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Using knowledge management systems: A taxonomy of SME strategies

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ABSTRACT

The paper 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 paper 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 paper points out that there is a relationship of reciprocity between KM-Tools and KM-Practices: one reinforces the other and vice versa. The paper proposes a taxonomy bringing together SME strategies for using KMSs. Specifically, four strategies are identified: guidepost, explorer, exploiter, and latecomer.

1. 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, Lee, & Cheung, 2009; Cerchione, Esposito, & Spadaro, 2016; Dyer & Hatch, 2006; Esper, Ellinger, Stank, Flint, & Moon, 2010; Gottschalk, 2000; Gunasekaran & Ngai, 2007; Lakshman & Parente, 2008; Lee, Wang, & Lin, 2010; Samuel, Goury, Gunasekaran, & Spalanzani, 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 & Edvardsson, 2012).

Within this scenario, Information and Communication Technologies (ICTs) are playing a vital role in the development of knowledge management (Bolisani & Scarso, 1999; Benbya, Passiante, & Belbaly, 2004; Chua, 2004; Adamides & 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 & Milosz, 2010; Nunes, Annansingh, & Eaglestone, 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, Geuna, & Steinmueller, 2000; Esposito & Mastroianni, 2001; Garrigos-Simon, Lapiedra Alcami, & Barbera Ribera, 2012; Matlay & 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, Hari, & Renukappa, 2005; Desouza & Awazu, 2006; Sparrow, 2001; Wong & Aspinwall, 2005; Wong, 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 paper 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

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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 paper 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.

2. 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, Thorpe and Jackson (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.

2.1. 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.

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.

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.

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.

Table 1
Material search.

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

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

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

2.2. 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, Esposito, and Spadaro, 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

2.2.1. KM-Tools supporting the knowledge creation phase

The first area includes 3 papers (Hari, Egbu, & Kumar, 2005; Perez-Araos, Barber, Munive-Hernandez, & Eldridge, 2007; Tan & 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.

2.2.2. 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, De Minicis, & Di Gravio, 2011; Heavin, 2011; Huang, Huang, Wu, & Lin, 2009; Lin, Seidel, Shekar, Shahbazpour, & Howell, 2012; Lockett, Cave, Kerr, & Robinson, 2009; Rosu, Dragoi, & Guran, 2009; Tan & 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)*.

2.2.3. KM-Tools supporting the knowledge transfer phase

The third area includes 13 papers (Aziz & Poorsartep, 2010; Beylier, Pourroy, Villeneuve, & Mille, 2009; Cagnazzo, Tiacci, & Rossi, 2014; Choudhary, Harding, Camarinha-Matos, Lenny Koh, & Tiwari, 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, Colomo-Palacios, & Popa, 2014; Tan and Hung, 2006; Taticchi, Tonelli, Hernandez, & Cagnazzo, 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. Choudhary et al. (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.

2.2.4. KM-Practices improving the knowledge creation phase

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

2.2.5. KM-Practices improving the knowledge storage phase

The fifth area includes 10 papers (Ambrosini and Bowman, 2008; Delen et al., 2013; Durst and Wilhelm, 2011; Fink and Ploder, 2009; Hutchinson and Quintas, 2008; du Plessis, 2008; Levy, Loebbecke, & Powell, 2003; Navarro, Dewhurst, & Eldridge, 2010; Phusavat and Manaves, 2008; Villar, Alegre, & Pla-Barber, 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; Durst and Wilhelm, 2011, 2012; Fink and Ploder, 2009; Levy et al., 2003; du Plessis, 2008) 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).

2.2.6. KM-Practices improving the knowledge transfer phase

The sixth area includes 17 papers concerning KM-Practices improving the knowledge transfer phase. Some authors (Chong, Chong, & Gan, 2011; Corso, Martini, Pellegrini, & Paolucci, 2003; Delen et al., 2013; Desouza and Awazu, 2006; du Plessis, 2008; Lin, Seidel, Shekar, Shahbazpour, & Howell, 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; Villar et al., 2014; Whyte and Classen, 2012; Yao, Othman, Abdalla, & Jing, 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

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

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.

3. 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, Tables 5 and 6 present a taxonomy of KM-Tools and KM-Practices respectively.

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.

4. 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 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.

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

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	
KnowledgeTransfer	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	Rating
	Interview	
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
		Informal Networks
	Communities of Sharing	Knowledge Cafes
	Focus Groups	Seminars
	Job Rotation	Storytelling
	Learning by doing	
	Project Teams Training	

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
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	

to a set of predetermined responses, but at the same time the use of predetermined questions gives uniformity to the investigation (Qu & Dumay, 2011). The investigation has been organised into the following five steps:

4.1. 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

4.2. 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.

4.3. 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.

5. 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.

5.1. 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, Fig. 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

Fig. 1. KM-Tools – Levels for the degree of diffusion.

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).

As far as KM-Practices adopted by SMEs are concerned, Fig. 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),

Fig. 2. KM-Practices – Levels for the degree of diffusion.

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).

5.2. 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 (Watanabe, 1979; Zadeh, 1965) 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 & 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 (Fig. 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, Velasevic, & Mastorakis, 2002). The result represents the intensity of use of an individual KM-Tool (KM-Practice).

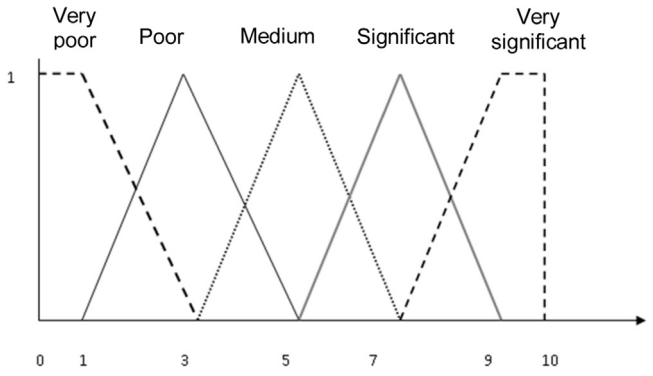

Fig. 3. Fuzzy sets representing qualitative judgements for the intensity of use of KMSs.

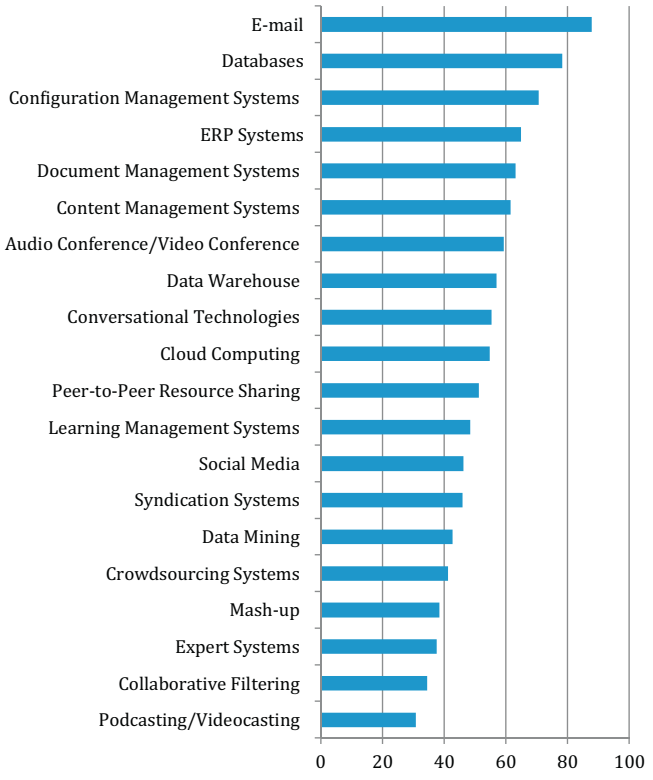

Fig. 4. KM-Tools – Levels for the intensity of use.

As for KM-Tools, Fig. 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.

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),

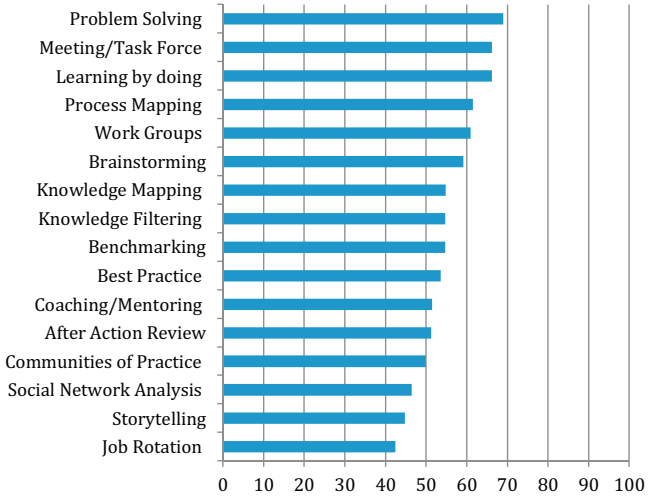

Fig. 5. KM-Practices – Levels for intensity of use.

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, Fig. 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.

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 paper 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 paper 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. 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. Fig. 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 $n - 2^{\circ}$ 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.

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

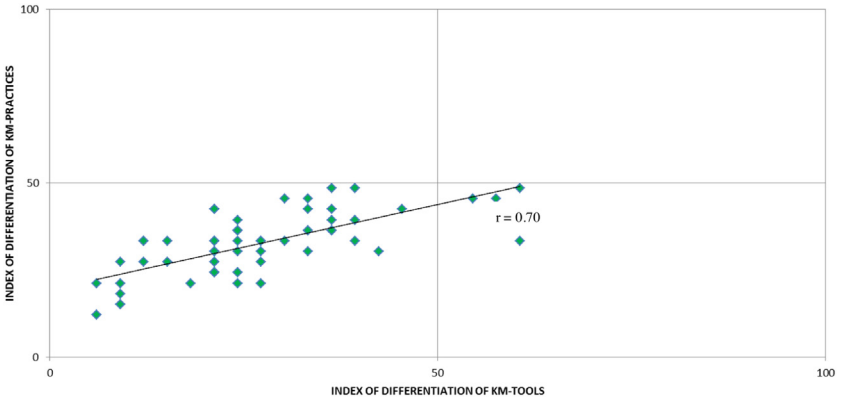

Fig. 6. Correlation between the index of differentiation of KM-Tools and KM-Practices.

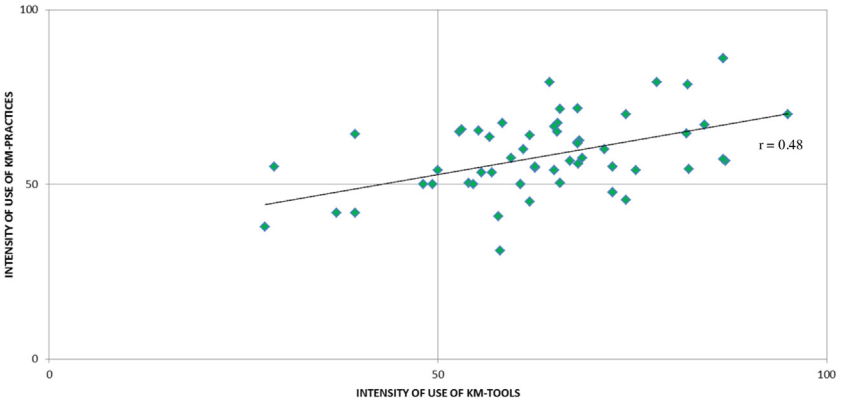

Fig. 7. Correlation between the intensity of use of KM-Tools and KM-Practices.

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			

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			

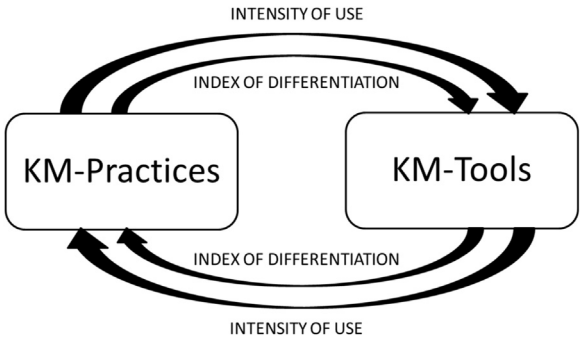

Fig. 8. Relationship of reciprocity between KM-Tools and M-Practices.

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 (Fig. 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° 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.

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 (Fig. 8).

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. Fig. 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). Fig. 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° 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 (Fig. 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*.

7. Conclusions and implications

The main aim of this paper 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

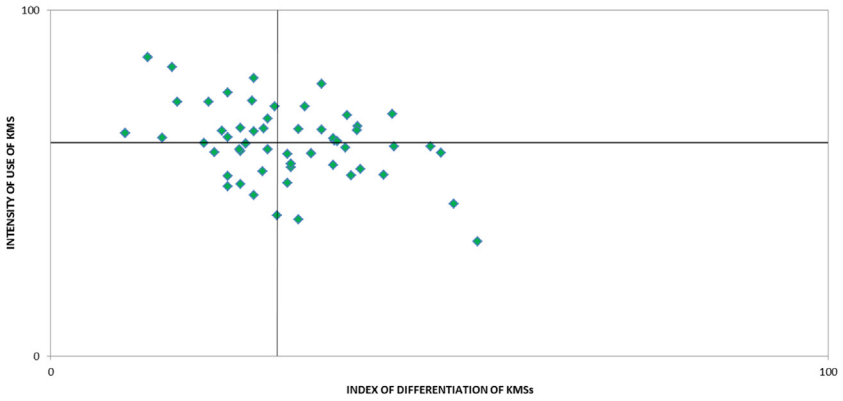

Fig. 9. Correlation between the intensity of use and the index of differentiation of KMSs.

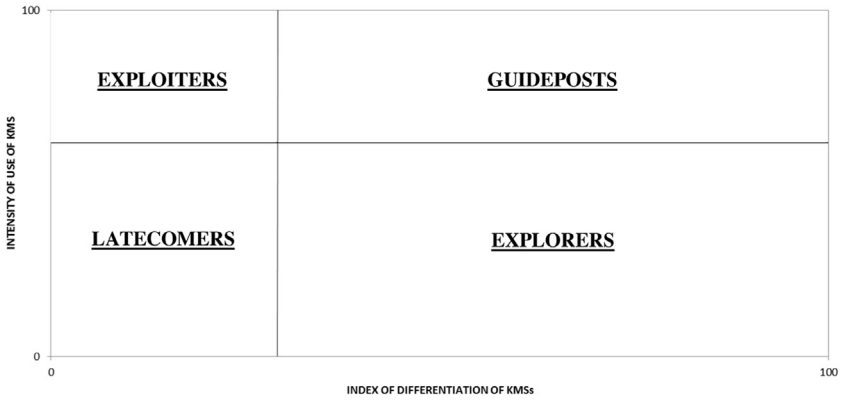

Fig. 10. Taxonomy of KM strategies.

different phases of the knowledge management process (creation, storage, transfer).

Regarding *RQ2*, using semi-structured interviews with 61 SMEs, this paper 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 paper 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 paper 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/organisational 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 paper highlights a negative relationship between the number of KMSs (KM-Tools and KM-Practices) used by SMEs and their intensity of use. Finally, the paper 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.

7.1. 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.

7.2. Implications

From the SMEs' point of view, this paper 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 paper 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.

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