

Article

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

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Academic Editor: Marc A. Rosen

Received: 16 May 2015 / Accepted: 28 July 2015 / Published: 31 July 2015

Abstract: This paper 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 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 Nevertheless, such systems are generally outdated in comparison with cheaper, more recent, and user-friendly applications.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 paper 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

1. 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 [1–10]. 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 [11–14]. 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 [15].

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 [16–24]:

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 [25–29]:

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 [12].

With this in mind, the aim of this paper 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 paper 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.

2. 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) [30], Petticrew and Roberts (2006) [31] and Easterby-Smith *et al.* (2012) [32].

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 articles; the addition of further articles, based on professional recommendation and references from reviewed articles.

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.

2.1. 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).

2.2. 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 articles whose abstracts focus on knowledge management SMEs. In order to achieve this objective, abstracts of the 428 articles 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 article. For this purpose articles 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.

2.3. 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 articles, 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.

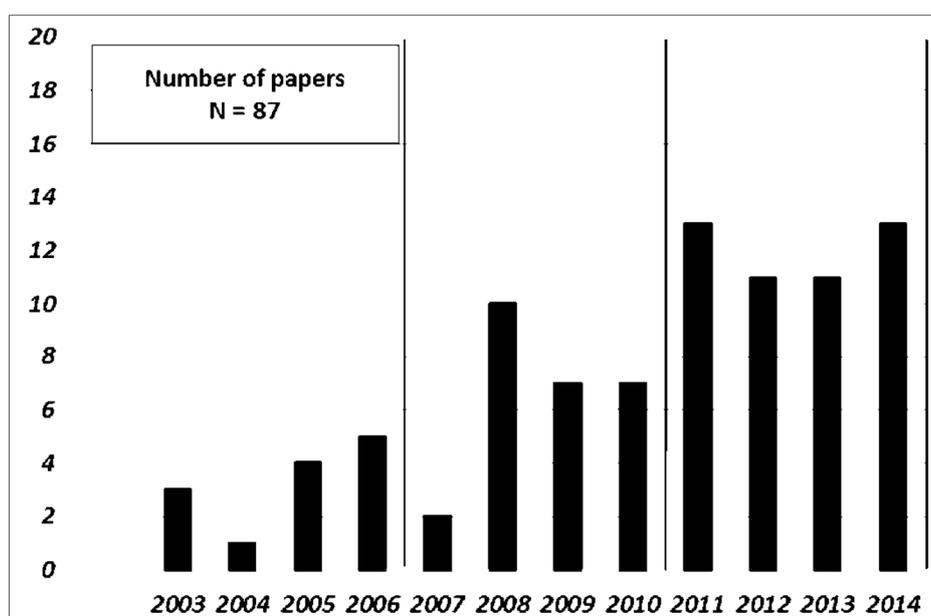


Figure 1. Article distribution over time.

The trend of articles on this topic has thus seen growth over recent years. This conclusion is in line with Serenko (2013) [33], 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.

2.4. 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.

2.4.1. 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 [34–36] and industrial characteristics [37]; *Environmental factors*, i.e., social context [38,39], environmental commitment [40], geographic proximity to the knowledge sources [41], and *Firm specific factors*, namely international interactions and organizational proximity [39,41], and organization size [42].

Table 1. Papers by topic and sub-topic.

Topic 1: Factors Affecting KM (41 Papers)	Topic 2: Systems Supporting KM (29 Papers)	Topic 3: KM and Performance (17 Papers)
Contingency factors (9 papers)	KM-Practices (18 papers)	
Cappellin (2003)	Ambrosini and Bowman (2008)	Alegre <i>et al.</i> (2011)
Davenport (2005)	Chong <i>et al.</i> (2011)	Bagnoli and Vedovato (2012)
Edwards (2007)	Corso <i>et al.</i> (2003)	Beck and Schenker-Wicki (2014)
Heavin and Adam (2014)	Desouza and Awazu (2006)	Daud and Yusoff (2011)
Hsu <i>et al.</i> (2007)	du Plessis (2008)	Delen <i>et al.</i> (2013)
Moffett and McAdam (2006)	Durst and Wilhelm (2011)	Egbu <i>et al.</i> (2005)
Purcarea (2013)	Durst and Wilhelm (2012)	Filippini <i>et al.</i> (2012)
Roy and Therin (2008)	Fink and Ploder (2009)	Gholami <i>et al.</i> (2013)
Soto-Acosta <i>et al.</i> (2014)	Hutchinson and Quintas (2008)	Gupta <i>et al.</i> (2014)
Critical success factors (28 papers)	Levy <i>et al.</i> (2003)	Hong <i>et al.</i> (2014)
Bocquet and Mothe (2010)	Lin <i>et al.</i> (2012)	Liu and Abdalla (2013)
Boden <i>et al.</i> (2012)	Massa and Testa (2011)	Omerzel and Antončič (2008)
Chen <i>et al.</i> (2012)	Navarro <i>et al.</i> (2010)	Roxas <i>et al.</i> (2014)
Chen <i>et al.</i> (2013)	Noblet and Simon (2012)	Salojärvi <i>et al.</i> (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 <i>et al.</i> (2011)
Gholipour <i>et al.</i> (2010)	Yao <i>et al.</i> (2011)	
Hussain <i>et al.</i> (2011)	KM-Tools (11 papers)	
Jones <i>et al.</i> (2010)	Beylier <i>et al.</i> (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 <i>et al.</i> (2006)	Lisanti and Luhukay (2014)	
Patalas-Maliszewska and Hochmeister (2011)	Lopez-Nicolas and Soto-Acosta (2010)	
Pillania (2008 b)	Razmerita and Kirchner (2011)	
Pool <i>et al.</i> (2014)	Rosu <i>et al.</i> (2009)	
Tan and Hung (2006)	Zhou (2014)	
Tseng <i>et al.</i> (2012)		
Vajjhala and Baghurst (2014)		
Valmohammadi (2010)		
Wee and Chua (2013)		
Wong (2005)		
Wong and Aspinwall (2005)		
Zapata Cantù <i>et al.</i> (2009)		
Zieba and Zieba (2014)		
Barriers to KMSs adoption (4 papers)		
Anand (2013)		
Joshi (2012)		
Milosz and Milosz (2010)		
Nunes <i>et al.</i> (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 [23,24,43–58], *Technical factors*, namely the degree of IT applications, the information system, infrastructure, degree of KM adoption, Total Quality Management practices [23,24,47,49–52,54,56,59], 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 [23,24,44,45,47,49–54,56,57,59–68].

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) [69–71], whereas others highlight the *financial issues* (return on investment and long term investments always have lower priority than short term investment) [72]. 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?

2.4.2. 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 [73]. Thus, it is not surprising that most of the practices are oriented toward the management of tacit knowledge. Some authors [16,21,74–82] 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) [83] underline that small firms are more likely to adopt informal processes to manage knowledge, other authors [84–88] 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 [78] or a project team [80,89].

As far as the second sub-topic (KM-Tools) is concerned, Grace (2009), Dotsika and Patrick (2013), Gresty (2013), and Razmerita and Kirchner (2011) [90–93] show the opportunities offered by wikis. Lopez-Nicolas and Soto-Acosta (2010) [94] identified intranet and webpages as KMSs to support organizational learning. Choundary *et al.* (2013) and Gresty (2013) [92,95] analyze the use of communication and collaborative tools. Similarly, Dotsika and Patrick (2013) [91] 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) [96,97] 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) [98] analyze a prototype KM-Tool to improve knowledge creation and sharing. Finally, Lisanti and Luhukay (2014) and Zhou *et al.* (2014) [99,100] 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?

2.4.3. 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 [101–103] indicate that KM supports all five performances; four contributions show that KM positively affects four performance types [17,104–106], two papers point out that KM positively influences three performances [107,108], whereas one paper highlights two performances [109], and seven papers show only one performance [110–116]. 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 <i>et al.</i> (2011)			●			1
Bagnoli and Vedovato (2012)	●		●			2
Beck and Schenker-Wicki (2014)	●					1
Daud and Yusoff (2011)	●	●	●		●	4
Delen <i>et al.</i> (2013)	●	●	●			3
Egbu <i>et al.</i> (2005)		●	●	●	●	4
Filippini <i>et al.</i> (2012)			●			1
Gholami <i>et al.</i> (2013)	●	●	●	●	●	5
Gupta <i>et al.</i> (2014)		●				1
Hong <i>et al.</i> (2014)	●	●	●		●	4
Liu and Abdalla (2013)	●	●	●	●	●	5
Omerzel and Antončič (2008)	●					1
Roxas <i>et al.</i> (2014)	●					1
Salojärvi <i>et al.</i> (2004)	●					1
Soon and Zainol (2011)	●	●	●	●		4
Talebi and Tajeddin (2011)		●	●	●		3
Wei <i>et al.</i> (2011)	●	●	●	●	●	5
Total	12	10	12	6	6	46

3. 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 [117].

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 [118]. 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 analyzed.

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. 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.

4.1. 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 [119,120]. Fuzzy logic gives us the possibility to use the rigor of logic to model natural language and common-sense reasoning [121,122]. 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 [123]. 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 and/or complex industries, highlight that both the results of Nunes *et al.* (2006) [72], concerning the financial barriers that hinder the implementation of KM in SMEs, and the conclusions of Milosz and Milosz (2010) [71] 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.

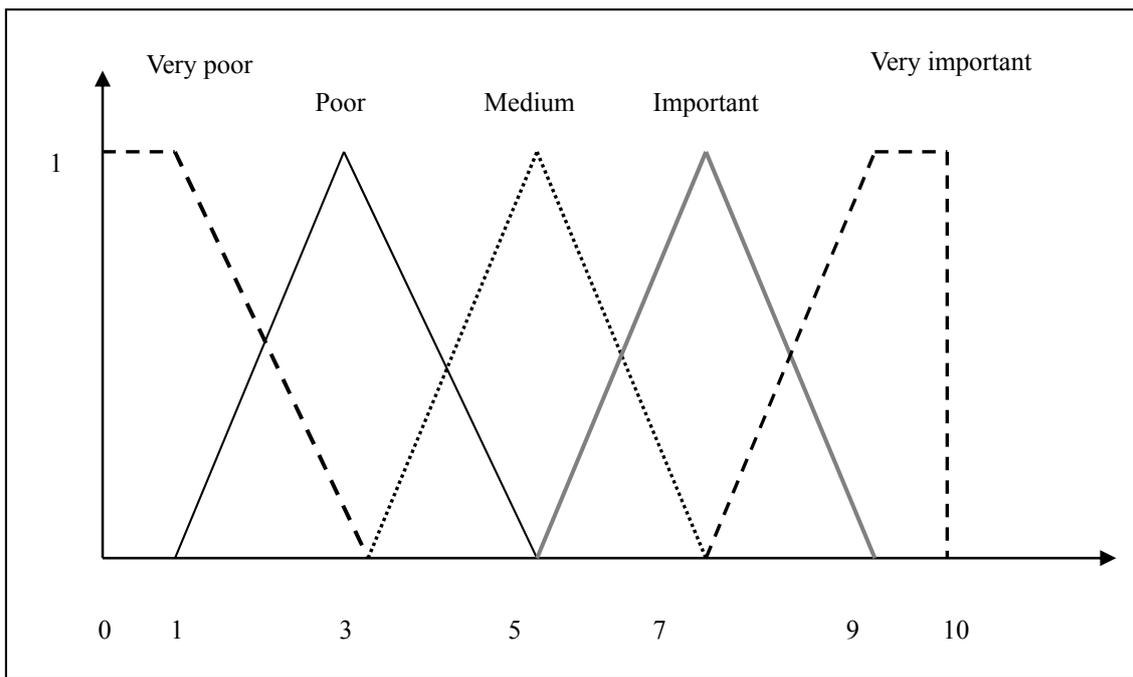


Figure 2. Fuzzy numbers associated to five qualitative levels.

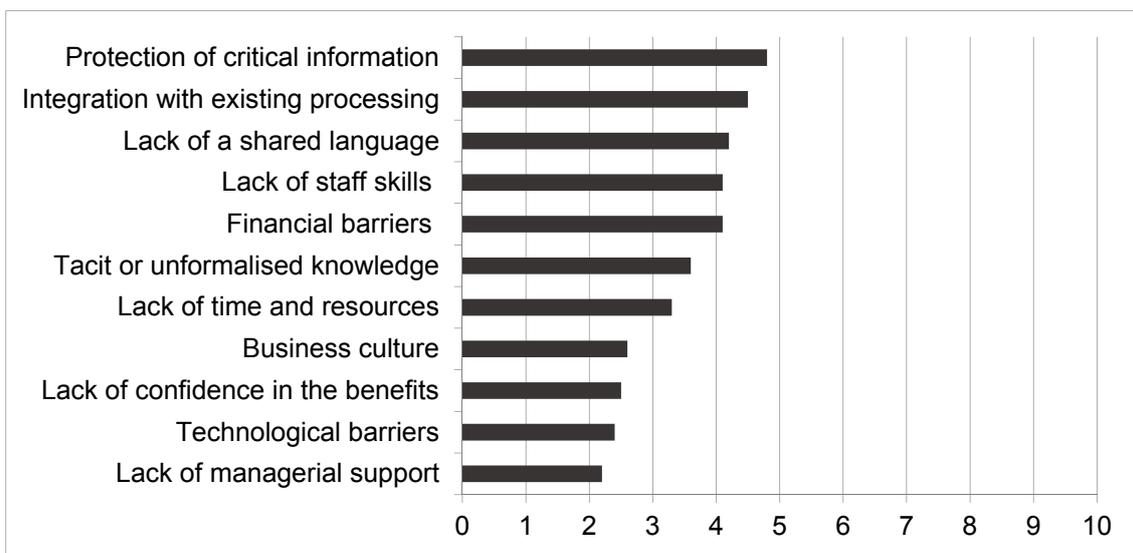


Figure 3. Barriers hindering KMS adoption—Level of importance (from 0 to 10).

4.2. The Adoption of Knowledge Management Systems

On the basis of the definition of KMSs used in this paper (IT-based systems to support methods and techniques of KM) that reflects that provided by Alavi and Leidner (2001) [11], 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) [11], Fink and Ploder (2009) [87] and Massa and Testa (2011) [77]. 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) [94], that identified Intranet and webpages as KMSs to support the process of organizational learning, and Rosu *et al.* (2009) [97], 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) [98], Grace (2009) [90], and Razmerita and Kirchner (2011) [93]. 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 paper 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 [124].

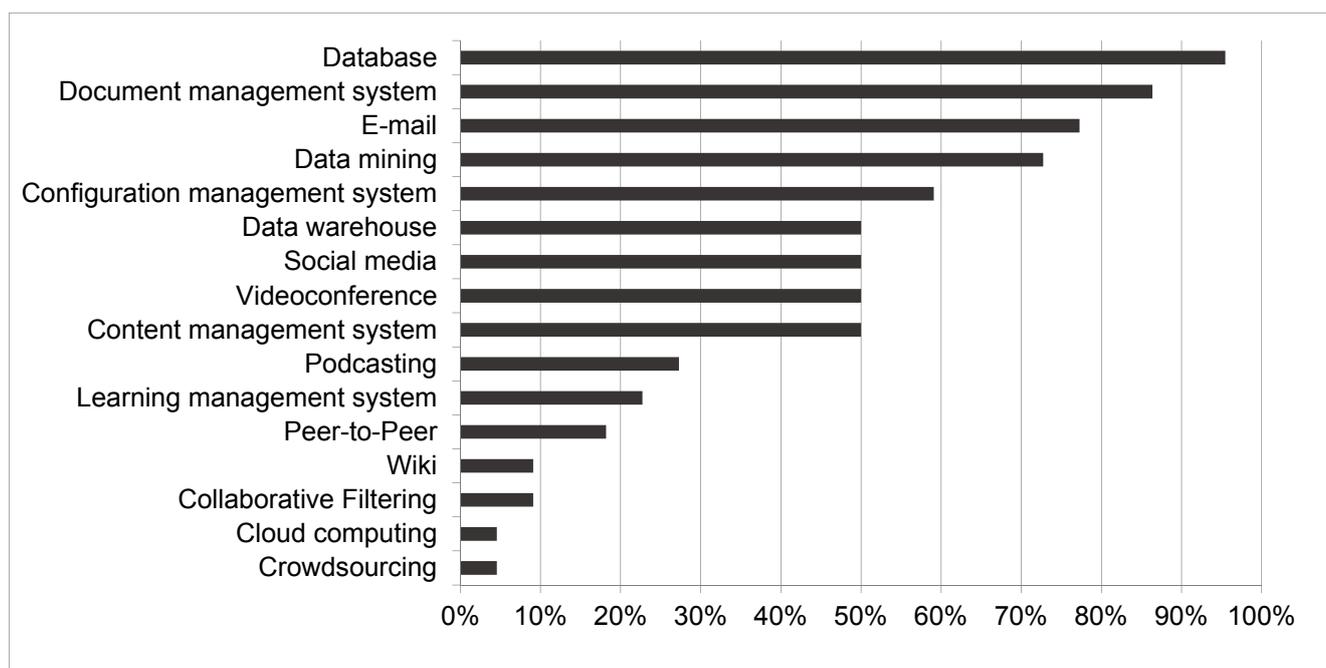


Figure 4. KMSs used by SMEs (%).

4.3. 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) [101–103] 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.

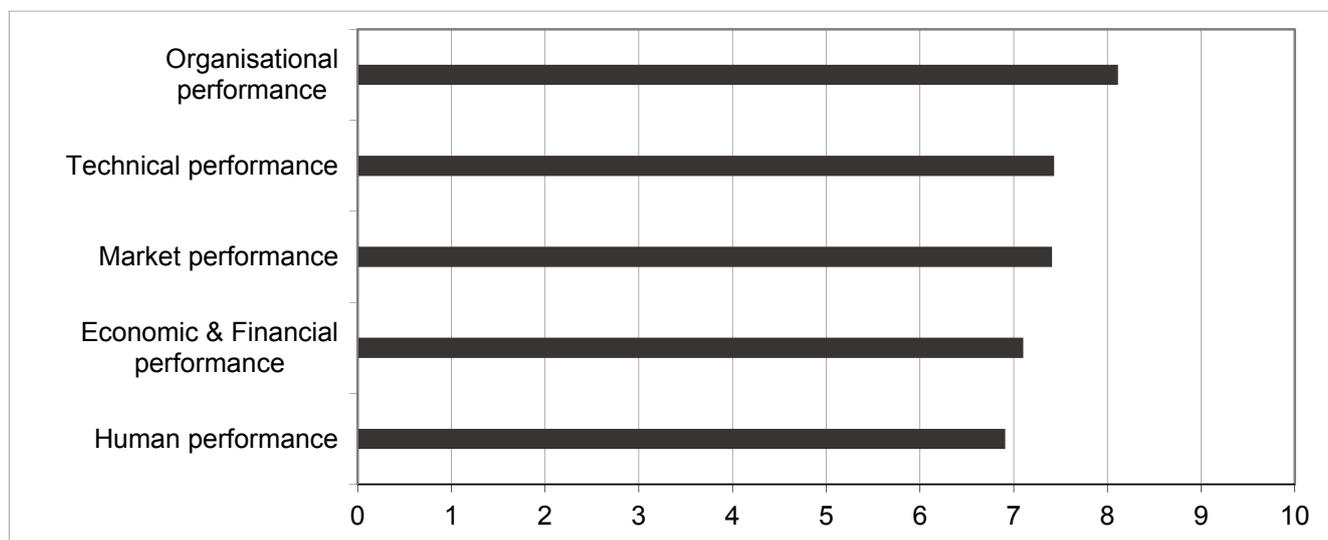


Figure 5. The impact of KM on firm performance—Level of importance (from 0 to 10).

5. Conclusions and Implications

The main aim of this paper 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.

5.1. Future Research

The paper 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.

5.2. Implications

From the SME point of view, this paper 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 paper 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.

5.3. Limitations

The results highlighted in this paper 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.

Author Contributions

These authors contributed equally to this work.

Conflicts of Interest

The authors declare no conflict of interest.

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