journal of Intelligent Manufacturing*, 20(5), 593-610.

Ambrosini, V., & Bowman, C. (2008). Surfacing tacit sources of success. *International Small Business Journal*, 26(4), 403-431.

Antonelli, C., Geuna, A., & Steinmueller, W.E. (2000). Information and communication technologies and the production, distribution and use of knowledge. *International Journal of Technology Management*, 20(1-2), 72-94.

Benbya, H., Passiante, G., & Belbaly, N.A. (2004). Corporate portal: A tool for knowledge management synchronization. *International Journal of Information Management*, 24(3), 201-220

Beylier, C., Pourroy, F., Villeneuve, F., & Mille, A. (2009). A collaboration-centred approach to manage engineering knowledge: a case study of an engineering SME. *Journal of Engineering Design*, 20(6), 523-542.

Boden, A., Avram, G., Bannon, L., & Wulf, V. (2012). Knowledge sharing practices and the impact of cultural factors: reflections on two case studies of offshoring in SME. *Journal of Software: Evolution and Process*, 24(2), 139-152.

Bolisani, E., & Scarso, E. (1999). Information technology management: a knowledge-based perspective. *Technovation*, 19(4), 209-217.

Cappellin, R. (2003). Territorial knowledge management: towards a metrics of the cognitive dimension of agglomeration economies. *International Journal of Technology Management*, 26(2-4), 303-325.

Carayannis, E.G. (1999). Fostering synergies between information technology and managerial and organizational cognition: the role of knowledge management. *Technovation*, 19(4), 219-231.

Cerchione, R., Esposito, E., & Spadaro, M.R. (2015). The Spread of Knowledge Management in SMEs: A Scenario in Evolution. *Sustainability*, 7, 10210-10232.

Chen, C.W., Chang, M.L., & Tseng, C.P. (2012). Human Factors of Knowledge-Sharing Intention among Taiwanese Enterprises: A Model of Hypotheses. *Human Factors and Ergonomics in Manufacturing & Service Industries*, 22(4), 362-371.

Chong, C.W., Chong, S.C., & Gan, G.C. (2011). Inter-organizational knowledge transfer needs among small and medium enterprises. *Library Review*, 60(1), 37-52.

Choudhary, A.K., Harding, J., Camarinha-Matos, L.M., Lenny Koh, S.C., & Tiwari, M.K. (2013). Knowledge management and supporting tools for collaborative networks. *International Journal of Production Research*, 51(7), 1953-1957.

Chua, A. (2004). Knowledge management system architecture: A bridge between KM consultants and technologists. *International Journal of Information Management*, 24(1), 87-98.

Corso, M., Martini, A., Pellegrini, L., & Paolucci, E. (2003). Technological and Organizational Tools for Knowledge Management: In Search of Configurations. *Small Business Economics*, 21(4), 397-408.

Davenport, S. (2005), Exploring the role of proximity in SME knowledge-acquisition. *Research Policy*, 34(5), 683-701.

Desouza, K.C., & Awazu, Y. (2006). Knowledge management at SMEs: five peculiarities. *Journal of Knowledge Management*, 10(1), 32-43.

Dotsika, F., & Patrick, K. (2013). Collaborative KM for SMEs: a framework evaluation study. *Information Technology & People*, 26(4), 368-382.

du Plessis, M. (2008). The strategic drivers and objectives of communities of practice as vehicles for knowledge management in small and medium enterprises. *International Journal of Information Management*, 28(1), 61-67.

Durst, S., & Edvardsson, I.R. (2012). Knowledge management in SMEs: a literature review. *Journal of Knowledge Management*, 16(6), 879-903.

Durst, S., & Wilhelm, S. (2011). Knowledge management in practice: insights into a medium sized enterprise's exposure to knowledge loss. *Prometheus: Critical Studies in Innovation*, 29(1), 23-38.

Dyer, J.H., & Hatch, N.W. (2006). Relation-specific capabilities and barriers to knowledge transfers: Creating advantage through network relationships. *Strategic Management Journal*, 27(8), 701-719.

Edvardsson, I.R. (2009). Is knowledge management losing ground? Developments among Icelandic SMEs. *Knowledge Management Research & Practice*, 7, 91-99.

Edwards, T. (2007). A critical account of knowledge management: agentic orientation and SME innovation. *International Journal of Entrepreneurial Behaviour & Research*, 13(2), 64-81.

Egbu, C.O., Hari, S., & Renukappa, S.H. (2005). Knowledge management for sustainable competitiveness in small and medium surveying practices. *Structural Survey*, 23(1), 7-21.

Esper, T.L., Ellinger, A.E., Stank, T.P., Flint, D.J., & Moon, M. (2010). Demand and supply integration: a conceptual framework of value creation through knowledge management. *Journal of the Academy of Marketing Science*, 38(1), 5-18.

Esposito, E., & Mastroianni, M. (2001). Information technology and personal computers: The relational life cycle. *Technovation*, 22(1), 41-50.

European Commission. (2005). The New SME Definition. User Guide and Model Declaration. European Commission, DG Enterprise & Industry, Bruxelles.

Fink, K., & Ploder, C. (2009). Knowledge Management Toolkit for SMEs. *International Journal of Knowledge Management*, 5(1), 46-60.

Garrigos-Simon, F.J., Lapiedra Alcami, R., & Barbera Ribera, T. (2012). Social networks and Web 3.0: their impact on the management and marketing of organizations. *Management Decision*, 50(10), 1880-1890.

Gholipour, R., Jandaghi, G., & Hosseinzadeh, S.A.A. (2010). Explanation of knowledge management enabler as a latent variable: A case study of SMEs in Iran African. *Journal of Business Management*, 4(9), 1863-1872.

Gottschalk, P. (2000). Studies of key issues in IS management around the world. *International Journal of Information Management*, 20(3), 169-180.

Grace, T.P.L. (2009). Wikis as a knowledge management tool. *Journal of Knowledge Management*, 13(4), 64-74.

Gresty, M. (2013). What role do information systems play in the knowledge management activities of SMEs? *Business Information Review*, 30(3), 144-151.

Gunasekaran, A., & Ngai, E.W.T. (2007). Knowledge management in 21st century manufacturing. *International Journal of Production Research*, 45(11), 2391-2418.

Hsu, R.G., Lawson, D., & Liang, T.P. (2007). Factors affecting knowledge management adoption of Taiwan small and medium-sized enterprises. *International Journal Management and Enterprise Development*, 4(1), 31-51.

Hussain, I., Xiaoyu, Y.U., Wang, L., Si, S., & Ahmed, S. (2011). Organizational knowledge management capabilities and Knowledge management success (KMS) in small and medium enterprises (SMEs). *African Journal of Business Management*, 5(22), 8971-8979.

Hutchinson, V., & Quintas, P. (2008). Do SMEs do knowledge management? Or Simply Manage what they Know? *International Small Business Journal*, 26(2), 131-154.

Kanat, S., & Atilgan, T. (2014). Effects of knowledge management on supply chain management in the clothing sector: Turkish case. *Fibres and Textiles in Eastern Europe*, 103, 9-13.

Lakshman, C., & Parente, R.C. (2008). Supplier-focused knowledge management in the automobile industry and its implications for product performance. *Journal of Management Studies*, 45(2), 317-342.

Lee, A.H.I., Wang, W.M., & Lin, T.Y. (2010). An evaluation framework for technology transfer of new equipment in high technology industry. *Technological Forecasting and Social Change*, 77(1), 135-150.

Lee, M.R., & Lan, Y.C. (2011). Toward a unified knowledge management model for SMEs. *Expert Systems with Applications*, 38(1), 729-735.

Levy, M., Loebbecke, C., & Powell, P. (2003). SMEs, co-opetition and knowledge sharing: the role of information systems. *European Journal of Information Systems*, 12(1), 3-17.

Lin, I., Seidel, R., Shekar, A., Shahbazpour, M., & Howell, D. (2012). Knowledge Sharing Differences Between Engineering Functional Teams: An Empirical Investigation. *Journal of Information & Knowledge Management*, 11(3), 1-14.

Lockett, N., Cave, F., Kerr, R., & Robinson, S. (2009). The influence of co-location in higher education institutions on small firms' perspectives of knowledge transfer. *Entrepreneurship & Regional Development*, 21(3), 265-283.

Lopez-Nicolas, C., & Soto-Acosta, P. (2010). Analyzing ICT adoption and use effects on knowledge creation: An empirical investigation in SMEs. *International Journal of Information Management*, 30(6), 521-528.

Massa, S., & Testa, S. (2011). Knowledge domain and innovation behaviour. VINE, 41(4), 483-454.

Matlay, H., & Westhead, P. (2005). Virtual teams and the rise of e-entrepreneurship in Europe. *International Small Business Journal*, 23(3), 279-302.

Michellone, G., & Zollo, G. (2000). Competences management in knowledge-based firms. *International Journal of Technology Management*, 20(1), 134-135.

Milosz, M., & Milosz, E. (2010). Critical success factors and barriers to implementation of knowledge management systems at polish SMEs. *Actual Problems of Economics*, 6, 309-315.

Moffett, S., & McAdam, R. (2006). The effects of organizational size on knowledge management implementation: Opportunities for small firms? *Total Quality Management*, 17(2), 221-241.

Navarro, J.G.C., Dewhurst, F.W., & Eldridge, S. (2010). Linking chief knowledge officers with customer capital through knowledge management practices in the Spanish construction industry. *The International Journal of Human Resource Management*, 21(3), 389-404.

Noblet, J.P., & Simon, E. (2012). The role of disseminative capacity in knowledge sharing: which model can be applied to SMEs? *Problems and Perspectives in Management*, 10(3), 57-66.

Nunes, M.P., Annansingh, F., & Eaglestone, B. (2006). Knowledge management issues in knowledge-intensive SMEs. *Journal of Documentation*, 62(1), 101-119.

Patalas-Maliszewska, J., & Hochmeister, M. (2011). Modeling Strategic-Knowledge-Resource Management Based on Individual Competencies in SMEs. *Contemporary Economics*, 5(2), 72-79.

Perez-Araos, A., Barber, K.D., Munive-Hernandez, J.E., & Eldridge, S. (2007). Designing a knowledge management tool to support knowledge sharing networks. *Journal of Manufacturing Technology Management*, 18(2), 153-168.

Pillania, R.K. (2008). Creation and categorization of knowledge in automotive components SMEs in India. *Management Decision*, 46(10), 1452-1464.

Qu, S.Q., & Dumay, J. (2011). The qualitative research interview. *Qualitative Research in Accounting & Management*, 8(3), 238-64.

Razmerita, L., & Kirchner, K. (2011). How wikis can be used to manage knowledge in SMEs: A case study. *Business Information Review*, 28(3), 175-178.

Rosu, S.M., Dragoi, G. & Guran, M. (2009). A Knowledge Management Scenario to Support Knowledge Applications Development in Small and Medium Enterprises. *Advances in Electrical and Computer Engineering*, 9(1), 8-15.

Roy, M.J., & Therin, F. (2008). Knowledge Acquisition and Environmental Commitment in SMEs. *Corporate Social Responsibility and Environmental Management*, 15(5), 249-259.

Samuel, K.E., Goury, M.L., Gunasekaran, A., & Spalanzani, A. (2011). Knowledge management in supply chain: an empirical study from France. *Journal of Strategic Information Systems*, 20(3), 283-306.

Shih, K.H., Chang, C.J., & Lin, B. (2010). Assessing knowledge creation and intellectual capital in banking industry. *Journal of Intellectual Capital*, 11(1), 74-89.

Sparrow, J. (2001). Knowledge management in small firms. *Knowledge and Process Management*, 8(1), 3-16.

Spraggon, M., & Bodolica, V. (2008). Knowledge creation processes in small innovative hi-tech firms. *Management Research News*, 31(11), 879-894.

Valmohammadi, C. (2010). Investigation and assessment of critical success factors of knowledge management implementation in Iranian small-to-medium sized enterprises. *Journal of Applied Sciences*, 10(19), 2290-2296.

Watanabe, N. (1979). Statistical Methods for Estimating Membership Functions. *Japanese Journal of Fuzzy Theory and Systems*, 5(4).

Whyte, G., & Classen, S. (2012). Using storytelling to elicit tacit knowledge from SMEs. *Journal of Knowledge Management*, 16(6), 950-962.

Wong, K.Y., & Aspinwall, E. (2005). An empirical study of the important factors for knowledge-management adoption in the SME sector. *Journal of Knowledge Management*, 9(3), 64-82.

Wong, K.Y. (2005). Critical Success factors for implementing knowledge management in small and medium enterprises. *Industrial Management & Data Systems*, 105(3), 261-279.

Yao, L., Othman, A., Abdalla, A.N., & Jing, W. (2011). A novel sense-making model of effective knowledge management within SMEs. *African Journal of Business Management*, 5(11), 4423-4431.

Zadeh, L.A. (1965). Fuzzy Sets. *Information and Control*, 8(3), 338-353.

Zimmermann, H. (2001). Fuzzy set theory and its applications, Kluwer Academic Publishers, Boston.

7. Alignment Evaluation between Knowledge Management Systems and the nature of SMEs' Knowledge: A 3D Fuzzy Model

7.1 Abstract

This chapter analyses the alignment between knowledge management systems and the nature of small and medium enterprises' knowledge. Based on a Delphi panel involving senior KM consultants and a field analysis conducted in 61 SMEs operating in complex manufacturing and service industries, a software in Matlab language named KM-Alignment Evaluation System (KM-AES) has been designed to elaborate the collected data. The methodology used by the software is based on a three-dimensional fuzzy term set. The results highlight that KM-Tools used by the firms are aligned with KM-Practices they should support according to the epistemological and ontological dimensions identified by Nonaka. Specifically, there is a relation of reciprocity between KM-Tools and KM-Practices used by the firms: the higher the degree of coverage of KM-Tools with KM-Practices, the higher the degree of coverage of KM-Practices with KM-Tools and vice versa. Nevertheless, both KM-Tools and KM-Practices are misaligned with firm's corporate knowledge used in five macro-processes identified (planning, production, organization, market relationships, strategic relationships). Moreover, the chapter has allowed to identify four different strategies of KMSs adoption for SMEs: misaligned SMEs, efficiently misaligned SMEs, effectively misaligned SMEs, aligned SMEs. The findings show that the majority of surveyed firms are efficiently misaligned SMEs. These latter have great potential for growth and through appropriate learning and training processes involving KM experts and/or KMSs' providers, they can become aligned SMEs.

Keywords - knowledge management systems; fuzzy logic; IT-based tools; practices; small and medium enterprises.

7.2 Introduction

Many papers have stressed that in modern industrial systems knowledge is a critical success factor for enterprises' competitiveness. Knowledge management is becoming increasingly important for both large companies and small and medium enterprises.

In the last fifteen years the interest of the literature on the issue of knowledge management has outclassed the one on technology management. Using Scopus database, between 1971 and 1985 the papers on KM represented the 29% of the ones on TM (33 papers VS 114 papers), between 1986 and 2000 this percentage rose to 84% (1130 papers VS 1349 papers), in the period that spans the years 2001-2015 the percentage exploded to 965% (51231 papers VS 5307). This enormous interest versus KM has brought to the fore the issues of creation and diffusion of knowledge. Many authors have dealt with these topics. Nonaka (1994), starting from the contribution of Polanyi (1966) that identifies two type of knowledge (tacit knowledge and explicit knowledge), proposes the SECI model that summarizes four modes for knowledge creation (Socialisation, Externalization, Internalization and Combination) and introduces the Spiral of organizational knowledge creation based on two dimensions of knowledge: epistemological and ontological. Davenport and Prusak (1998) highlight the processes of knowledge generation and transfer that allow the exploitation of the system of interpersonal relationships. Von Krogh (1998) looks at the knowledge from two perspectives (cognitivist and constructionist), the author identifies four processes of knowledge creation: Capturing, transacting, bestowing and indwelling. Andrews and Delahaye (2000) underline the psychological filters influencing the knowledge process in the organisational learning. Bhatt (2001) divide the process of knowledge management in five phases (knowledge creation, knowledge validation, knowledge presentation, knowledge distribution, and knowledge application activities) and analyses the relationship among technologies, techniques, and people. Zack (1999) proposes a knowledge management architecture for configuring firm’s resources and capability to leveraging its codified knowledge. Many papers have highlighted the factors that affect knowledge management (Liu et al., 2014; Mak and Ramaprasad, 2003; Sudhindra et al., 2014; Anand, 2013; Joshi, 2012; Milosz and Milosz, 2010; Nunes et al. 2006), the impact of knowledge management on firm’s performance (Bagnoli and Vedovato, 2012; Daud and Yusoff, 2011; Delen et al., 2013; Gholami et al., 2013; Hong et al., 2014; Liu and Abdalla, 2013; Omerzel and Antončič, 2008; Roxas et al., 2014; Salojärvi et al., 2005; Soon and Zainol, 2011; Wei et al., 2011), and the knowledge management systems supporting the process of knowledge management (Beylier et al., 2009; Choudhary, 2013; Dotsika and Patrick, 2013; Edvardsson,

2009; Grace, 2009; Gresty, 2013; Lisanti and Luhukay, 2014; Lopez-Nicolas and Soto-Acosta, 2010; Razmerita and Kirchner, 2011; Rosu et al., 2009; Zhou, 2014).

Although this ample literature analyses the topic of knowledge management from a variety points of view, the issue of alignment between the nature of firm's knowledge and the knowledge management systems (KMSs) used to support knowledge management appear to be largely neglected. Nevertheless, this issue is extremely relevant for three main aspects. Firstly, a correct alignment between the nature of knowledge and the KMSs used is itself a factor that could affect positively the process of KM (vice versa could be a barrier to the process of KM). Secondly, a misalignment between the nature of knowledge and KMSs generates problems of inefficiency (i.e.: underutilization of KMSs) and inefficacy (i.e.: use of not suitable KMSs). Thirdly, in the last twenty years the information and communications technologies (ICTs) are offering more and more new knowledge management tools that are low cost, easy to use and with an increasing ratio performance/price (Antonelli, et al., 2000; Esposito and Mastroianni, 1998 and 2001; Garrigos-Simon, et al., 2012; Matlay and Westhead, 2005).

In this context, the aim of this chapter is to deal with the issue of alignment between the nature of firm's knowledge and the knowledge management systems used. Specifically, the chapter proposes a fuzzy methodology to evaluate the level of alignment between KMSs and the nature of knowledge. This latter is identified through the epistemological and ontological dimensions (Nonaka, 1994). With these premises this chapter aims to provide an answer to this research question:

RQ1: What is the degree of alignment between KMSs adopted by SMEs and the nature of their knowledge in the ontological and epistemological dimensions?

According with the main aim of providing an overview on the alignment among firm's knowledge, KM-Tools and KM-Practices, this latter has been subdivided into three research questions:

RQ1.1: What is the degree of alignment between KM-Tools adopted by SMEs and the nature of their knowledge in the ontological and epistemological dimensions?
RQ1.2: What is the degree of alignment between KM-Practices adopted by SMEs and the nature of their knowledge in the ontological and epistemological dimensions?
RQ1.3: What is the degree of alignment between KM-Tools and KM-Practices adopted by SMEs in the ontological and epistemological dimensions?

In order to provide answers to the above three research questions semi-structured interviews

were carried out in a sample of SMEs.

The chapter is structured in six sections. After the introduction, the context of investigation is analysed in the second section. In the third section the methodology is presented. The fourth section is dedicated to the phase of presentation of results. Finally, conclusions and implications.

The following section provides an overview of the research context in which the field analysis was conducted.

7.2 The context of investigation

The field analysis was carried out on a sample of 61 SMEs located in the south of Italy. They mainly comprise small firms as shown in table 1. For this table, the latest EU definition of SMEs proposed by the EU Commission is adopted (European Commission, 2005).

Table 1. Breakdown of SMEs by employee bands

Employees band	Number of SMEs	%
Micro (0-9)	9	15
Small (10-49)	30	49
Medium (50-249)	22	36
Total	61 SMEs	

Table 2 shows that the 61% of SMEs operates in high-tech and complex manufacturing industries, such as aerospace, automotive and engineering. The 39% in service industry, such as information and communications technology, research and development, and management consulting.

Table 2. Supply firm industries

Overall economic industry	Specific industry	Number of SMEs	%
Manufacturing	Aerospace	12	20
	Automotive	20	33
	Engineering	5	8
Service	Research and Development	7	11
	Information and Communications Technology	14	23
	Management Consulting	3	5
Total		61 SMEs	

The following section presents the methodological steps to be taken to provide an answer to the three research questions identified.

7.3. Methodology

The methodology has been divided into the following four different steps (Figure 1):

STEP 1 - Field Analysis, which provides as outputs a list of KM-Tools, a list of KM-Practices used by the surveyed SMEs and for each firm a map of firm's knowledge associated to the five macro-processes identified: planning, production, organization, market relationships, strategic relationships. These maps are defined by the epistemological and ontological dimensions identified by Nonaka;

STEP 2 - Meetings with experts, in which KM-Tools and KM-Practices used by the surveyed sample of SMEs are included in two maps according to the epistemological and ontological dimensions;

STEP 3 - Identification of alignment maps, which allows to identify the logical intersections among the three maps provided in the previous steps: the map of firm's knowledge, the map of KM-Tools and the map of KM-Practices used by the firm. The outputs of this step are three alignment maps including the following logical intersections: 1) firm's knowledge and KM-Tools, 2) firm's knowledge and KM-Practices, and 3) KM-Tools and KM-Practices;

STEP 4 - Definition of alignment indexes, which consists in the definition of the six following indexes to evaluate the degree of alignment among firm's knowledge, KM-Tools and KM-Practices adopted by the firm: the degree of exploitation of KM-Tools (DET), the degree of exploitation of KM-Practices (DEP), the degree of satisfaction of KM-Tools (DST), the degree of satisfaction of KM-Practices (DSP), the degree of coverage of KM-Tools with KM-Practices (DCT), the degree of coverage of KM-Practices with KM-Tools (DCP).

Finally, the results obtained for the sample of surveyed firms are compared analysing the relations between the defined indexes: 1) the relation between DET and DST, 2) the relation between DEP and DSP, and 3) the relation between DCT and DCP. The four steps of the methodology are described in depth in the following paragraphs.

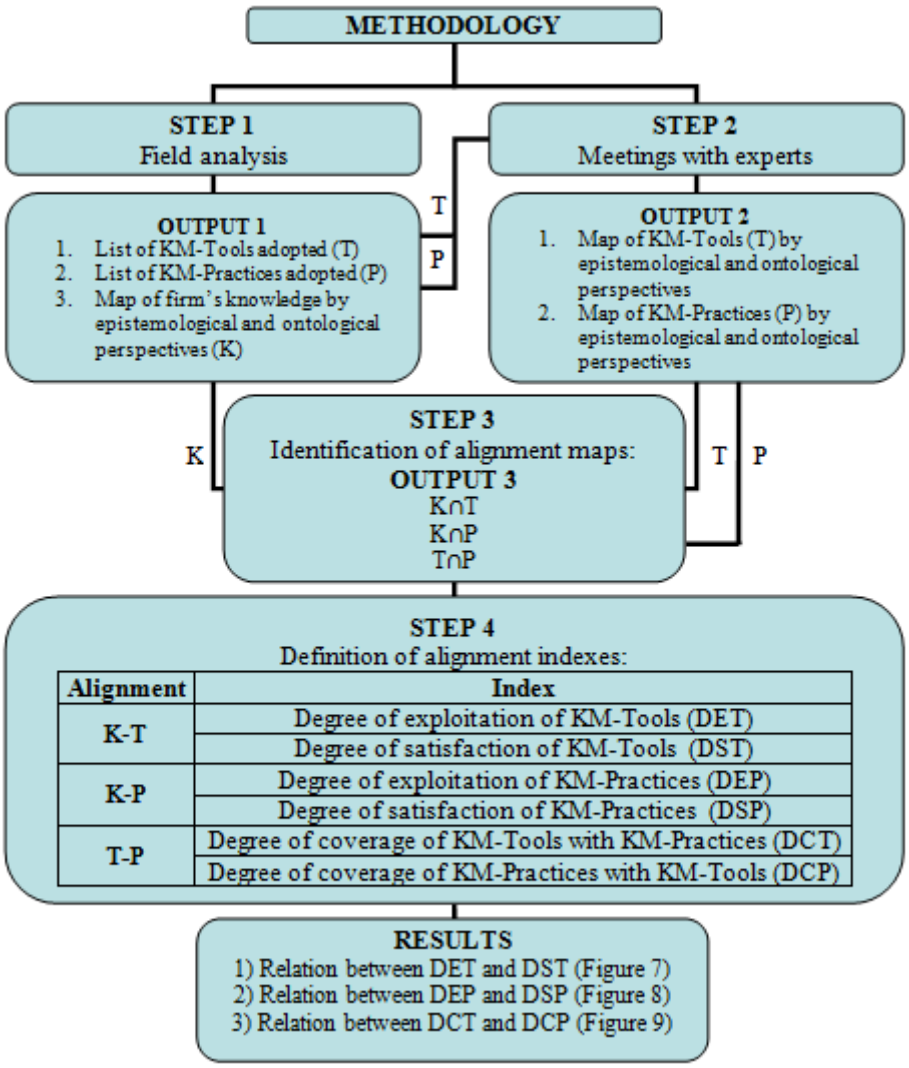


Figure 1. Flow chart of the methodology

STEP 1 - Field analysis

The investigation methodology used in the first step of field analysis is based on semi-structured interviews. The semi-structured interview approach has the advantage that it does not limit the interview to a set of predetermined responses, but at the same time the use of predetermined questions gives uniformity to the investigation (Qu and Dumay, 2011). The investigation was organised into the following three phases:

1) *Definition of basic research objectives and preparation of the draft semi-structured questionnaire*. In this phase, a first version of the semi-structured questionnaire was prepared starting from the basic objectives of the investigation.

2) *Testing the semi-structured questionnaire*. In this step, the semi-structured questionnaire was

tested through 3 pilot interviews carried out in three firms from the surveyed sample. The semi-structured questionnaire was revised on the basis of the feedback received.

3) *Face-to-face distribution of the questionnaire*. This phase consists in a face-to-face distribution of the questionnaire to two managers with different skills and roles. This allowed us to obtain different strategic and operational perspectives. The total number of respondents was 61 out of 78 firms with a response rate of 78.2%.

This phase provides two main findings: 1) a list of KM-Tools adopted by the selected firm (Output 1.1), 2) a list of KM-Practices adopted by the selected firm (Output 1.2), and 3) a map of firm's knowledge according to the epistemological and ontological dimensions (Output 1.3).
As far as the output 1.1 and 1.2, previous desk analysis on KMSs allowed to select a first list of KM-Tools and KM-Practices that can be adopted by SMEs. Then, the field analysis has allowed to exclude from the above list the KM-Practices and KM-Tools not used by the surveyed firms. The final list of KM-Tools and KM-Practices, which includes exclusively those knowledge management systems adopted by at least one firm of the sample investigated, is reported respectively in Table 3 and Table 4. The complete list of KM-Tools and KM-Practices adopted by each firm is reported in the appendix (Table A.1).

Table 3. List of KM-Tools adopted

KM-TOOLS	
Audio Conference/Video Conference	Document Management Systems
Cloud Computing	E-mail
Collaborative Filtering	ERP Systems
Configuration Management Systems	Expert Systems
Content Management Systems	Learning Management Systems
Conversational Technologies	Mash-up
Crowdsourcing Systems	Peer-to-Peer Resource Sharing
Data Mining	Podcasting/Videocasting
Data Warehouse	Social Media
Databases	Syndication Systems

Table 4. List of KM-Practices adopted

KM-PRACTICES	
After Action Review	Knowledge Mapping
Benchmarking	Learning by doing
Best Practice	Meeting/Task Force
Brainstorming	Problem Solving
Coaching/Mentoring	Process Mapping
Communities of Practice	Social Network Analysis
Job Rotation	Storytelling
Knowledge Filtering	Work Groups

Regarding the output 1.3, in order to provide a map of firm's knowledge by ontological and epistemological dimensions firms' managers have been involved to indicate the nature of their firm's knowledge used in five different macro-processes identified: planning, production, organization, market relationships, strategic relationships.

The fuzzy set theory (FST) based approach (Zadeh, 1965; Watanabe, 1979) was used to aggregate approximate judgments expressed by managers during semi-structured interviews. This approach allows to integrate the rigor of logic to model natural language and common-sense reasoning (Michellone and Zollo, 2000; Zimmermann, 2001).

In particular, the epistemological and ontological dimensions of firm's knowledge were defined as described in the following five steps:

1. A *first term set* of five qualitative judgments ("very poorly formalised", "poorly formalised", "medium formalised", "significantly formalised", "very significantly formalised") has been defined to categorise firm's knowledge according to the degree of formalisation (epistemological dimension);

2. A *second term set* of five qualitative judgments ("mainly individual", "inside group", "inside organization", "open to partner", "fully open") has been identified to categorise firm's knowledge according to the degree of sharing (ontological dimension);

3. During the semi-structured interviews, managers provided two qualitative judgments about the epistemological and ontological nature of their firm's knowledge used in the five macro-processes identified;

4. Each qualitative judgment was codified into the correspondent fuzzy number (Figure 2, Figure 3);

5. A map of firm's knowledge was provided by combining the qualitative judgments

indicated by managers for the five macro-processes.

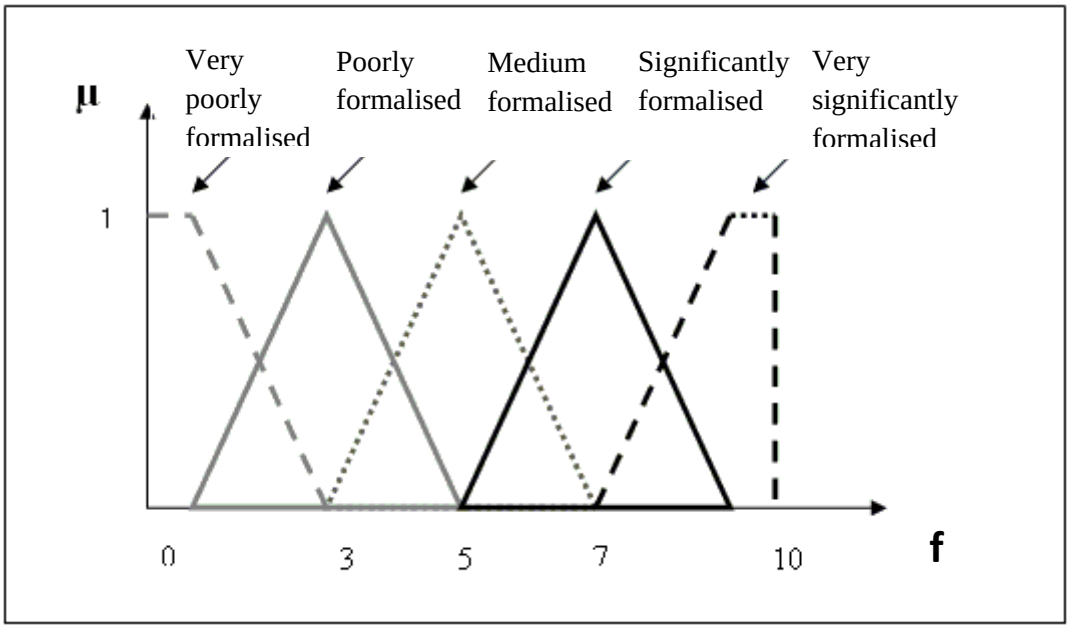


Figure 2. Fuzzy term set for the degree of formalisation (epistemological dimension)

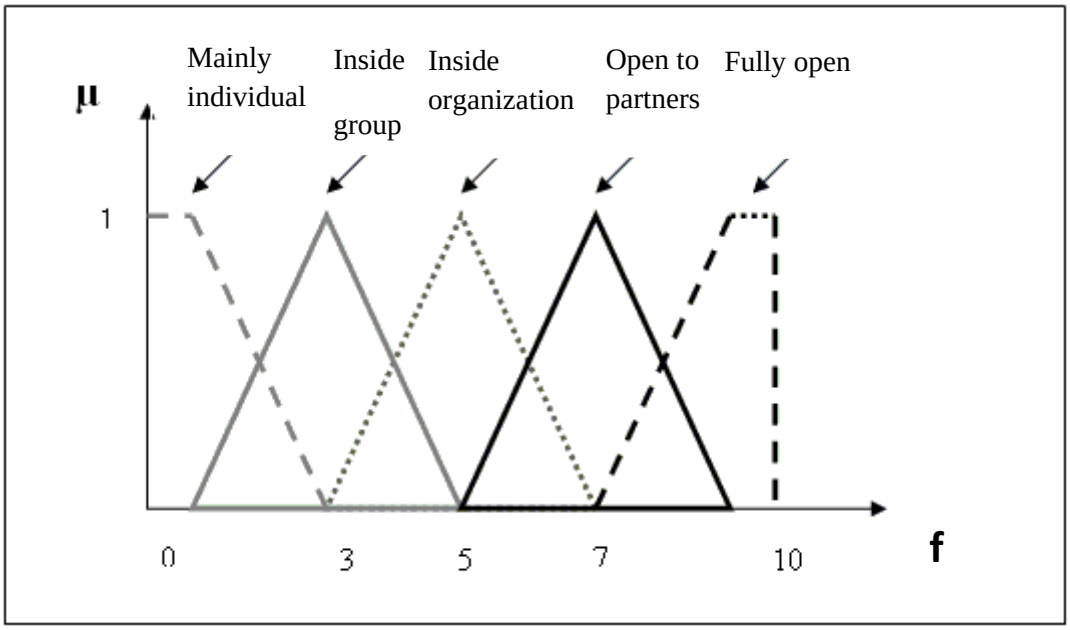


Figure 3. Fuzzy term for the degree of sharing (ontological dimension)

In order to make clear the way FST is applied in the field under investigation, a definition of fuzzy numbers used to represent the five qualitative levels of the linguistic variables "degree of formalization" and "degree of sharing" is provided in this section.

A fuzzy number can be described as a convex, normalized fuzzy set defined on a set of real numbers: $A \in R$.

As far as the epistemological dimension “degree of formalization”, the assertion “very poorly formalised” is represented by the trapezoidal fuzzy number *VPF = (0,0,1,3)*. The membership function associated to this trapezoidal fuzzy number is the following:

$$VPF\ (f) = \begin{cases} 1 & per\ 0 \leq f \leq 1; \\ \dfrac{3-f}{2} & per\ 1 \leq f \leq 3; \end{cases}$$

The assertions “poorly formalised”, “medium formalised” and “significantly formalised” are represented respectively by the following triangular fuzzy numbers: *PF = (1,3,3,5)*, *MF = (3,5,5,7)*, *SF = (5,7,7,9)*. These are the analytical expressions of their membership functions:

$$PF\ (f) = \begin{cases} \dfrac{f-1}{2} & per\ 1 \leq f \leq 3 \\ \dfrac{5-f}{2} & per\ 3 \leq f \leq 5 \end{cases}$$

$$MF\ (f) = \begin{cases} \dfrac{f-3}{2} & per\ 3 \leq f \leq 5 \\ \dfrac{7-f}{2} & per\ 5 \leq f \leq 7 \end{cases}$$

$$SF\ (f) = \begin{cases} \dfrac{f-5}{2} & per\ 5 \leq f \leq 7 \\ \dfrac{9-f}{2} & per\ 7 \leq f \leq 9 \end{cases}$$

Finally, the assertion “very significantly formalised” is represented by the trapezoidal fuzzy number *VSF = (7,9,10,10)*. The membership function associated to this trapezoidal fuzzy number is:

$$VSF\ (f) = \begin{cases} \dfrac{f-7}{2} & per\ 7 \leq f \leq 9 \\ 1 & per\ 9 \leq f \leq 10 \end{cases}$$

With regard to the ontological dimension “degree of sharing”, the analytical expressions associated to the assertions mainly individual *MI = (0,0,1,3)*, inside group *IG = (1,3,3,5)*, inside organization *IO = (3,5,5,7)*, open to partners *OP = (5,7,7,9)*, fully open *FO = (7,9,10,10)* are the following:

$$MI\ (f) = \begin{cases} 1 & per\ 0 \leq f \leq 1 \\ \dfrac{3-f}{2} & per\ 1 \leq f \leq 3 \end{cases}$$

$$IG\ (f) = \begin{cases} \dfrac{f-1}{2} & per\ 1 \leq f \leq 3 \\ \dfrac{5-f}{2} & per\ 3 \leq f \leq 5 \end{cases}$$

$$IO\ (f) = \begin{cases} \dfrac{f-3}{2} & per\ 3 \leq f \leq 5 \\ \dfrac{7-f}{2} & per\ 5 \leq f \leq 7 \end{cases}$$

$$OP\ (f) = \begin{cases} \dfrac{f-5}{2} & per\ 5 \leq f \leq 7 \\ \dfrac{5-f}{2} & per\ 7 \leq f \leq 9 \end{cases}$$

$$FO\ (f) = \begin{cases} \dfrac{f-7}{2} & per\ 7 \leq f \leq 9 \\ 1 & per\ 9 \leq f \leq 10 \end{cases}$$

With these methodological premises, two managers of each firm have been involved to express ten judgments about the degree of formalisation and the degree of sharing of their firms' knowledge associated to the five macro-processes identified (planning, production, organization, market relationships, strategic relationships). These judgments allow to define for each SME a map of its knowledge categorised by the epistemological dimension (ED) and the ontological dimension (OD). The results for the surveyed 61 SMEs are reported in the appendix (Table A.2). In summary, this step provides as outputs a list of KM-Tools, a list of KM-Practices adopted by surveyed SMEs, and for each of them a map of firm's knowledge categorised by the epistemological and ontological dimensions. In a similar way, two maps of KM-Tools and KM-Practices are provided in the following step.

STEP 2 - Meetings with experts

In the second step two IT senior consultants and a researcher have been involved to categorise KM-Tools and KM-Practices included in the previous paragraph (Table 3, Table 4) using the two term sets identified in the step 1 for the categorisation of firm's knowledge. A Delphi panel was used to converge the answers of the experts' group. At the end of the process of convergence, the Delphi method gives us the shared answer (Okoli and Pawlowski, 2004; Hsu and Sandford,

2007). During these meetings, the three experts converge towards a shared judgment about the epistemological and ontological dimensions associated to the individual KM-Tools and KM-Practices adopted by the firms. Each qualitative judgment was codified into the corresponding fuzzy number according to the two fuzzy sets defined in the first step of the methodology (Figure 2, Figure 3). The fuzzy numbers associated to the degree of formalisation and the degree of sharing of KM-Tools and KM-Practices are reported respectively in table 5 and table 6. These numbers allow to identify for each SME a map of KM-Tools and a map of KM-Practices used according to the epistemological and ontological dimensions.

Table 5. Fuzzy numbers associated to KM-Tools

KMSs	**Fuzzy numbers**	
KM-Tools	**Degree of formalization (Epistemological dimension)**	**Degree of sharing (Ontological dimension)**
Audio Conference/Video Conference	VPF = (0,0,1,3)	OP = (5,7,7,9)
Cloud Computing	MF = (3,5,5,7)	OP = (5,7,7,9)
Collaborative Filtering	PF = (1,3,3,5)	OP = (5,7,7,9)
Configuration Management Systems	PF = (1,3,3,5)	IG = (1,3,3,5)
Content Management Systems	PF = (1,3,3,5)	FO = (7,9,10,10)
Conversational Technologies	VPF = (0,0,1,3)	FO = (7,9,10,10)
Crowdsourcing Systems	VPF = (0,0,1,3)	FO = (7,9,10,10)
Data Mining	VSF = (7,9,10,10)	IO = (3,5,5,7)
Data Warehouse	SF = (5,7,7,9)	IG = (1,3,3,5)
Databases	SF = (5,7,7,9)	IG = (1,3,3,5)
Document Management Systems	PF = (1,3,3,5)	IG = (1,3,3,5)
E-mail	VPF = (0,0,1,3)	FO = (7,9,10,10)
ERP Systems	MF = (3,5,5,7)	IO = (3,5,5,7)
Expert Systems	VSF = (7,9,10,10)	IO = (3,5,5,7)
Learning Management Systems	PF = (1,3,3,5)	IO = (3,5,5,7)
Mash-up	PF = (1,3,3,5)	OP = (5,7,7,9)
Peer-to-Peer Resource Sharing	MF = (3,5,5,7)	FO = (7,9,10,10)
Podcasting/Videocasting	VPF = (0,0,1,3)	FO = (7,9,10,10)
Social Media	VPF = (0,0,1,3)	FO = (7,9,10,10)
Syndication Systems	PF = (1,3,3,5)	OP = (5,7,7,9)

Table 6. Fuzzy numbers associated to KM-Practices

KM-Practices	Degree of formalization (Epistemological dimension)	Degree of sharing (Ontological dimension)
After Action Review	MF = (3,5,5,7)	IO = (3,5,5,7)
Benchmarking	VSF = (7,9,10,10)	IG = (1,3,3,5)
Best Practice	MF = (3,5,5,7)	IO = (3,5,5,7)
Brainstorming	VPF = (0,0,1,3)	IG = (1,3,3,5)
Coaching/Mentoring	VPF = (0,0,1,3)	MI = (0,0,1,3)
Communities of Practice	VSF = (7,9,10,10)	FO = (7,9,10,10)
Job Rotation	VPF = (0,0,1,3)	MI = (0,0,1,3)
Knowledge Filtering	VSF = (7,9,10,10)	IO = (3,5,5,7)
Knowledge Mapping	SF = (5,7,7,9)	IO = (3,5,5,7)
Learning by doing	VPF = (0,0,1,3)	MI = (0,0,1,3)
Meeting/Task Force	VPF = (0,0,1,3)	OP = (5,7,7,9)
Problem Solving	MF = (3,5,5,7)	IG = (1,3,3,5)
Process Mapping	SF = (5,7,7,9)	IO = (3,5,5,7)
Social Network Analysis	VSF = (7,9,10,10)	FO = (7,9,10,10)
Storytelling	MF = (3,5,5,7)	OP = (5,7,7,9)
Work Groups	VPF = (0,0,1,3)	IG = (1,3,3,5)

STEP 3 - Identification of alignment maps

The main aim of the third step is to combine into alignment maps the three maps obtained for each SME by the first and the second step of the methodology. Data have been elaborated using the software *KM-Alignment Evaluation Systems* (*KM-AES*) designed by the authors. Fuzzy 3D term sets have been used to represent in a three-dimensional plot firm's knowledge, KM-Tools and KM-Practices used. The x-axis and the y-axis are respectively the degree of formalisation (epistemological dimension) and the degree of sharing (ontological dimension), whereas the z-axis is the fuzzy membership function. Specifically, each couple of qualitative judgments associated to the degree of formalisation and the degree of sharing of firm's knowledge used in one of the five macro-process identified or associated to an individual KM-Tool/KM-Practice is represented by a 3D fuzzy set that could be a pyramid or a truncated square pyramid according to three-dimensional term set defined above.

Figure 4,5,6 show, by way of example, the case of an individual firm A5. The first output of the third step is an alignment map obtained by the intersection of the map of firm's knowledge (K) and the map of KM-Tools (T) adopted by the surveyed firm (Figure 4).

The second output is an alignment map provided by the intersection of the map of firm's knowledge and the map of KM-Practices (P) used (Figure 5). Finally, the third output of this step is an alignment map obtained by the two maps representing the KM-Tools and KM-Practices used by the firm (Figure 6).

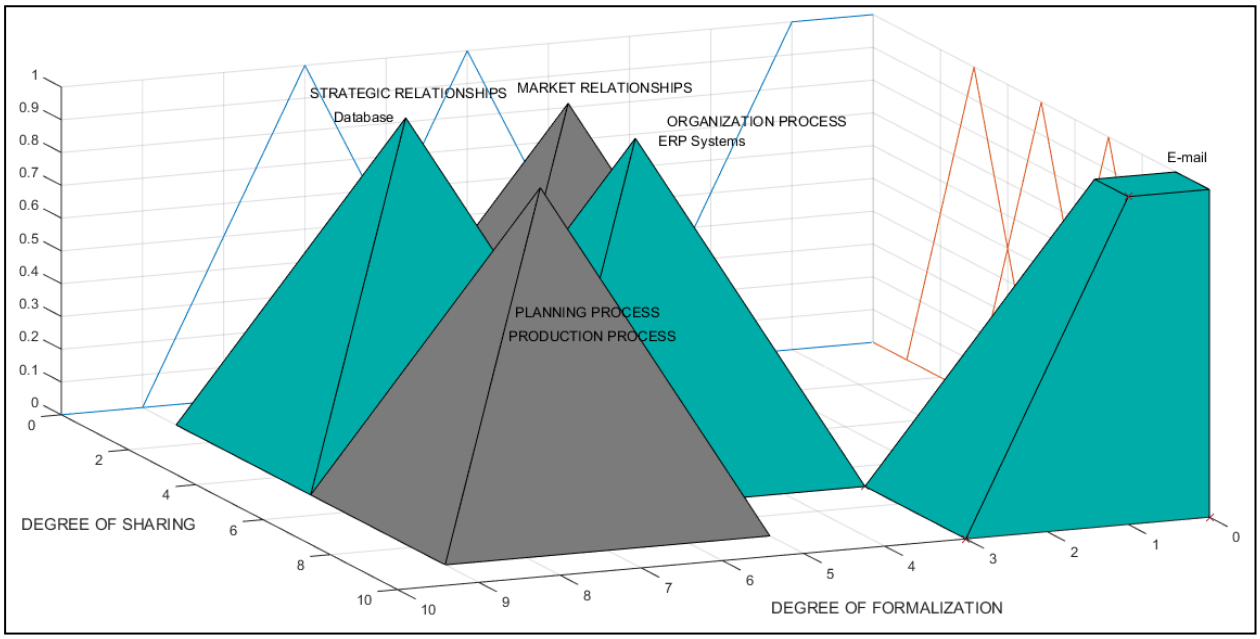


Figure 4. Example of alignment map between firm's knowledge and KM-Tools

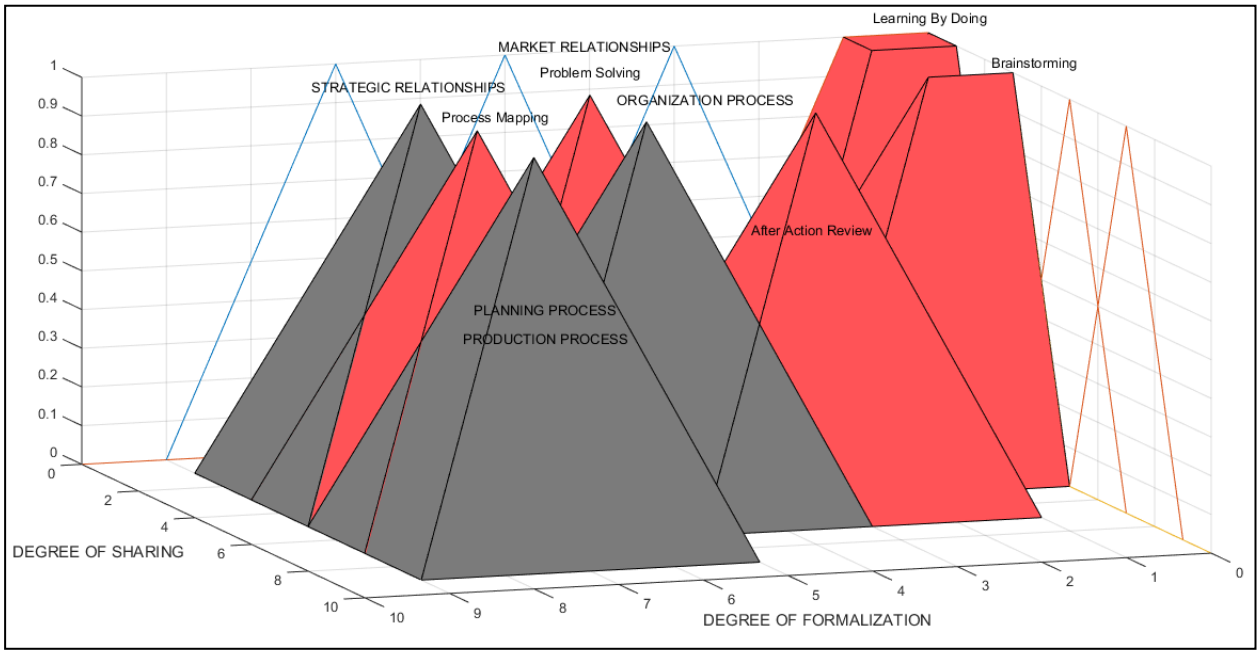


Figure 5. Example of alignment map between firm's knowledge and KM-Practices

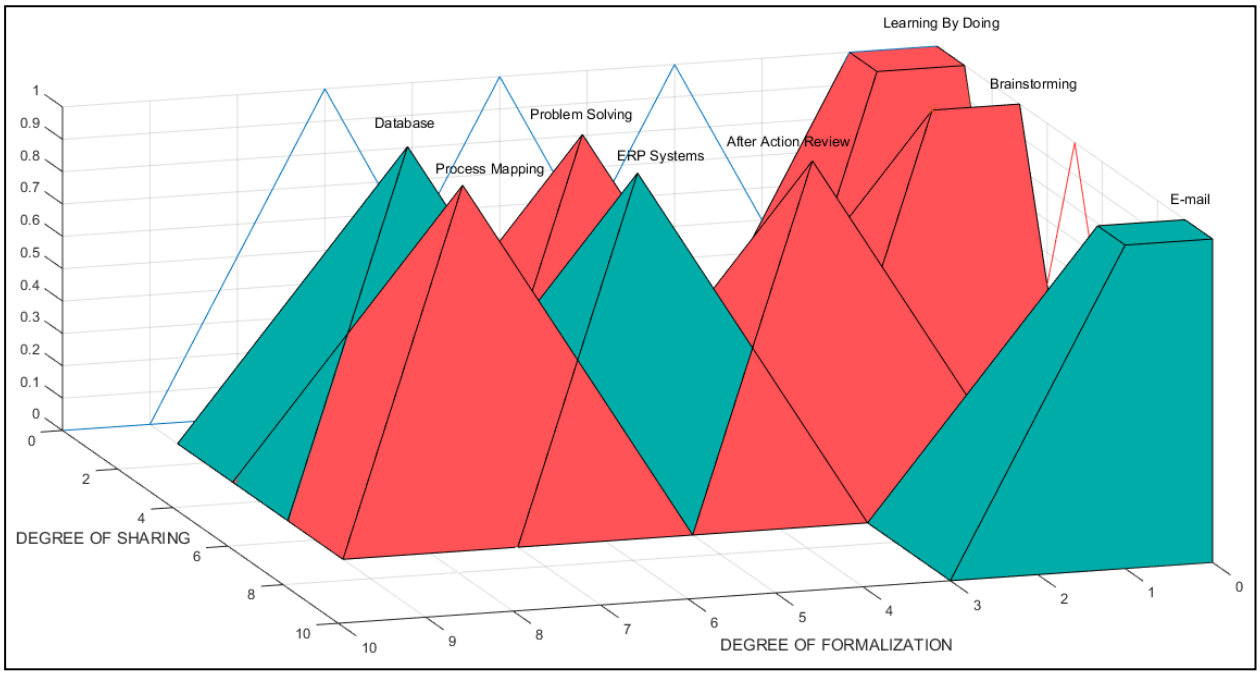


Figure 6. Example of alignment map between KM-Tools and KM-Practices

The three alignment maps identified in this paragraph are useful to define in the following paragraph six alignment indexes.

STEP 4 - Definition of alignment indexes

In this fourth step six indexes are defined to evaluate the degree of alignment among firm's knowledge, KM-Tools and KM-Practices adopted by the firm: the degree of exploitation of KM-Tools (DET), the degree of exploitation of KM-Practices (DEP), the degree of satisfaction of KM-Tools (DST), the degree of satisfaction of KM-Practices (DSP), the degree of coverage of KM-Tools with KM-Practices (DCT), the degree of coverage of KM-Practices with KM-Tools (DCP). The analytical expressions of these indexes are the following:

$\text{DET} = \frac{K \cap T}{T}$;

$\text{DEP} = \frac{K \cap P}{P}$;

$\text{DST} = \frac{K \cap T}{K}$;

$\text{DSP} = \frac{K \cap P}{K}$;

$\text{DCT} = \frac{T \cap P}{P}$

DCP = $\frac{T \cap P}{T}$;

in which:

K = Firm's knowledge;
T = KM-Tools;
P = KM-Practices.

Specifically, K is the union of five 3D fuzzy sets associated to firm's knowledge used in the five macro-processes identified (planning, production, organization, market relationship, strategic relationship). Similarly, T is the union of 3D fuzzy sets associated to the individual KM-Tools adopted by the firm. Finally, P is the union of 3D fuzzy sets associated to the individual KM-Practices used.

As for the degree of exploitation of KM-Tools (DET) and the degree of exploitation of KM-Practices (DEP), they are two *efficiency indexes* of KMSs ranging from 0 to 1.

The index DET (DEP) measures how the KM-Tools (KM-Practices) used are aligned with the nature of firm's knowledge in the epistemological and ontological dimensions. DET (DEP) is zero, if the fuzzy 3D term sets associated to K and T are disjointed, and it is 1 if K coincides with T (K with P) and therefore all the KM-Tools (KM-Practices) used by the firm are aligned with the nature of firm's knowledge, or if T is a subset of K (P is a subset of K) and therefore all KM-Tools (KM-Practices) used are aligned with firm's knowledge. In this last case KM-Tools (KM-Practices) are aligned with firm's knowledge needs associated to a subset of the five macro-processes identified. Nevertheless, in this last case there are also other firm's knowledge needs not satisfied that belong to the volumes covered by K, but not covered by T (P). The *efficiency indexes* DET and DEP are lower than 1 if there are respectively some KM-Tools or KM-Practices used by the firm that are not efficient, as they are not aligned with firm's knowledge associated to the five macro-processes.

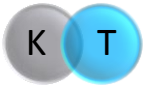
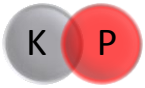
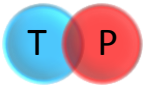
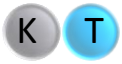
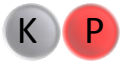
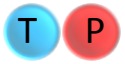
With regard to the degree of satisfaction of KM-Tools (DST) and the degree of satisfaction of KM-Practices (DSP), they are two *effectiveness indexes* of KMSs ranging from 0 to 1. The index DST (DSP) is an *effectiveness index* measuring how the firm's knowledge is aligned with the KM-Tools (KM-Practices) used according to the epistemological and ontological dimensions. DST (DSP) is 0 if K and T (P) are disjointed, whereas it is equal to 1 if K coincides with T (P) and therefore firm's knowledge associated to the five macro-processes is aligned with the KM-Tools (KM-Practices) used, or if K is a subset of T (K is a subset of P). A firm with this configuration uses KM-Tools (KM-Practices) that are not effective, as all its knowledge needs

are met by a part of its KM-Tools (KM-Practices), whereas all the others are not aligned with the nature of firm's knowledge they should manage. The *effectiveness indexes* are lower than 1 if firm's knowledge associated to one of the five macro-processes is not aligned with KM-Tools (KM-Practices) used.

Finally, also the two indexes regarding the degree of coverage of KM-Tools and KM-Practices (DCP, DCT) range from 0 to 1. The degree of coverage DCP measures how KM-Practices are covered by KM-Tools. This index ranges from zero, if no KM-Tool adopted is aligned with one of the KM-Practices, to 1, if all the KM-Practices are aligned with the KM-Tools adopted. In this last case, the three-dimensional term sets representing the KM-Tools coincide or are a subset of the three-dimensional term sets associated to the KM-Practices used. The index DCT measures the degree of coverage of KM-Tools by KM-Practices. This index ranges from zero, if no KM-Practices used is aligned with one of the KM-Tools, to 1, if all the KM-Tools are aligned with the KM-Practices used. This configuration means that the 3D term sets associated to the KM-Practices used coincide or are a subset of the term sets associated to the KM-Tools used. In summary, the values of the six alignment indexes have been compared to all the possible configurations of fuzzy 3D term sets (Table 7).

According to the definition provided in this paragraph, the six alignment indexes identified are calculated for each of the 61 surveyed firms as described in the following paragraph.

Table 7. Alignment indexes by 3D fuzzy tem sets

ALIGNMENT INDEXES								
K-T			K-P			T-P		
3D TERM SETS	DET	DST	3D TERM SETS	DEP	DSP	3D TERM SETS	DCT	DCP
	[0, 1]	[0, 1]		[0, 1]	[0, 1]		[0, 1]	[0, 1]
	0	0		0	0		0	0
	1	[0, 1]		1	[0, 1]		1	[0, 1]
	[0, 1]	1		[0, 1]	1		[0, 1]	1
	1	1		1	1		1	1

7.4. Results

This paragraph provides the main findings concerning the six alignment indexes evaluated for the 61 surveyed SMEs. The objective is to stress difference and homogeneity among surveyed SMEs and show the degree of alignment among their knowledge, the use of KM-Tools, and the use of KM-Practices. The results are presented in table 8.

Table 8. Alignment indexes of KM-Tools and KM-Practices

FIRM	ALIGNMENT INDEXES					
	K-T		K-P		T-P	
	DET	DST	DEP	DSP	DCT	DCP
A1	0.44	0.65	0.32	0.78	0.44	0.74
A2	0.20	0.52	0.32	0.79	0.85	0.82
A3	0.58	0.54	0.51	0.79	0.25	0.42
A4	0.25	0.74	0.29	1.00	0.65	0.76
A5	0.53	0.40	0.36	0.72	0.27	0.71
A6	0.12	0.12	0.53	0.86	0.41	0.67
A7	0.00	0.00	0.09	0.16	0.00	0.00
A8	0.30	0.89	0.45	0.84	0.97	0.62
A9	0.41	0.66	0.36	0.83	0.50	0.73
A10	0.58	0.43	0.24	0.30	0.21	0.36
A11	0.25	0.54	0.23	0.63	0.42	0.52
A12	0.20	0.70	0.13	0.57	0.51	0.65
A13	0.27	0.62	0.27	0.72	0.73	0.86
A14	0.35	0.80	0.20	0.50	0.31	0.33
A15	0.18	0.70	0.14	0.70	0.47	0.57
A16	0.19	0.74	0.26	1.00	0.85	0.82
A17	0.26	0.90	0.29	0.90	0.82	0.73
A18	0.22	0.52	0.24	0.73	0.57	0.73
A19	0.38	0.82	0.29	0.55	0.92	0.79
A20	0.44	0.65	0.32	0.78	0.44	0.74
A21	0.82	0.58	0.53	0.63	0.25	0.42
A22	0.69	0.50	0.34	0.65	0.27	0.71
A23	0.00	0.00	0.49	0.48	0.00	0.00
A24	0.45	0.73	0.37	0.87	0.50	0.73
A25	0.25	0.57	0.31	0.87	0.42	0.52
A26	0.02	0.11	0.05	0.29	0.55	0.67
A27	0.44	0.91	0.46	0.94	0.82	0.81
A28	0.35	0.70	0.20	0.50	0.62	0.77
A29	0.36	0.66	0.20	0.32	0.79	0.68
A30	0.36	1.00	0.26	0.71	0.78	0.76
A31	0.38	0.82	0.26	0.68	0.72	0.87
A32	0.23	0.44	0.39	0.70	0.62	0.59
A33	0.47	0.63	0.40	0.67	0.54	0.67
A34	0.22	0.34	0.62	0.73	0.58	0.44
A35	0.46	0.68	0.21	0.30	0.77	0.74
A36	0.12	0.12	0.56	0.65	0.36	0.42
A37	0.21	0.60	0.25	0.60	0.62	0.54
A38	0.26	0.84	0.30	0.81	0.48	0.39
A39	0.20	0.84	0.23	0.81	0.64	0.54
A40	0.20	0.70	0.17	0.57	0.60	0.59
A41	0.38	0.74	0.31	0.65	0.57	0.61
A42	0.53	0.90	0.53	0.88	0.73	0.70
A43	0.61	0.76	0.53	0.63	0.37	0.35
A44	0.21	1.00	0.23	0.84	0.82	0.64
A45	0.20	0.21	0.15	0.30	0.26	0.51
A46	0.07	0.07	0.21	0.55	0.11	0.28
A47	0.49	0.48	0.37	0.71	0.35	0.69
A48	0.15	0.53	0.07	0.30	0.55	0.70
A49	0.45	0.65	0.43	0.71	0.31	0.36
A50	0.17	0.24	0.29	0.48	0.24	0.28
A51	0.27	0.46	0.30	0.51	0.58	0.58
A52	0.11	0.08	0.49	0.76	0.20	0.40
A53	0.28	0.55	0.24	0.57	0.70	0.82
A54	0.26	0.84	0.20	0.84	0.64	0.81
A55	0.28	0.70	0.14	0.47	0.29	0.40
A56	0.21	0.59	0.37	0.81	0.47	0.37
A57	0.21	0.41	0.34	0.65	0.52	0.52
A58	0.51	0.84	0.47	0.84	0.60	0.66
A59	0.16	0.15	0.41	0.90	0.12	0.30
A60	0.50	0.88	0.42	0.94	0.68	0.87
A61	0.20	0.59	0.21	0.67	0.72	0.76
Mean	**0.31**	**0.58**	**0.31**	**0.67**	**0.51**	**0.59**
Coefficient of variation	**0.54**	**0.44**	**0.42**	**0.29**	**0.45**	**0.34**

As for the alignment between firm's knowledge (K) and KM-Tools (T), for each supply firm the degree of exploitation of KM-Tools (DET) and the degree of satisfaction of KM-Tools (DST) were calculated. Table 8 highlights that the index DET ranges from 0.00 (firms A7, A23) to 0.82 (A21) with a mean of 0.31 and coefficient of variation 0.54, whereas the index DST ranges from 0.00 (A7,A23) to 1.00 (A30, A44) with a mean of 0.58 and coefficient of variation 0.44. It is possible to identify four areas limited by the average of the possible values that the two indexes DET and DST can assume. The comparison between the two indexes (Figure 7) shows that the majority of SMEs (61%) are located in the high-left quadrant and tend to adopt KM-Tools that are effective (DST higher than 0.5), but not efficient (DET lower than 0.5); 25% belongs to the low-left quadrant and these firms are characterised by the use of KM-Tools that are not efficient or effective; 11% of firms adopt KM-Tools efficient and effective and are localised in the high-right quadrant; the remaining 3% belongs to the low-right quadrant including firms adopting effective but not efficient KM-Tools.

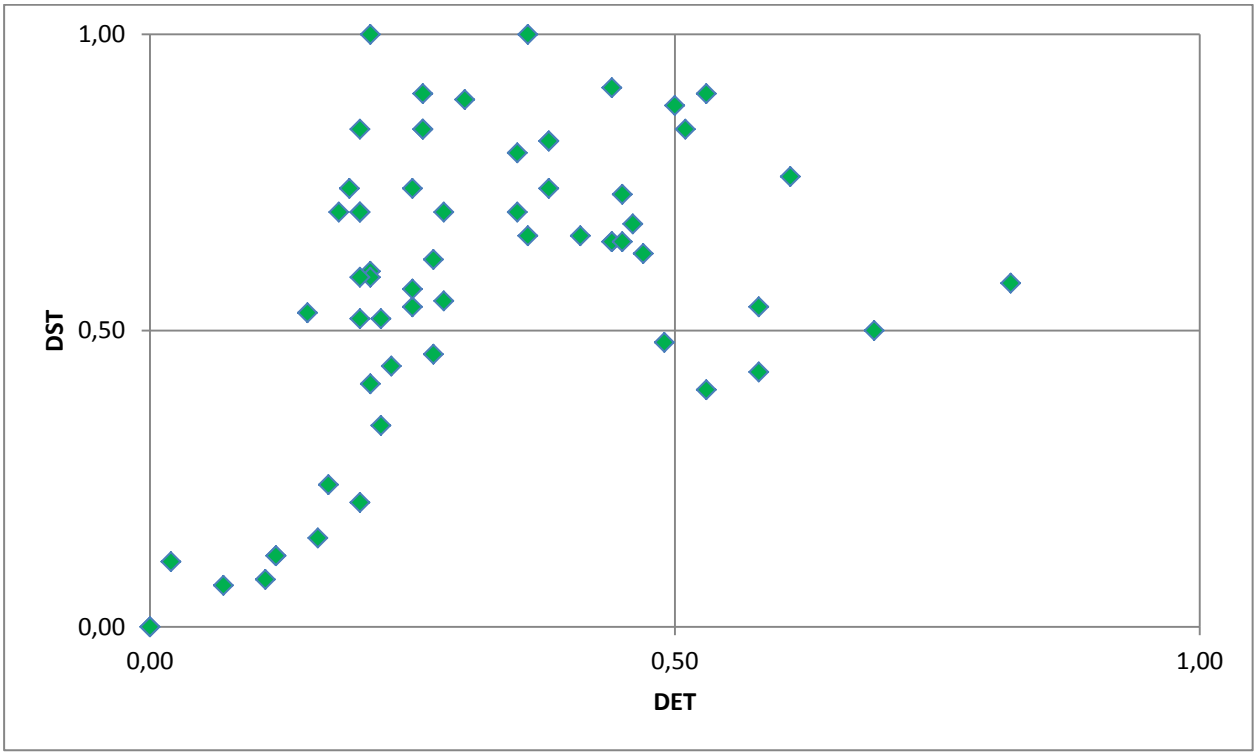


Figure 7. Relation between DET and DST

With regard to the alignment between firm's knowledge (K) and KM-Practices (P) the degree of exploitation of KM-Practices (DET) and the degree of satisfaction of KM-Practices (DST) have been compared. Figure 8 highlights that most of the selected firms (72%) are localized in the quadrant high-left and tend to adopt practices that are more effective than efficient; 16% of firms belongs to the low-left quadrant characterised by the use of KM-Practices that have both a low

efficiency and effectiveness; 11% of firms are located in the high-right quadrant characterised by KM-Practices that are more efficient than effective; there are no firms included in the low-right quadrant.

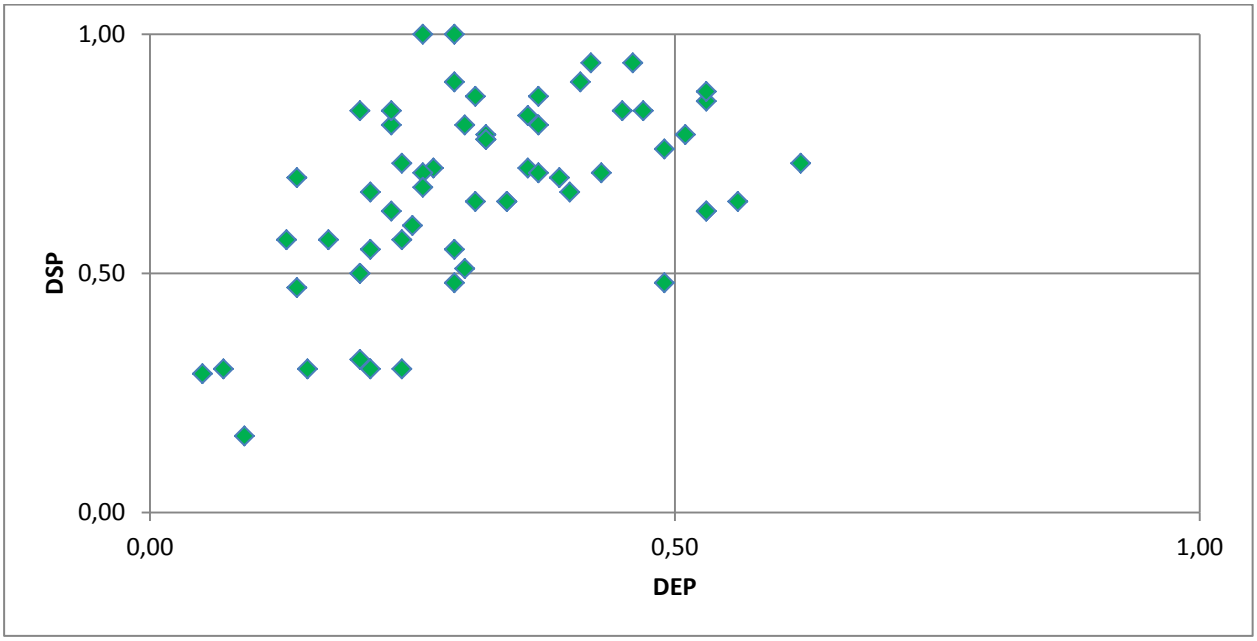


Figure 8. Relation between DEP and DSP

To highlight the alignment between both the KM-Practices and KM-Tools adopted by an SME and their knowledge, two more indexes were introduced: the degree of exploitation of KM-Systems (DES) adopted by SMEs and the index of satisfaction of KM-Systems (DSS) adopted by SMEs.

$$DES = \frac{\sqrt{DET^2 + DEP^2}}{\sqrt{2}}$$

$$DSS = \frac{\sqrt{DST^2 + DSP^2}}{\sqrt{2}}$$

The two indices were calculated for each SME. They range from 0 to 1. Figure 9 shows that the DES ranges from 0.04 to 0.69 (mean of 0.32), whereas the DSP ranges from 0.11 to 0.93 (mean of 0.64). Figure 9 highlights also that it is possible to identify four areas limited by the average of the possible values that the two indexes can assume. Low-left located are “misaligned SMEs” and do not use the KMSs adopted efficiently and effectively (A1). High-left located are “efficiently misaligned SMEs”, which use effectively the KMSs adopted (A2). High-right located are “aligned SMEs”, which make both an efficiently and effectively use of KMSs (A3). Low-right located are “effectively misaligned SMEs”, which use the KMSs at their disposal

efficiently (A4).

These four areas identify different strategies of KMSs adoption for SME (Figure 10).

Misaligned SMEs (A1) includes firms that adopt a limited set of mainly traditional KM-Tools (e.g. databases, document management system, e-mail) and KM-Practices not specifically dedicated to knowledge management (e.g. brainstorming, learning by doing, problem solving, process mapping) exploiting them inefficiently and ineffectively. A misaligned SME could improve the effectiveness of its process of knowledge management and migrate in the high-left quadrant A2 through the acquisition of additional KM-Tools and KM-Practices. In this case, the acquisition process by SME does not follow a phase of monitoring and selecting appropriate knowledge systems that are aligned with firm's knowledge. Moreover, a low-located SME could improve the efficiency of KM-Process and migrate in the quadrant A4 selecting and continuing to use exclusively those KMSs that are adequate to satisfy its knowledge needs.

The majority of surveyed SMEs are "*efficiently misaligned SMEs*" (A2). These SMEs tend to adopt an overabundant number of knowledge management systems including also those that are not aligned with firm's knowledge according to the epistemological and ontological dimensions. The SMEs in this area tend to adopt traditional KM-Tools (e.g. databases, video conference, ERP systems, e-mail, document management system), innovative KM-Tools (e.g. data mining, collaborative filtering, syndication systems, mash-up, content management systems, social media, cloud computing, learning management systems, podcasting, peer-to-peer), and KM-Practices not specifically dedicated to knowledge management (e.g. brainstorming, problem solving, process mapping, after action review, job rotation, work groups, meeting/task force, learning by doing). The fact that the majority of these SMEs do not use KM-Practices specifically dedicated to knowledge management (such as: knowledge filtering, knowledge mapping, social network analysis, best practices, community of practices, storytelling) highlights that they tend to use the practices they already know. Nevertheless, the inappropriate use of those generic KM-Practices, i.e. not aligned with firm's knowledge they should support, damages the KM process in terms of efficiency. The SMEs located in this quadrant have great potential for growth. Through appropriate learning and training processes involving KM experts and/or KMSs' providers, they can migrate towards the high-right area A3. Specifically, to shift towards A3, a SME needs to acquire awareness of the importance of investing resources not to acquire new KM-Systems, but to select an efficient and effective subsystem of those SME already uses.

The area A3 includes "*aligned SMEs*" that have a perception of the strategic value of knowledge management and so explore the potentiality of KMSs in terms of both efficiency and effectiveness. SMEs located in this area tend to adopt a number of KMSs that is lower than those

belonging to the quadrant A2. However, figure 10 shows that the use of these knowledge management systems allows a SME located in A3 to satisfy the knowledge needs associated to the same volume of a firm located in A2, but in a more efficient mode.

The area A4 does not contain any "*effectively misaligned SME*" using KMSs that are more efficient than effective. If there was a SME located in this position, it should introduce new selected tools aligned with its knowledge in order to migrate in the high-right quadrant A3.

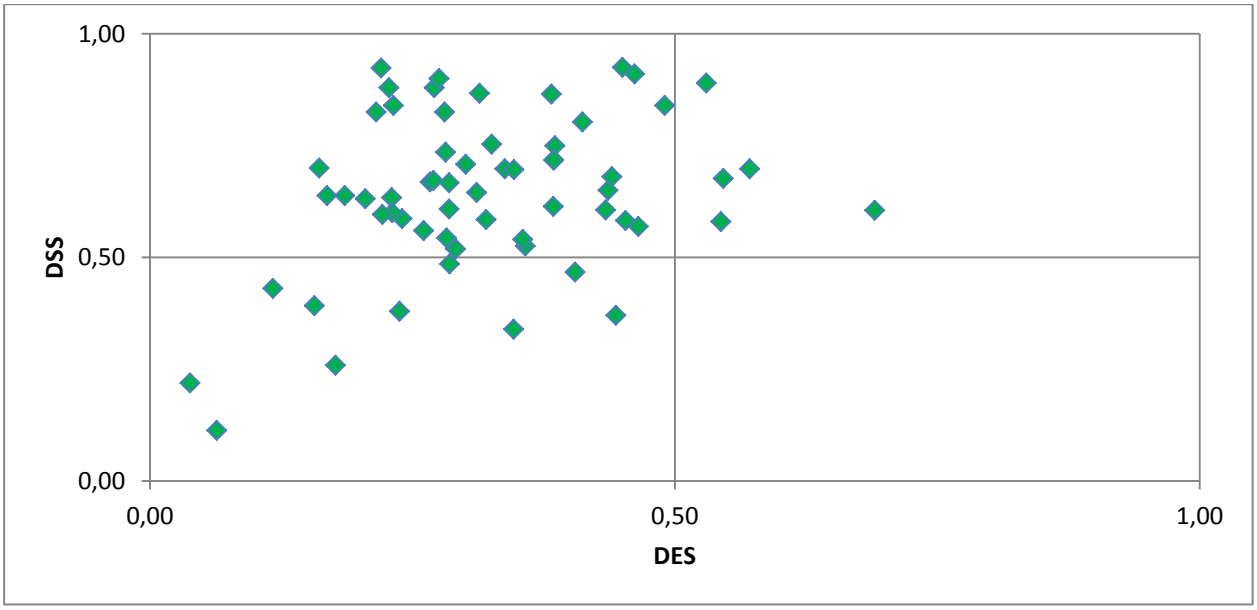


Figure 9. Relation between DES and DCS

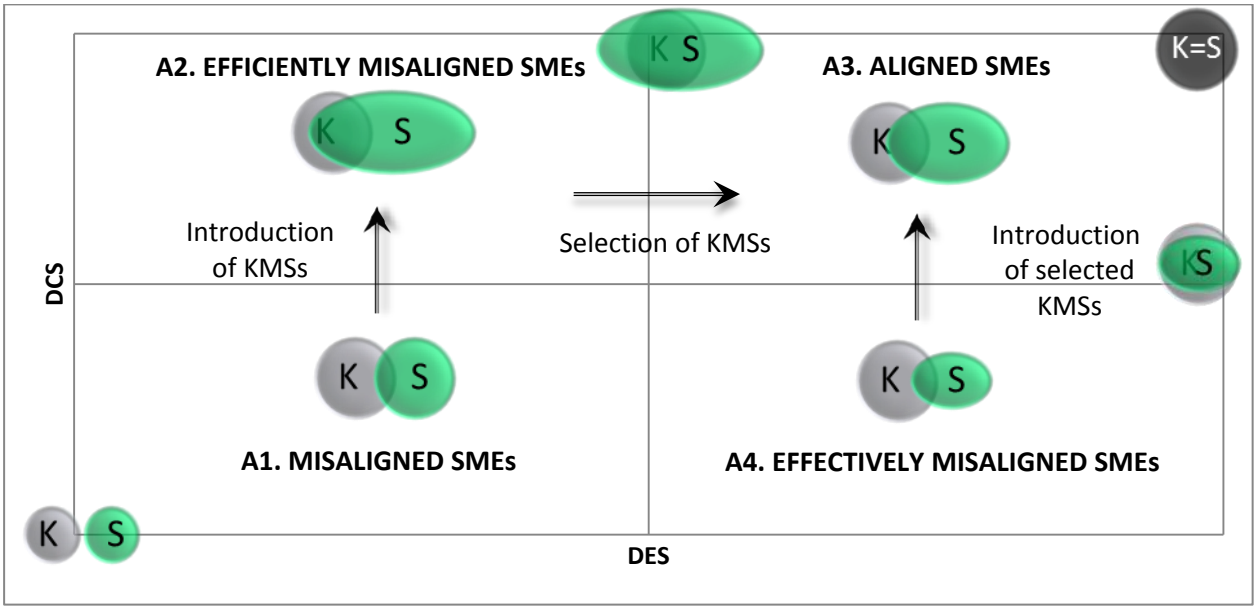


Figure 10. Taxonomy of KMSs adoption strategies

Concerning the alignment between KM-Tools and KM-Practices figure 11 points out that the

higher the degree of coverage of KM-Tools with KM-Practices (DCT), the higher the degree of coverage of KM-Practices with KM-Tools (DCT) and vice versa. Specifically, 60% of firms belongs to the high-right quadrant characterised by both a degree of coverage of KM-Tools with KM-Practices and a degree of coverage of KM-Practices with KM-Tools higher than 0.5; 26% of firms present a index of DCT and DCP lower than 0.5; 16% belongs to the high-left quadrant with a DCT higher than 0.5 and a DCP lower than 0.5; the remaining 2% is localised in the low-right quadrant characterised by a DCP higher than 0.5 and a DCP lower than 0.5.

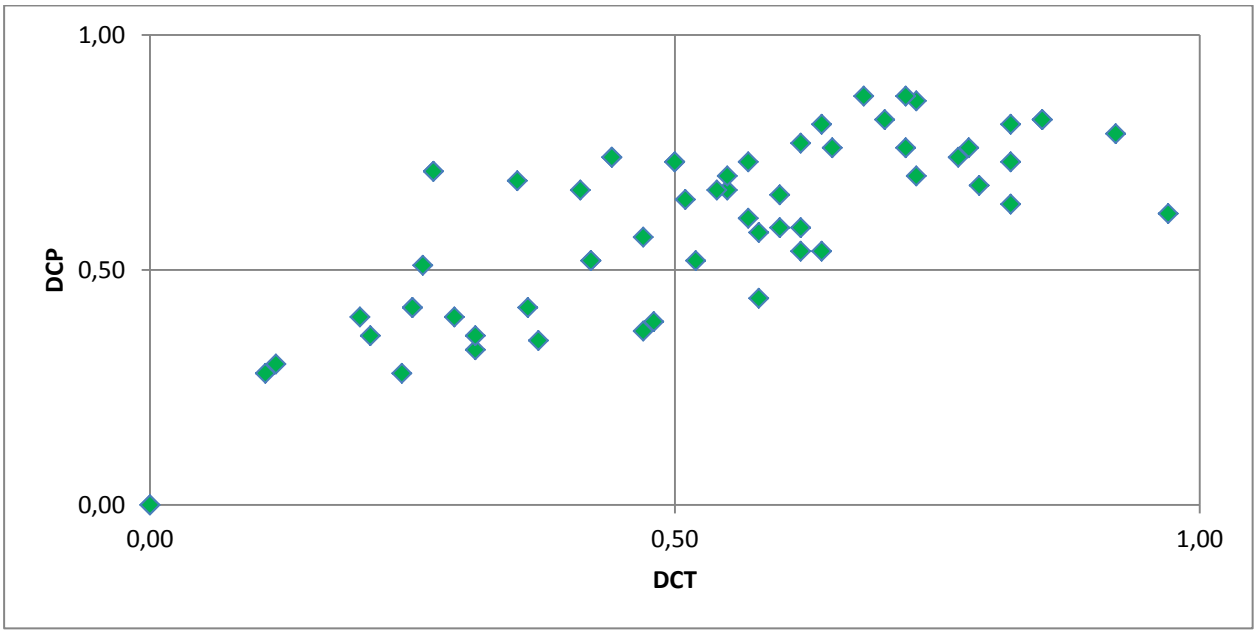


Figure 11. Relation between DCT and DCP

The results highlight that KM-Tools used by the firms are aligned with KM-Practices they should support according to the epistemological and ontological dimensions identified by Nonaka. Nevertheless, both KM-Tools and KM-Practices seem to be not aligned with firm's knowledge with regard to the five macro-processes identified (planning, production, organization, market relationships, strategic relationships). The main problem encountered in the surveyed sample of SMEs concerns the efficiency of both KM-Tools and KM-Practices used by the firms (Figure 12).

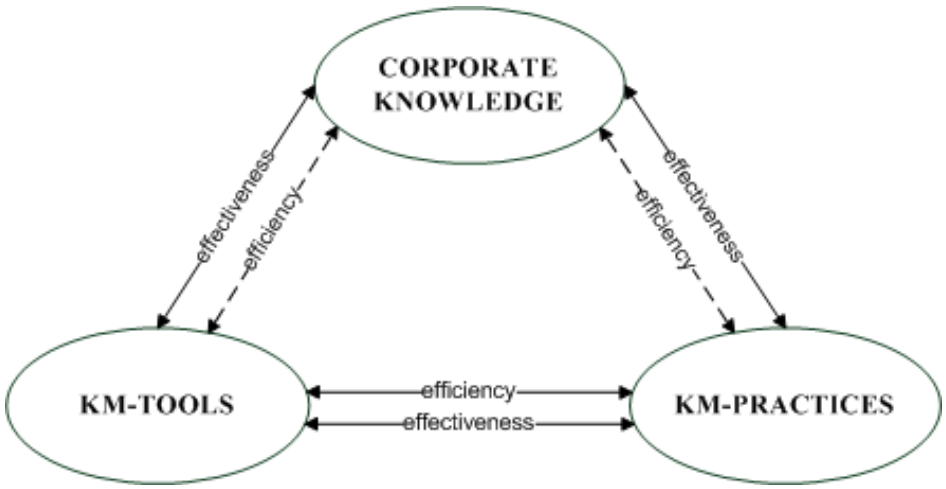


Figure 12. Alignment among firm's knowledge, KM-Tools and KM-Practices

Specifically, the firms tend to use several KM-Tools or KM-Practices that are not efficient, as they are not aligned with firm's knowledge associated to the nature of knowledge embedded in their organisational processes. In fact, the results highlight that in many cases KM-Tools and KM-Practices are not aligned with firm's knowledge needs associated to a subset of the five macro-processes identified.

These results are in line with Cerchione et al. (2015), who highlight how technological barriers have a very low impact on the adoption of KM in SMEs. By contrasts, these results, despite collected in a sample of SMEs which operate in high-tech industries, show that the findings of Nunes et al. (2006), regarding the financial barriers hindering the adoption of KM in SMEs, no longer seem valid. This point demonstrates that within a few years the technological context has changed rapidly, but this change is in favour of SMEs. Moreover, this study partially confirm and partially modify the conclusions of Milosz and Milosz (2010). Contrary to Milosz and Milosz (2010), the results highlight nowadays SMEs are prepared technologically for KM and they tend to adopt an overabundance of tools and practices that in part are not aligned to the degree of formalization and sharing of their knowledge. These tools and practices are already owned by the SMEs before the adoption of the KM, and they are used for other purposes and to manage other business processes. Not fully understanding their process of KM and consequently how to meet their knowledge needs with the support of informational tools and organizational practices, small and medium enterprises tend to use these latter inefficiently. According with Milosz and Milosz (2010) this is a cultural gap of SMEs. Therefore, SMEs are achieving their KM goals but with a cost higher than that due.

7.5 Conclusions and implications

The main purpose of this chapter is to contribute to the literature on the adoption of knowledge management systems in SMEs. A content analysis of the previous body of literature on the topic has allowed us to identify a research gap and consequently formulate three research questions (*RQs*):

RQ1.1: What is the degree of alignment between KM-Tools adopted by SMEs and the nature of their knowledge in the ontological and epistemological dimensions?

RQ1.2: What is the degree of alignment between KM-Practices adopted by SMEs and the nature of their knowledge in the ontological and epistemological dimensions?

RQ1.3: What is the degree of alignment between KM-Tools and KM-Practices adopted by SMEs in the ontological and epistemological dimensions?

These three *RQs* have been addressed through a field analysis conducted in 61 SMEs and a Delphi panel involving senior KM consultants operating for small and medium enterprises.
Concerning the alignment between KM-Tools and SMEs' knowledge (*RQ1.1)*, the results highlight that a large percentage of surveyed SMEs (61%) adopts KM-Tools that are effective but not efficient to manage the nature of their knowledge according to the epistemological and ontological dimensions.
Similarly, as for the alignment KM-Practices and SMEs' knowledge (*RQ1.2)* the findings show that the majority of SMEs (72%) uses knowledge management practices that are more efficient than effective to meet their knowledge needs in terms of both the degree of formalisation and degree of sharing.
Integrating the answers to these first two research questions the chapter has allowed to identify four different strategies of KMSs adoption for SMEs: misaligned SMEs, efficiently misaligned SMEs, effectively misaligned SMEs, aligned SMEs.
The "misaligned SME" is a firm that adopts a limited set of mainly traditional KM-Tools (e.g. databases, document management system, e-mail) and KM-Practices not specifically dedicated to knowledge management (e.g. brainstorming, learning by doing, problem solving, process mapping) exploiting them inefficiently and ineffectively.
The "efficiently misaligned SME" is a firm that adopt an overabundant number of knowledge management systems including also those that are not aligned with firm's knowledge according to the epistemological and ontological dimensions. This SME uses traditional KM-Tools (e.g.

databases, video conference, ERP systems, e-mail, document management system), innovative KM-Tools (e.g. data mining, collaborative filtering, syndication systems, mash-up, content management systems, social media, cloud computing, learning management systems, podcasting, peer-to-peer), and KM-Practices not specifically dedicated to knowledge management (e.g. brainstorming, problem solving, process mapping, after action review, job rotation, work groups, meeting/task force, learning by doing).

The "aligned SME" is a firm that has a perception of the strategic value of knowledge management and so explore the potentiality of KMSs in terms of both efficiency and effectiveness.

The "effectively misaligned SME" is a firm that adopts KMSs that are more efficient than effective.

The majority of surveyed firms are efficiently misaligned SMEs. These latter have great potential for growth and through appropriate learning and training processes involving KM experts and/or KMSs' providers, they can become aligned SMEs.

Regarding *RQ*3, the results highlight that there is a relation of reciprocity between KM-Tools and KM-Practices used by the firms: the higher the degree of coverage of KM-Tools with KM-Practices (DCT), the higher the degree of coverage of KM-Practices with KM-Tools (DCT) and vice versa. In fact, a large percentage of firms (60%) are characterised by an high degree of coverage of KM-Tools with KM-Practices and a degree of coverage of KM-Practices with KM-Tools. This result is in line with Carayannis (1999), which assumed that KM plays a crucial role in achieving a synergistic symbiosis between ICTs and organization practices used by the firm.

Implications

From the SMEs' point of view, this chapter shows that they could grow the efficiency and the effectiveness of KM process by better evaluating and selecting the knowledge management tools and practices they already adopt, and introducing exclusively the innovative KMSs that are aligned with the nature of their knowledge according to the epistemological and ontological dimensions. To achieve this aim SMEs have to invest in the education of KM analysts/managers able to analyse their knowledge management process, instead of investing exclusively in new tools/practices geared to their knowledge needs, or seeking to adapt the tools/practices they already use to the new requirements of KM.

From the KMS providers' point of view, this chapter highlights that SMEs typically do not yet have trained resources that are able to monitor and follow the processes of innovation affecting KMSs. Nevertheless, they may well represent a significant niche market. To seize this

opportunity, it is necessary to bring in balance supply and demand through direct channels of communication, even virtual, between SMEs and KM providers, and through the organisation of technology fairs and salons dedicated to small and medium enterprises.

Future research

The above findings provide guidance for future research directions. A research direction is due to the growing importance of SMEs networks in the development of KM and regards the ways through which knowledge is spread across networks.

References

Anand, A., Kant, R., & Singh, M.D. (2013). Knowledge sharing in SMEs: Modelling the barriers. *Int. J. Manag. Enterp. Dev., 12,* 385-410.

Andrews, K. M., & Delahaye, B. L. (2000). Influences on knowledge processes in organizational learning. *Journal of Management Studies, 37*, 797-810.

Antonelli, C., Geuna, A., & Steinmueller, W. E. (2000). Information and communication technologies and the production, distribution and use of knowledge. *Int. J. Technol. Manag., 20*, 72–94.

Bagnoli, C., & Vedovato, M. (2012). The impact of knowledge management and strategy configuration coherence on SME performance. *Journal of Management & Governance, 16(4),* 1-33.

Beylier, C., Pourroy, F., Villeneuve, F., & Mille, A. (2009) A collaboration-centred approach to manage engineering knowledge: a case study of an engineering SME. *Journal of Engineering Design, 20(6),* 523-542.

Bhatt, G. D. (2001). Knowledge management in organizations: examining the interaction between technologies, techniques, and people. *Journal of Knowledge Management, 5(1),* 68-75.

Carayannis, E. G. (1999). Fostering synergies between information technology and managerial and organizational cognition: the role of knowledge management. *Technovation, 19(4),* 219-231.

Cerchione, R., Esposito, E., & Spadaro, M. R. (2015). The Spread of Knowledge Management in SMEs: A Scenario in Evolution. *Sustainability, 7,* 10210-10232.

Choudhary, A. K., Harding, J., Camarinha-Matos, L. M., Lenny Koh, S. C., & Tiwari, M.K. (2013). Knowledge management and supporting tools for collaborative networks. *International Journal of Production Research, 51(7),* 1953-1957.

Daud, S., & Yusoff, W. F. W. (2011). How intellectual capital mediates the relationship between knowledge management processes and organizational performance? *African Journal of Business*

Management, 5(7), 2607-2617.

Davenport, T. H., & Prusak, L. (1998). Working Knowledge: How organisations manage what they know. Harvard Business School Press. Cambridge, MA.

Delen, D., Zaim, H., Kuzey, C., & Zaim, S. (2013). A comparative analysis of machine learning systems for measuring the impact of knowledge management practices. *Decision Support Systems, 54(2),* 1150-1160.

Dotsika, F., & Patrick, K. (2013). Collaborative KM for SMEs: a framework evaluation study. *Information Technology & People, 26(4),* 368-382.

Edvardsson, I. R. (2009). Is knowledge management losing ground? Developments among Icelandic SMEs. *Knowledge Management Research & Practice, 7,* 91-99.

Esposito, E., & Mastroianni, M. (2001). Information technology and personal computers: The relational life cycle. *Technovation, 22,* 41–50.

Esposito, E., & Mastroianni, M. (1998). Technological Evolution of Personal Computers and Market Implications. *Technol. Forecast. Soc. Chang., 59,* 235–254.

European Commission (2005). The New SME Definition. User Guide and Model Declaration. European Commission, DG Enterprise & Industry, Bruxelles.

Garrigos-Simon, F. J., Lapiedra Alcami, R., & Barbera Ribera, T. (2012) Social networks and Web 3.0: Their impact on the management and marketing of organizations. *Manag. Decis., 50,* 1880-1890.

Gholami, M. H., Asli, M. N., Nazari-Shirkouhi, S., & Noruzy, A. (2013). Investigating the Influence of Knowledge Management Practices on Organizational Performance: An Empirical Study. *Acta Polytechnica Hungarica, 10(2),* 205-216.

Grace, T. P. L. (2009). Wikis as a knowledge management tool. *Journal of Knowledge Management, 13(4),* 64-74.

Gresty, M. (2013). What role do information systems play in the knowledge management activities of SMEs? *Business Information Review, 30(3),* 144-151.

Hong, P. A., Park, Y. W. B., Choi, S. B. C., & Shin, G. C. D. (2014). Achieving knowledge management excellence for competitive advantage: An integrative model for empirical research. *International Journal of Knowledge Management Studies, 5(3-4),* 285-303.

Hsu, C. C., & Sandford, B. A. (2007). The Delphi technique: Making sense of consensus. *Practical Assessment, Research and Evaluation, 12(10),* 1-8.

Joshi, Y., Parmer, S., & Chandrawat, S. S. (2012). Knowledge Sharing in Organizations: Modeling the Barriers, an Interpretive Structural Modeling Approach. *International Journal of Engineering and Innovative Technology, 2(3),* 207-214.

Lisanti, Y., & Luhukay, D. (2014). The design of knowledge management system model for SME (UKM). *Journal of Theoretical and Applied Information Technology, 64(3),* 746-755.

Liu, Y., & Abdalla, A. N. (2013). Evaluating the managerial behavior of managing knowledge in Chinese SMEs. *Information Technology and Management, 14(2),* 159-165.

Liu, S., Moizer, J., Megicks, P., Kasturiratne, D., & Jayawickrama, U. (2014). A knowledge chain management framework to support integrated decisions in global supply chains. *Production Planning and Control, 25(8),* 639-649.

Lopez-Nicolas, C., & Soto-Acosta, P. (2010). Analyzing ICT adoption and use effects on knowledge creation: An empirical investigation in SMEs International. *Journal of Information Management, 30(6),* 521-528.

Mak, K. T., & Ramaprasad, A. (2003). Knowledge supply network. *Journal of the Operational Research Society, 54(2),* 175-183.

Matlay, H., & Westhead, P. (2005). Virtual teams and the rise of e-entrepreneurship in Europe. *Int. Small Bus. J., 23,* 279–302.

Michellone, G., & Zollo, G. (2000). Competences management in knowledge-based firms. *International Journal of Technology Management, 20(1),* 134-135.

Milosz, M., & Milosz, E. (2010). Critical success factors and barriers to implementation of knowledge management systems at polish SMEs. *Actual Problems of Economics, 6,* 309-315.

Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation. *Organization Science, 5(1),* 14-37.

Nunes, M. P., Annansingh, F., & Eaglestone, B. (2006). Knowledge management issues in knowledge-intensive SMEs. *Journal of Documentation, 62(1),* 101-119.

Okoli, C., & Pawlowski, S. D. (2004). The Delphi method as a research tool: An example, design considerations and applications. *Information and Management, 42 (1),* 15-29.

Omerzel, D.G., & Antončič, B. (2008). Critical entrepreneur knowledge dimensions for the SME performance. *Industrial Management & Data Systems, 108(9),* 1182-1199.

Polanyi, M. (1966). The Tacit Dimension, Doubleday, Garden City, NY.

Qu, S. Q., & Dumay, J. (2011). The qualitative research interview. *Qualitative Research in Accounting & Management, 8(3),* 238-64.

Razmerita, L., & Kirchner, K. (2011). How wikis can be used to manage knowledge in SMEs: A case study. *Business Information Review, 28(3),* 175-178.

Rosu, S. M., Dragoi, G., & Guran, M. (2009). A Knowledge Management Scenario to Support Knowledge Applications Development in Small and Medium Enterprises. *Advances in Electrical and Computer Engineering, 9(1),* 8-15.

Roxas, B. A., Battisti, M. B., & Deakins, D. B. (2014). Learning, innovation and firm performance: Knowledge management in small firms. *Knowledge Management Research and Practice, 12(4)*, 443-453.

Salojärvi, S., Furu, P., & Sveiby, K. E. (2005). Knowledge management and growth in Finnish SMEs. *Journal of Knowledge Management, 9(2)*, 103-122.

Soon, T. T., & Zainol, F. A. (2011). Knowledge Management Enablers, Process and Organizational Performance: Evidence from Malaysian Enterprises. *Asian Social Science, 7(8)*, 186-202.

Sudhindra, S., Ganesh, L. S., & Arshinder, K. (2014). Classification of supply chain knowledge: a morphological approach. *Journal of Knowledge Management, 18(4)*, 812-823.

Von Krogh, G. (1998). Care in knowledge creation. *California Management Review, 40*, 133-154.

Watanabe, N. (1979). Statistical Methods for Estimating Membership Functions. *Japanese Journal of Fuzzy Theory and Systems, 5*, 4.

Wei, C. C., Choy, C. S., & Chew, G. G. (2011). The KM processes in Malaysian SMEs: an empirical validation. *Knowledge Management Research & Practice, 9(2)*, 185-196.

Zack, M. (1999). Managing codified knowledge, *Sloan Management Review, Summer*, 45-58.

Zadeh, L. A. (1965). *Fuzzy Sets. Information and Control, 8(3)*, 338-353.

Zhou, Y., Zhan, H., & Zhang, Y. (2014). Design and development of knowledge management platform for SMEs. *Journal of Chemical and Pharmaceutical Research, 6(7)*, 1035-1041.

Zimmermann, H. (2001). Fuzzy set theory and its applications. Boston: Kluwer Academic Publishers.

Appendix A

Table A.1 List of KM-Tools and KM-Practices adopted by individual firms

FIRMS	KM-TOOLS	KM-PRACTICES
A1	Audio Conference/Video Conference, Configuration Management Systems, Database, E-mail, ERP Systems, Peer-to-Peer Resource Sharing, Podcasting/Videocasting	After Action Review, Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Job Rotation, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Storytelling, Work Groups
A2	Audio Conference/Video Conference, Cloud Computing, Collaborative Filtering, Configuration Management Systems, Content Management Systems, Conversational Technologies, Data Warehouse, Database, Document Management Systems, E-mail, ERP Systems, Expert Systems, Learning Management Systems, Mash-up, Peer-to-Peer Resource Sharing, Podcasting/Videocasting, Social Media, Syndication Systems	After Action Review, Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Communities of Practice, Job Rotation, Knowledge Filtering, Knowledge Mapping, Meeting/Task Force , Problem Solving, Process Mapping, Social Network Analysis Storytelling, Work Groups
A3	Database, E-mail, ERP Systems	After Action Review, Brainstorming, Learning by doing, Problem Solving, Process Mapping
A4	Audio Conference/Video Conference, Cloud Computing, Configuration Management Systems, Conversational Technologies, Data Warehouse, Database, Document Management Systems, E-mail, ERP Systems, Learning Management Systems, Peer-to-Peer Resource Sharing	After Action Review, Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Communities of Practice, Job Rotation, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Social Network Analysis, Work Groups
A5	Conversational Technologies, Database, Document, Management Systems, E-mail	After Action Review, Best Practice, Brainstorming, Coaching/Mentoring, Communities of Practice, Job Rotation, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Work Groups
A6	Audio Conference/Video Conference, Cloud Computing, Database, E-mail, Peer-to-Peer Resource Sharing	After Action Review, Brainstorming, Job Rotation, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Storytelling, Work Groups
A7	Audio Conference/Video Conference, E-mail	Benchmarking, Brainstorming, Learning by doing, Problem Solving
A8	Audio Conference/Video Conference, Cloud Computing Collaborative Filtering, Configuration Management Systems, Content Management Systems, Conversational Technologies, Crowdsourcing Systems, Data Mining, Data Warehouse, Database, Document Management Systems, E-mail, ERP Systems, Expert Systems, Learning Management Systems, Mash-up, Peer-to-Peer Resource Sharing, Podcasting/Videocasting, Social Media, Syndication Systems	After Action Review, Benchmarking, Brainstorming Coaching/Mentoring, Communities of Practice, Job Rotation, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Work Groups
A9	Audio Conference/Video Conference, Cloud Computing, Conversational Technologies, Data Mining, Database, Document Management Systems, E-mail, Peer-to-Peer Resource Sharing	After Action Review, Benchmarking, Best Practice, Brainstorming, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Storytelling, Work Groups
A10	Database, Document Management Systems, E-mail	After Action Review, Best Practice, Coaching/Mentoring, Learning by doing, Problem Solving, Work Groups
A11	Audio Conference/Video Conference, Configuration Management Systems, Content Management Systems, Database, Document Management Systems, E-mail, Peer-to-Peer Resource Sharing	After Action Review, Benchmarking, Best Practice Brainstorming, Coaching/Mentoring, Communities of Practice, Knowledge Filtering, Learning by doing, Meeting/Task Force, Process Mapping, Work Groups
A12	Audio Conference/Video Conference, Content Management Systems, Data Warehouse, Database, Document Management Systems, E-mail, ERP Systems, Peer-to-Peer Resource Sharing	After Action Review, Benchmarking, Best Practice, Coaching/Mentoring, Communities of Practice, Job Rotation, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Work Groups
A13	Audio Conference/Video Conference, Cloud Computing, Configuration Management Systems, Conversational Technologies, Database, Document Management Systems, E-mail, ERP Systems, Learning Management Systems, Peer-to-Peer Resource Sharing	After Action Review, Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Communities of Practice, Job Rotation, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Storytelling, Work Groups
A14	Cloud Computing, Configuration Management Systems, Content Management Systems, Data Mining, Data Warehouse, Database, Document Management Systems, Peer-to-Peer Resource Sharing	Benchmarking, Best Practice, Brainstorming, Communities of Practice, Job Rotation, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Process Mapping, Work Groups

A15	Audio Conference/Video Conference, Cloud Computing, Configuration Management Systems, Content Management Systems, Conversational Technologies, Database, Document Management Systems, E-mail, Peer-to-Peer Resource Sharing, Podcasting/Videocasting, Social Media	After Action Review, Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Communities of Practice, Knowledge Filtering, Learning by doing, Problem Solving, Process Mapping, Social Network Analysis, Work Groups
A16	Audio Conference/Video Conference, Cloud Computing, Collaborative Filtering, Configuration Management Systems, Content Management Systems, Conversational Technologies, Crowdsourcing Systems, Data Mining, Data Warehouse, Database, Document Management Systems, E-mail, ERP Systems, Expert Systems, Learning Management Systems, Mash-up, Peer-to-Peer Resource Sharing, Podcasting/Videocasting, Social Media, Syndication Systems	After Action Review, Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Communities of Practice, Job Rotation, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Social Network Analysis, Storytelling, Work Groups
A17	Audio Conference/Video Conference, Cloud Computing, Configuration Management Systems, Content Management Systems, Data Mining, Data Warehouse, Database, Document Management Systems, E-mail, ERP Systems, Learning Management Systems, Peer-to-Peer Resource Sharing	After Action Review, Benchmarking, Best Practice Brainstorming, Coaching/Mentoring, Communities of Practice, Job Rotation, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Work Groups
A18	Audio Conference/Video Conference, Cloud Computing, Conversational Technologies, Data Warehouse, Database, Document Management Systems, E-mail, Learning, Management Systems, Peer-to-Peer Resource Sharing, Podcasting/Videocasting, Social Media	After Action Review, Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Knowledge Mapping, Learning by doing, Meeting/Task Force Problem Solving, Process Mapping, Storytelling, Work Groups
A19	Audio Conference/Video Conference, Configuration Management Systems, Content Management Systems, Crowdsourcing Systems, Data Mining, Data Warehouse, Database, Document Management Systems, E-mail, ERP Systems, Learning Management Systems	After Action Review, Brainstorming, Coaching/Mentoring, Communities of Practice, Knowledge Filtering, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Work Groups
A20	Audio Conference/Video Conference, Configuration Management Systems, Database, E-mail, ERP Systems, Peer-to-Peer Resource Sharing, Podcasting/Videocasting	After Action Review, Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Job Rotation, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Storytelling, Work Groups
A21	Database, E-mail, ERP Systems	After Action Review, Brainstorming, Learning by doing, Problem Solving, Process Mapping
A22	Conversational Technologies, Database, Document Management Systems, E-mail	After Action Review, Best Practice, Brainstorming, Coaching/Mentoring, Communities of Practice, Job Rotation, Learning by doing, Meeting/Task Force , Problem Solving, Process Mapping, Work Groups
A23	Audio Conference/Video Conference, E-mail	Benchmarking, Brainstorming, Learning by doing, Problem Solving
A24	Audio Conference/Video Conference, Cloud Computing, Conversational Technologies, Data Mining, Database, Document Management Systems, E-mail, Peer-to-Peer Resource Sharing	After Action Review, Benchmarking, Best Practice, Brainstorming, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Storytelling, Work Groups
A25	Audio Conference/Video Conference, Configuration Management Systems, Content Management Systems, Database, Document Management Systems, E-mail, Peer-to-Peer Resource Sharing	After Action Review, Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Communities of Practice, Knowledge Filtering, Learning by doing, Meeting/Task Force, Process Mapping, Work Groups
A26	Cloud Computing, Collaborative Filtering, Configuration Management Systems, Content Management Systems, Database, Document Management Systems, E-mail, Peer-to-Peer Resource Sharing	Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Communities of Practice, Job Rotation, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Storytelling, Work Groups
A27	Audio Conference/Video Conference, Cloud Computing, Collaborative Filtering, Configuration Management Systems, Content Management Systems, Conversational Technologies, Crowdsourcing Systems, Data Mining, Data Warehouse, Database, Document Management Systems, E-mail, ERP Systems, Expert Systems, Mash-up, Peer-to-Peer Resource Sharing, Podcasting/Videocasting, Social Media, Syndication Systems	After Action Review, Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Communities of Practice, Job Rotation, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Storytelling, Work Groups
A28	Cloud Computing Collaborative Filtering Configuration Management Systems Content Management Systems Crowdsourcing Systems Data Mining Data Warehouse Database	After Action Review, Best Practice, Brainstorming, Coaching/Mentoring, Communities of Practice, Job Rotation, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Storytelling, Work Groups

	E-mail Expert Systems Mash-up Peer-to-Peer Resource Sharing Podcasting/Videocasting Social Media Syndication Systems	
A29	Audio Conference/Video Conference, Cloud Computing, Collaborative Filtering, Configuration Management Systems, Conversational Technologies, Data Mining, Data Warehouse, Database, Document Management Systems, E-mail, Expert Systems, Social Media, Syndication Systems	After Action Review, Brainstorming, Coaching/Mentoring, Communities of Practice, Job Rotation, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Work Groups
A30	Audio Conference/Video Conference, Collaborative Filtering, Configuration Management Systems, Content Management Systems, Conversational Technologies, Crowdsourcing Systems, Data Mining, Data Warehouse, Database, Document Management Systems, ERP Systems, Expert Systems, Social Media	Best Practice, Brainstorming, Coaching/Mentoring, Communities of Practice, Job Rotation, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Storytelling, Work Groups
A31	Audio Conference/Video Conference, Cloud Computing, Configuration Management Systems, Content Management Systems, Conversational Technologies, Data Mining, Data Warehouse, Database, Document Management Systems, E-mail, ERP Systems	After Action Review, Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Communities of Practice, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Storytelling, Work Groups
A32	Cloud Computing, Configuration Management Systems, Database, Document Management Systems, E-mail, ERP Systems, Peer-to-Peer Resource Sharing	After Action Review, Brainstorming, Coaching/Mentoring, Communities of Practice, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Work Groups
A33	Audio Conference/Video Conference, Cloud Computing, Configuration Management Systems, Content Management Systems, Data Warehouse, Database, Document Management Systems, E-mail, Mash-up	Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Job Rotation, Knowledge Filtering, Meeting/Task Force, Problem Solving, Social Network Analysis, Storytelling, Work Groups
A34	Audio Conference/Video Conference, Content Management Systems, Data Mining, Data Warehouse, Database, Document Management Systems, E-mail, Peer-to-Peer Resource Sharing, Social Media	After Action Review, Brainstorming, Knowledge Mapping, Meeting/Task Force, Problem Solving, Process Mapping, Work Groups
A35	Audio Conference/Video Conference, Configuration Management Systems, Data Mining, Data Warehouse, Database, Document Management Systems, E-mail	Brainstorming, Communities of Practice, Job Rotation, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Work Groups
A36	Audio Conference/Video Conference, Cloud Computing, Data Warehouse, Database, E-mail, Peer-to-Peer Resource Sharing, Podcasting/Videocasting, Social Media	Benchmarking, Brainstorming, Job Rotation, Knowledge Mapping, Learning by doing. Meeting/Task Force, Problem Solving, Work Groups
A37	Audio Conference/Video Conference, Cloud Computing, Content Management Systems, Crowdsourcing Systems, Database, Document Management Systems, E-mail, ERP Systems, Learning Management Systems, Peer-to-Peer Resource Sharing, Podcasting/Videocasting, Social Media	After Action Review, Benchmarking, Brainstorming, Coaching/Mentoring, Job Rotation, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Work Groups
A38	Audio Conference/Video Conference, Cloud Computing, Data Warehouse, Database, Document Management Systems, E-mail, ERP Systems, Peer-to-Peer Resource Sharing, Podcasting/Videocasting	Brainstorming, Job Rotation, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Social Network Analysis, Work Groups
A39	Audio Conference/Video Conference, Cloud Computing, Database, Document Management Systems, E-mail, ERP Systems, Expert Systems, Learning Management Systems, Peer-to-Peer Resource Sharing	Benchmarking, Brainstorming, Coaching/Mentoring, Communities of Practice, Job Rotation, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Work Groups
A40	Audio Conference/Video Conference, Content Management Systems, Database, Document Management Systems, E-mail, ERP Systems, Peer-to-Peer Resource Sharing	After Action Review, Best Practice, Brainstorming, Communities of Practice, Job Rotation, Meeting/Task Force, Problem Solving, Work Groups
A41	Collaborative Filtering, Configuration Management Systems, Content Management Systems, Data Mining, Data Warehouse, Database, Document Management Systems, ERP Systems, Peer-to-Peer Resource Sharing	Benchmarking, Best Practice, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Social Network Analysis, Work Groups
A42	Audio Conference/Video Conference, Cloud Computing, Configuration Management Systems, Data Warehouse, Database, Document Management Systems, E-mail, ERP Systems, Learning Management Systems, Peer-to-Peer Resource Sharing, Podcasting/Videocasting, Social	After Action Review, Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Communities of Practice, Job Rotation, Knowledge Mapping, Problem Solving, Process Mapping, Social Network Analysis, Work Groups

	Media	
A43	Cloud Computing, Conversational Technologies, Database, Document Management Systems, E-mail, ERP Systems, Social Media	Brainstorming, Coaching/Mentoring, Job Rotation, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Work Groups
A44	Audio Conference/Video Conference, Cloud Computing, Configuration Management Systems, Content Management Systems, Conversational Technologies, Data Warehouse, Database, Document Management Systems, E-mail, ERP Systems, Learning Management Systems, Peer-to-Peer Resource Sharing, Podcasting/Videocasting, Social Media	After Action Review, Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Job Rotation, Knowledge Mapping, Meeting/Task Force, Problem Solving, Process Mapping
A45	Data Warehouse, E-mail, ERP Systems	After Action Review, Brainstorming, Coaching/Mentoring, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Work Groups
A46	Data Warehouse, E-mail	After Action Review, Brainstorming, Job Rotation, Knowledge Mapping, Problem Solving, Process Mapping, Work Groups
A47	Cloud Computing, Database, Document Management Systems, E-mail, Social Media	After Action Review, Benchmarking, Brainstorming, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Storytelling, Work Groups
A48	Audio Conference/Video Conference, Cloud Computing, Database, Document Management Systems, E-mail, ERP Systems, Peer-to-Peer Resource Sharing	After Action Review, Benchmarking, Best Practice, Brainstorming, Job Rotation, Knowledge Filtering, Learning by doing, Meeting/Task Force, Process Mapping, Storytelling
A49	Cloud Computing, Content Management Systems, Data Warehouse, Database, Document Management Systems, E-mail, Peer-to-Peer Resource Sharing	After Action Review, Benchmarking, Brainstorming, Coaching/Mentoring, Job Rotation, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Work Groups
A50	Cloud Computing, Content Management Systems, Conversational Technologies, Database, Document Management Systems, E-mail	Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Knowledge Mapping, Problem Solving, Process Mapping
A51	Cloud Computing, Content Management Systems, Document Management Systems, ERP Systems, Expert Systems, Learning Management Systems, Podcasting/Videocasting, Social Media	After Action Review, Best Practice, Brainstorming, Job Rotation, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Work Groups
A52	Cloud Computing, Database, E-mail	After Action Review, Benchmarking, Best Practice, Coaching/Mentoring, Job Rotation, Knowledge Mapping, Problem Solving
A53	Audio Conference/Video Conference, Cloud Computing, Content Management Systems, Data Warehouse, Database, Document Management Systems, E-mail, ERP Systems, Expert Systems, Learning Management Systems, Peer-to-Peer Resource Sharing, Social Media	After Action Review, Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Communities of Practice, Job Rotation, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Social Network Analysis, Storytelling, Work Groups
A54	Audio Conference/Video Conference, Cloud Computing, Database, Document Management Systems, E-mail, ERP Systems, Expert Systems	Benchmarking, Best Practice, Brainstorming, Communities of Practice, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Storytelling, Work Groups
A55	Cloud Computing, Data Warehouse, Database, Document Management Systems, E-mail, Peer-to-Peer Resource Sharing, Social Media	After Action Review, Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Learning by doing, Meeting/Task Force, Problem Solving, Work Groups
A56	Audio Conference/Video Conference, Cloud Computing, Database, E-mail, ERP Systems, Peer-to-Peer Resource Sharing, Podcasting/Videocasting, Social Media	Benchmarking, Brainstorming, Coaching/Mentoring, Learning by doing, Meeting/Task Force, Problem Solving, Work Groups
A57	Audio Conference/Video Conference, Cloud Computing, Data Warehouse, Database, E-mail, ERP Systems, Peer-to-Peer Resource Sharing	Best Practice, Coaching/Mentoring, Job Rotation, Knowledge Filtering, Knowledge Mapping, Meeting/Task Force, Problem Solving, Process Mapping
A58	Collaborative Filtering, Content Management Systems, Crowdsourcing Systems, Data Warehouse, Database, Document Management Systems, E-mail, ERP Systems, Expert Systems, Social Media	After Action Review, Brainstorming, Coaching/Mentoring, Communities of Practice, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Work Groups
A59	Audio Conference/Video Conference, Database, E-mail, Social Media	After Action Review, Benchmarking, Best Practice, Brainstorming, Job Rotation, Knowledge Mapping, Problem Solving, Process Mapping, Work Groups
A60	Audio Conference/Video Conference, Cloud Computing, Configuration Management Systems, Content,	After Action Review, Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Communities of

	Management Systems, Conversational Technologies, Data Warehouse, Database, Document Management Systems, E-mail, ERP Systems, Learning Management Systems, Podcasting/Videocasting, Social Media	Practice, Job Rotation, Knowledge Filtering, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Social Network Analysis, Storytelling, Work Groups
A61	Audio Conference/Video Conference, Cloud Computing, Configuration Management Systems, Data Warehouse, Database, Document Management Systems, E-mail, ERP Systems, Learning Management Systems, Peer-to-Peer Resource Sharing, Podcasting/Videocasting, Social Media	After Action Review, Benchmarking, Best Practice, Brainstorming, Coaching/Mentoring, Communities of Practice, Job Rotation, Knowledge Mapping, Learning by doing, Meeting/Task Force, Problem Solving, Process Mapping, Social Network Analysis

Table A.2 Fuzzy numbers associated to firms' knowledge

FIRMS	PLANNING		PRODUCTION		ORGANIZATION		MARKET RELATIONSHIPS		STRATEGIC RELATIONSHIPS	
	ED	OD	ED	OD	ED	OD	ED	OD	ED	OD
A1	VSF	IG	MF	IO	SF	IG	SF	IG	PF	MI
A2	VSF	OP	MF	OP	VSF	FO	VPF	IG	MF	FO
A3	SF	IO	SF	IO	MF	IO	MF	IO	PF	IG
A4	VSF	IO	VSF	IO	MF	IG	MF	IO	MF	IG
A5	SF	IO	MF	IG	MF	MI	PF	MI	PF	MI
A6	MF	IG	MF	IO	VSF	IO	PF	MI	VPF	MI
A7	MF	IO	MF	OP	MF	IO	MF	OP	MF	IO
A8	VSF	IG	VSF	IG	MF	IO	MF	IG	PF	IG
A9	SF	OP	SF	OP	MF	IO	MF	IG	SF	IG
A10	SF	IG	SF	MI	PF	MI	MF	OP	PF	MI
A11	SF	IO	MF	IG	MF	OP	MF	IG	MF	IG
A12	SF	IG	SF	IG	SF	IG	PF	MI	PF	MI
A13	MF	IO	VSF	IG	VSF	OP	PF	IG	PF	IG
A14	PF	IG	MF	IG	PF	IG	VPF	IG	VPF	IG
A15	MF	IG	MF	IG	MF	MI	MF	MI	MF	MI
A16	SF	IO	SF	IO	VSF	IG	MF	OP	MF	OP
A17	SF	IG	SF	IG	SF	IO	MF	IO	SF	IO
A18	SF	IG	SF	IG	VSF	IO	VSF	IO	VSF	IG
A19	SF	IG	MF	IO	MF	IO	PF	IG	SF	MI
A20	VSF	IG	MF	IO	SF	IG	SF	IG	PF	MI
A21	SF	OP	SF	OP	MF	IO	MF	IG	SF	IG
A22	SF	FO	SF	IG	SF	FO	MF	IG	SF	IO
A23	VSF	IO	MF	IO	VSF	IG	MF	MI	MF	MI
A24	VSF	IO	VSF	IO	VSF	IG	MF	IO	SF	IG
A25	VPF	IG	SF	IO	SF	IO	PF	IG	PF	IG
A26	VSF	OP	VSF	OP	VSF	OP	PF	MI	PF	MI
A27	MF	IO	PF	IG	SF	IO	MF	IG	PF	IO
A28	VSF	IG	VSF	IG	SF	IG	MF	IG	SF	MI
A29	VSF	FO	PF	IG	SF	FO	PF	FO	SF	IG
A30	SF	IG	SF	IG	MF	IG	PF	IG	MF	IG
A31	SF	IG	MF	IO	MF	IO	PF	IG	SF	MI
A32	VSF	IO	VPF	MI	VSF	IO	VPF	IG	SF	IG
A33	SF	IO	MF	IO	MF	IG	PF	MI	PF	IO
A34	SF	IO	MF	IG	MF	IG	MF	IO	MF	OP
A35	VSF	IO	VSF	OP	VSF	IO	MF	IO	SF	IG
A36	VSF	IO	VPF	MI	MF	IO	PF	IG	MF	IG
A37	SF	IO	SF	IO	MF	IO	MF	IO	SF	OP
A38	MF	IG	MF	IG	MF	IG	PF	IG	MF	IG
A39	MF	IG	PF	IG	MF	IG	PF	IG	PF	IG
A40	PF	IG	PF	IG	PF	IG	PF	MI	PF	MI
A41	MF	IG	MF	IG	MF	IO	MF	OP	MF	IG
A42	SF	IG	SF	IO	MF	IO	PF	IG	MF	MI
A43	MF	IG	SF	IG	MF	IG	PF	IG	MF	IG
A44	MF	IG	MF	IG	MF	IG	PF	IG	PF	IG
A45	VSF	MI	VSF	IG	VSF	MI	VSF	IG	VSF	MI
A46	PF	IO	PF	IO	PF	IO	PF	IO	PF	IO
A47	PF	OP	PF	IG	PF	IO	PF	MI	PF	MI
A48	MF	IG	MF	IG	MF	IG	MF	IG	MF	IG
A49	SF	IG	MF	IG	MF	IO	PF	MI	VPF	MI
A50	VSF	MI	SF	MI	SF	MI	MF	MI	VSF	MI
A51	SF	IG	SF	IG	SF	IG	MF	OP	MF	IG
A52	PF	IG	VPF	IG	PF	IG	VPF	MI	PF	MI
A53	SF	IG	MF	IG	SF	MI	SF	MI	PF	MI
A54	SF	IG	SF	IG	MF	IG	SF	IG	SF	IG
A55	SF	IG	SF	IG	SF	MI	SF	IG	SF	MI
A56	MF	IG	MF	IG	MF	IG	SF	IG	SF	IG
A57	MF	IG	SF	IG	SF	IG	VPF	IG	MF	IG
A58	MF	IG	SF	IO	SF	IO	PF	IG	MF	IO
A59	MF	IG	MF	IG	MF	IO	PF	IG	PF	IG
A60	VSF	IG	MF	IG	MF	IO	PF	IO	PF	IG
A61	SF	IG	SF	IO	SF	IO	SF	IG	SF	MI

8. Conclusions and implications

This final chapter summarises the conclusions, the practical implications provided by this thesis, the limitations of the results, and the future research directions.

The aim of this thesis is to analyse the crucial role of knowledge management in supply chain starting from a systematic literature review on the topic. The phase of material comprehensive search has been conducted using two academic databases (Scopus and Web of Science) that have allowed to select and analyse the body of literature on the topic. The descriptive analysis of papers has not only confirmed that knowledge management in supply chain is a topic still neglected in literature, but has highlighted that is overlooked even from journals of supply management and journals of knowledge management. Nevertheless, the trend of papers on this topic is therefore growing in recent years. The content analysis of papers highlights a set of main literature gaps that have allowed to formulate consequent research questions. These research questions represent some possible areas of investigation to improve the literature on both knowledge management and supply chain. The aim of field analysis is to provide an answer to the research questions identified:

RQ1: *What are the major barriers hindering the spread of knowledge management practices in SMEs?*

RQ2: *What are the main knowledge management systems adopted by SMEs?*

RQ3: *What is the impact of the use of knowledge management practices on SMEs' performance?*

RQ4: *What is the degree of adoption of KMSs by SMEs?*

RQ5: *What is the relationship between KM-Practices and KM-Tools used by SMEs?*

RQ6: *Which KM-tools and KM-Practices are used by SMEs?*

RQ7: *What is the degree of diffusion and the intensity of use of KM-Tools and KM-Practices among SMEs?*

RQ8: *What are the strategies for using KM-Tools and KM-Practices among SMEs?*

RQ9: *What is the degree of alignment between KM-Tools adopted by SMEs and the nature of their knowledge in the ontological and epistemological dimensions?*

RQ10: *What is the degree of alignment between KM-Practices adopted by SMEs and the nature of their knowledge in the ontological and epistemological dimensions?*

RQ11: *What is the degree of alignment between KM-Tools and KM-Practices adopted by SMEs in the ontological and epistemological dimensions?*

In relation to the first research question (***RQ1***), the field analysis results indicate that although SMEs are usually characterized by scarce human and financial resources, they are able to overcome the barriers preventing the spread of KM practices. Thanks to technological innovation in the field of ICTs, cheaper and very easy to use KMSs are available posing reduced financial, technical and cultural barriers. This aspect stresses that the scenario is evolving and is offering SMEs new opportunities and new frontiers to explore in the field of KM.

As for the second research question (***RQ2***), empirical evidence shows that the SMEs investigated have perceived the strategic value of KM and consequently adopt a variety of KMSs. Nevertheless, it emerged that they are generally prone to using outdated KMSs rather than the newer ones, which are also cheaper and user friendly. This gap shows the difficulties that SMEs usually have in following rapid technological changes, as well as the lack of support from ICT vendors in the decision-making process regarding the choice of appropriate KM tools and systems.

With regards to the third research question (***RQ3***), empirical evidence points out that the impact of the use of practices of KM on firm performance can be extremely significant and at the same time improves a variety of performance. In particular, it emerges that KM contributes positively to the overall growth of SMEs by enhancing financial, market, technical, human and organizational performance.

To address the fourth research question (***RQ4***), this chapter has first divided KMSs into two categories, i.e. knowledge management tools (KM-Tools) and knowledge management practices (KM-Practices), and then has identified twenty KM-Tools and sixteen KM-Practices used by SMEs. Successively, it has been identified the degree of adoption of KM-Tools and the degree of adoption of KM-Practices. As far as the KM-Tools, the chapter has shown that SMEs have a strong variety of behaviours, which ranges between two extremes. Some SMEs use many KM-Tools, while others focus on a few KM-Tools. SMEs adopting many KM-Tools use both traditional and innovative ones. By contrast, SMEs that adopt few KM-Tools use exclusively traditional ones. As far as the KM-Practices, the chapter has highlighted a quite homogeneous behaviour. Apart from a few SMEs, the majority of SMEs investigated uses a wide range of practices. To sum up, as regards the adoption of KMSs, the chapter highlights that SMEs are not a homogeneous world that replays indistinctly the same choices and adopts the same solutions but there are a variety of approaches and behaviours.

As far as the fifth research question (***RQ5***), the comparison between the degree of adoption of KM-Tools and KM-Practices has pointed out a significant and positive correlation: the higher the

use of KM-Practices, the higher the adoption of KM-Tools. Moreover, the chapter has highlighted three groups of SMEs. The first, encompasses SMEs that have a low level of adoption of KM-Practices and KM-Tools. These SMEs use exclusively generalist KM-Practices and traditional KM-Tools. The second group includes SMEs that have a high index of adoption of KM-Practices and a low index of adoption of KM-Tools. These SMEs adopt traditional KM-Tools and use specialist KM-Practices (along with generalist KM-Practices). The third group encompasses SMEs that have a high degree of adoption of KM-Practices and KM-Tools. These SMEs use innovative tools (along with traditional ones) and specialist KM-Practices (along with generalist ones).

As for the sixth research question (***RQ6***), on the base of a study of the literature and a focus group that involved senior IT consultants/researchers operating in the field of SMEs, a taxonomy of KM-Tools and KM-Practices was identified. These two taxonomies offer SMEs the opportunity to identify a set of tools and practices that could be used to improve the different phases of the knowledge management process (creation, storage, transfer).

Regarding the seventh research question (***RQ7***), using semi-structured interviews with 61 SMEs, this chapter highlights that the SMEs surveyed adopt and make more intensive use of traditional KM-Tools rather than new and more updated ones that are generally cheaper and easier to use. This gap could be the result of the rapidity of technological changes in the field of ICTs. Moreover, considering that SMEs generally do not have dedicated resources to monitor and follow technological evolution, this forces them to remain in a backward position. The chapter also shows that the SMEs surveyed adopt KM-Practices use more intensively those that do not focus exclusively on the KM process. From the semi-structured interviews it emerged that this trend is due to two characteristics of SMEs. Firstly, SMEs have scarce resources and so instead of investing in new practices geared to knowledge management, they seek to adapt the practices they already know to the new requirements of knowledge management. The second peculiarity is connected to the nature of knowledge. Knowledge of SMEs is mainly embedded in human resources, and this does not promote a wide diffusion of formal KM-Practices. In summary, these results seem to show that SMEs tend to use more traditional tools and adapt practices already used for knowledge management.

Concerning the eight research question (***RQ8***), the chapter points out *a relationship of reciprocity* between KM-Tools and KM-Practices: one reinforces the other and vice versa. The higher the number of KM-Practices used by SMEs, the higher the number of KM-Tools they use. This result is in line with the previous study by Carayannis (1999) in which it is assumed that

KM plays a crucial role in fostering a synergistic symbiosis between ICTs and managerial/organizational practices.

Concerning the alignment between KM-Tools and SMEs' knowledge (***RQ9)***, the results highlight that a large percentage of surveyed SMEs (61%) adopts KM-Tools that are effective but not efficient to manage the nature of their knowledge according to the epistemological and ontological dimensions.

Similarly, as for the alignment KM-Practices and SMEs' knowledge (***RQ10)*** the findings show that the majority of SMEs (72%) uses knowledge management practices that are more efficient than effective to meet their knowledge needs in terms of both the degree of formalisation and degree of sharing.

Integrating the answers to these first two research questions the chapter has allowed to identify four different strategies of KMSs adoption for SMEs: misaligned SMEs, efficiently misaligned SMEs, effectively misaligned SMEs, aligned SMEs. The "misaligned SME" is a firm that adopts a limited set of mainly traditional KM-Tools (e.g. databases, document management system, e-mail) and KM-Practices not specifically dedicated to knowledge management (e.g. brainstorming, learning by doing, problem solving, process mapping) exploiting them inefficiently and ineffectively. The "efficiently misaligned SME" is a firm that adopt an overabundant number of knowledge management systems including also those that are not aligned with firm's knowledge according to the epistemological and ontological dimensions. This SME uses traditional KM-Tools (e.g. databases, video conference, ERP systems, e-mail, document management system), innovative KM-Tools (e.g. data mining, collaborative filtering, syndication systems, mash-up, content management systems, social media, cloud computing, learning management systems, podcasting, peer-to-peer), and KM-Practices not specifically dedicated to knowledge management (e.g. brainstorming, problem solving, process mapping, after action review, job rotation, work groups, meeting/task force, learning by doing). The "aligned SME" is a firm that has a perception of the strategic value of knowledge management and so explore the potentiality of KMSs in terms of both efficiency and effectiveness. The "effectively misaligned SME" is a firm that adopts KMSs that are more efficient than effective. The majority of surveyed firms are efficiently misaligned SMEs. These latter have great potential for growth and through appropriate learning and training processes involving KM experts and/or KMSs' providers, they can become aligned SMEs.

Regarding the eleventh research question (***RQ11***), the results highlight that there is a relation of reciprocity between KM-Tools and KM-Practices used by the firms: the higher the degree of

coverage of KM-Tools with KM-Practices (DCT), the higher the degree of coverage of KM-Practices with KM-Tools (DCT) and vice versa. In fact, a large percentage of firms (60%) are characterised by an high degree of coverage of KM-Tools with KM-Practices and a degree of coverage of KM-Practices with KM-Tools. This result is in line with Carayannis (1999), which assumed that KM plays a crucial role in achieving a synergistic symbiosis between ICTs and organization practices used by the firm.

Implications

From the SMEs' point of view, this thesis has highlighted that KM contributes to overall growth by enhancing their performance simultaneously and significantly. However, SMEs could further increase the impact of KM by better exploiting the opportunities offered by the new ICTs (such as: cloud computing, crowd-sourcing, collaborative filtering, wiki, etc.). In addition they could grow the efficiency and the effectiveness of KM process by better evaluating and selecting the knowledge management tools and practices they already adopt, and introducing exclusively the innovative KMSs that are aligned with the nature of their knowledge according to the epistemological and ontological dimensions. To achieve this aim SMEs have to invest in the education of KM analysts/managers able to analyse their knowledge management process, instead of investing exclusively in new tools/practices geared to their knowledge needs, or seeking to adapt the tools/practices they already use to the new requirements of KM.

From the KMS providers' point of view, this thesis has stressed that SMEs typically do not have dedicated resources to monitor the innovation process in the field of KMSs. Furthermore SMEs typically do not have yet have trained resources that are able to monitor and follow the processes of innovation affecting KMSs. Nevertheless, they could represent a significant niche market. To seize this opportunity, it is necessary create a new market segment dedicated to SMEs, reducing the cultural distance between demand and supply by developing direct channels of communication (including virtual means) between SMEs and KMS providers, and through the organisation of technology fairs and salons dedicated to small and medium enterprises.

Limitations

The results highlighted in this thesis can be broadly applied to SMEs operating in high-tech end/or complex industries. Future studies will extend these results, expanding the sample and taking care to include SMEs representing different industries.

Future research

The thesis provides guidance for future research. The firs research direction is a consequence of the taxonomy of the strategies of SMEs (Guideposts, Explorers, Exploiters, Latecomers). This issue requires an in-depth analysis to verify whether the strategy used affects the performance of an SME. The second research direction derives from the importance of SMEs networks in the development of KM in supply chain and regards the ways through which knowledge is spread across networks populated by SMEs.

9. Author's biographical note and publication list

Roberto Cerchione is Ph.D. candidate and researcher at the Department of Industrial Engineering of the University of Naples Federico II. He received with honors the M.Sc. Degree in Engineering Management in 2013. His research projects are focused on knowledge management, technology management, logistics and supply chain management, startups and entrepreneurship, environmental sustainability. His doctoral research activity is reflected in 26 papers including manuscripts submitted or published in international journals, book chapters, and papers published in international conference proceedings. The full list of publications is reported below:

- A1: Papers published in international journals;
- A2: Papers at the second-step of review process
- A3: Papers under review in international journals;
- B: International books and chapters in international books;
- C: Papers in proceedings of international conferences and workshops;
- D: Abstracts published in international journals;
- E: Master degree thesis (Assistant supervisor).

A1: Papers published in international journals;

A1.8. Centobelli P., Cerchione R., Esposito E., Raffa M. "The Evolution of Engineering Management Education", International Journal of Engineering Education. Accepted 14 March 2016.

A1.7. Cerchione R., Esposito E., Spadaro M.R. (2016). "A literature review on Knowledge Management in SMEs", Knowledge Management Research and Practice. Accepted 5 August 2015 (Advance online publication 28 September 2015).

A.1.6 Centobelli P., Cerchione R., Gallo M., Murino T. (2016). "Layout and Material Flow Optimization in Digital Factory", International Journal of Simulation Modelling, 15(2).

A1.5. Centobelli P., Cerchione R., Esposito E., Raffa M. (2015). "The Revolution of Crowdfunding in social knowledge economy: Literature Review and Identification of Business Models", Advanced Science Letters. Accepted 8 September 2015.

A1.4. Centobelli P., Cerchione R., Esposito E., Raffa M. (2015). "Digital Marketing in SMEs: The Impact of Web-based Technologies", Advanced Science Letters. Accepted 6 September 2015.

A1.3. Centobelli P., Cerchione R., Esposito E., Raffa M. (2015). "What is the Engineering Management? Exploring the Emerging Knowledge and Skills for Engineers", Advanced Science Letters. Accepted 21 March 2015.

A1.2. Cerchione R., Esposito E., Raffa M. (2015). "Il Knowledge Management nelle PMI subfornitrici: Il caso "Polo High Tech di Napoli Est", Piccola Impresa (Small Business), 3, 69-90.

A1.1. Cerchione R., Esposito E., Spadaro M.R. (2015). "The Spread of Knowledge Management in SMEs: A Scenario in Evolution", Sustainability, 7(8), 10210-10232.

A2: Papers at the second-step of review process;

A2.1. Cerchione R., Esposito E. "Literature Review on Knowledge Management in Supply Chain: State of Art and Research Opportunities", International Journal of Production Economics.

A3: Papers under review in international journals;

A.3.6. Centobelli P., Cerchione R., Esposito E. "Alignment Evaluation between Knowledge Management Systems and the nature of SMEs' Corporate Knowledge: A 3D Fuzzy Model", Expert Systems with Applications.

A3.5. Cerchione R., Esposito E. "Environmental sustainability in the service industry of third-party logistics: Literature review and research directions", Journal of Cleaner Production.

A3.4. Cerchione R., Esposito E. "Using Knowledge Management Systems: A Taxonomy of SME Strategies", International Journal of Information Management.

A3.3. Cerchione R., Esposito E. "Knowledge Management Systems: The Hallmark of SMEs", Knowledge Management Research and Practice.

A3.2. Cerchione R., Esposito E., Raffa M., Sgammato S.R. "Towards a more entrepreneurial university: Taxonomy of definitions, literature review and future research directions", SAGE Open.

A3.1. Cerchione R., Esposito E. "Knowledge Management Systems in Small Supply Firms: Taxonomy and Evaluation of their Intensity of Use", Journal of Purchasing and Supply Management.

B: International books and chapters in international books;

B1. Cerchione R., Esposito E., Raffa M. (2015). "Tools and Practices for Knowledge Management in Small Supply Firms", Research in the Decision Sciences for the Service Economy, Pearson, London, UK, Chapter 16.

C: Papers in proceedings of international conferences and workshops;

C10. Cerchione R., Esposito E., Raffa M. (2016). "Knowledge Management: A Taxonomy of Supply Firms", Proceedings of the 25th IPSERA Conference.

C9. Cerchione R., Esposito E. (2016). "Environmental sustainability in third-party logistics industry: Literature review and research directions", Proceedings of the 25th IPSERA Conference.

C8. Cerchione R., Esposito E., Raffa M. (2016). "Storia della letteratura sull'Ingegneria Gestionale", Proceedings of the 2nd International Conference on the History of Engineering.

C7. Cerchione R., Esposito E., Raffa M. (2015). "Tools and practices for Knowledge Management in Small Supply Firms", Proceedings of the 6th EDSI Conference.

C6. Cerchione R., Esposito E. (2015). "Knowledge Management Tools and Practices alignment in SMEs, Proceedings of the 10th IFKAD Conference.

C5. Cerchione R., Esposito E., Raffa M. (2015). "Knowledge Management Systems in Small Supply Firms", Proceedings of the 24th IPSERA Conference.

C4. Cerchione R., Esposito E. (2015). "Knowledge Management in Supply Chain: A literature review", Proceedings of the 24th IPSERA Conference.

C3. Cerchione R., Esposito E., Raffa M. (2014). "Evolution of Small Firm's Network in Aircraft Industry", Proceedings of the 59th ICSB Conference.

C2. Cerchione R., Esposito E., Raffa M. (2014). "Evolution of Local Supply System in aircraft industry", Proceedings of the 23rd IPSERA Conference.

C1. Cerchione R., Esposito E., Raffa M. (2013). "Ingegneria Gestionale: dalle esperienze pionieristiche a giorni nostri", Proceedings of the 1st International Conference on the History of Engineering.

D: Abstracts published in international journals;

D1. Cerchione R. , Esposito E. , Raffa M. (2014). 'A New Profile of Engineer: From Management Engineering to Entrepreneurial Engineering'. World Academy of Science, Engineering and Technology, International Science Index, Humanities and Social Sciences, 1(4), 684.

E: Master degree thesis (Assistant supervisor).

E12. Iniziative green e tecnologie ICT per la sostenibilità ambientale nel settore della logistica e dei trasporti (2016).
Supervisor: Prof. Emilio Esposito

E11. Business Model Analysis applied to the Museums Sector: Case Studies from Campania (2016).
Supervisor: Prof. Mario Raffa

E10. Le opportunità dei Big Data e l'utilizzo del software R: Valutazione mediante DEA dell'efficienza del sistema di trasporto di un operatore logistico 3PL (2016).
Supervisor: Prof. Mario Raffa.

E9. Il knowledge management nelle imprese fornitrici del settore automotive e confronto con il settore aerospaziale (2016).
Supervisor: Prof. Emilio Esposito

E8. Il ruolo dei fab lab e della digital fabrication nello sviluppo di un nuovo prodotto: Caso di studio del prodotto Smart Size (2016).
Supervisor: Prof. Mario Raffa.

E7. L'allineamento tra i sistemi di gestione della conoscenza e la natura della conoscenza nelle piccole e medie imprese (2015).
Supervisor: Prof. Emilio Esposito

E6. L'Europrogettazione: Strumenti e Tecniche per la Gestione dei Fondi Europei (2015).
Supervisor: Prof. Mario Raffa.

E5. The Spread of Crowd-based Economy: Managing Tools and Practices supporting Platforms and Campaigns (2015).
Supervisor: Prof. Mario Raffa

E4. La gestione della sostenibilità nelle imprese di logistica e di trasporto (2015).
Supervisor: Prof. Emilio Esposito

E3. Il Knowledge Management nella Supply Chain (2014).
Supervisor: Prof. Emilio Esposito

E2. L'evoluzione dei sistemi di subfornitura nel settore aerospaziale (2014).
Supervisor: Prof. Emilio Esposito

E1. La gestione della conoscenza nelle PMI del settore aerospaziale campano (2014).
Supervisor: Prof. Emilio Esposito