How to deal with knowledge management misalignment: a taxonomy based on a 3D fuzzy methodology

Piera Centobelli, Roberto Cerchione and Emilio Esposito

Abstract

Purpose – *This paper aims to propose a new three-dimensional (3D) fuzzy logic methodology to evaluate the level of misalignment between an enterprise's knowledge and the knowledge management systems (KMSs) it adopts.*

Design/methodology/approach – *The proposed methodology was implemented by means of a field analysis based on semi-structured face-to-face interviews involving a sample of 61 small and medium enterprises (SMEs) operating in high-tech and/or complex industries.*

Findings – *The paper highlights that while there is generally a high level of misalignment between an enterprise's knowledge and the KMSs adopted, there are also a broad variety of behaviours. The paper identifies a taxonomy able to bring together the various types of behaviour associated with how an enterprise's knowledge is related to KMS selection. Specifically, four behaviour patterns were identified, and the enterprises were then categorised accordingly as being guideposts, practice laggards, tool laggards or latecomers.*

Practical implications – *The proposed taxonomy provides an operational tool that can be used by enterprises and policy makers alike. The paper shows how enterprises can use this tool to understand which category they belong to and support decision-making to introduce changes leading to improved levels of alignment. Policy makers, on the other hand, can use the proposed taxonomy to identify measures to support the competitiveness of local systems by improving management processes and knowledge sharing among enterprises.*

Originality/value – *The paper highlights the difficulties that SMEs experience in adopting KMSs that are truly aligned with their knowledge and proposes a methodology to improve alignment.*

Keywords *Knowledge management systems, Knowledge management, Small to medium sized enterprises, Decision-making strategies, Supply firms, Three-dimensional fuzzy set theory (3D-FST)*

Paper type *Research paper*

Piera Centobelli is based at the Department of Industrial Engineering, University of Naples, Frederico II, Naples, Italy.
Roberto Cerchione is based at the Department of Engineering, University of Naples Parthenope, Naples, Italy.
Emilio Esposito is Professor at the Department of Industrial Engineering, University of Naples, Frederico II, Naples, Italy.

1. Introduction

In recent years, the literature on the subject of knowledge management (KM) has grown in comparison with studies on technology management (TM). According to the Scopus database, papers on KM made up only 29 per cent of those on TM (33 out of 114) in the period from 1971 to 1985, but between 1986 and 2000, this percentage increased to 84 per cent (1,130 out of 1,349), and in the period spanning 2001 to 2015, the percentage reached a remarkable 965 per cent (51,231 papers compared to 5,307). This enormous interest in KM has brought the issues of knowledge creation and dissemination to the fore and is reflected in the large number of studies now being published.

Many papers have stressed that knowledge is a critical success factor in competitiveness for modern industrial systems (Carayannis *et al.*, 2014; Desouza and Awazu, 2006; Lee and

Received 21 October 2016
Revised 28 June 2017
25 September 2017
21 November 2017
Accepted 22 December 2017

Wong, 2017; Lee *et al.*, 2016; Mariano and Awazu, 2017; Wang *et al.*, 2016), and knowledge management is becoming increasingly important for both large companies and small and medium enterprises (SMEs) (Calvo-Mora *et al.*, 2016; Chawinga and Chipeta, 2017; Mcadam and Reid, 2001). Nevertheless, despite the extensive literature on the successful implementation of knowledge management initiatives in large companies, there has so far been little focus on SMEs. This gap is particularly relevant, as SMEs now drive economic growth in both developed and developing countries (Bagnoli and Vedovato, 2014; Cantú *et al.*, 2009; Durst and Edvardsson, 2012; Massaro *et al.*, 2016; Patrice *et al.*, 2014; Serenko, 2013; Wee and Chua, 2013).

Although various aspects of knowledge management have been explored in the literature, alignment between enterprises' knowledge and the knowledge management systems (KMSs) used to support KM still appears to have been largely neglected. However, this is an extremely important gap, as correct alignment between an enterprise's knowledge and its KMSs is in itself a factor that impacts positively on the processes of knowledge creation and dissemination.

The relevance of this topic is justified by the fact that the literature has paid attention to the concept of knowledge as an asset but not knowledge as a liability which is created when the organisation mismanages knowledge or when the organisation adopts KMSs that are misaligned with the enterprise's knowledge and risks to make decisions that reduce the value of assets (Caddy, 2000; Hora and Klassen, 2013; Kivits and Furneaux, 2013; Levine and Prietula, 2012; Wallace *et al.*, 2005).

This paper therefore sets out to explore the alignment between enterprise knowledge and KMSs in SMEs. In particular, it proposes a new three-dimensional (3D) fuzzy logic methodology to evaluate levels of misalignment. The proposed methodology was implemented through a field analysis based on semi-structured face-to-face interviews with representatives of a sample of 61 SMEs operating in high-tech and/or complex industries. The paper also highlights how the proposed methodology may be used as a decision-making tool to diagnose the state of individual enterprises and suggest appropriate changes to improve alignment.

The remainder of the paper is organised as follows: after this introduction, Section 2 presents the background of the study, Section 3 illustrates the various phases of the research methodology, with details of enterprise knowledge, KMSs, and the formulation of alignment indices. Section 4 describes the field analysis and the context of investigation, and Section 5 discusses the results of the field analysis. Finally, Section 6 sets out the conclusions, offering ideas for future research and suggesting some possible implications.

2. Background

Numerous papers have addressed the topic of knowledge management, proposing a variety of methodologies and interpretative models. Polanyi (1966) identified two types of knowledge (tacit knowledge and explicit knowledge), and Nonaka (1994) proposed the SECI model, with four modes of converting knowledge into organisational knowledge (i.e. socialisation, externalisation, internalisation and combination). This model is based on the concepts of explicit and tacit knowledge. Tacit knowledge resides in the human mind and entails a body of perspectives, perceptions, beliefs and values, and is difficult to access without engaging continuously with the knowledge holder. Explicit knowledge is set out, codified and communicated in symbolic form and/or natural language and may be accessed and used even in the knowledge creator's absence.

Nonaka (1994) integrates two dimensions of knowledge creation: the epistemological dimension (degree of formalisation) and the ontological dimension (degree of sharing). The epistemological dimension concerns the nature of the knowledge (i.e. tacit or explicit knowledge) and is related to the conversion of knowledge from tacit to explicit, and vice

versa. The ontological dimension concerns the level of knowledge sharing (whether individual, group, organisational, inter-organisational, open to partners or fully open). Combining these two dimensions, Nonaka concludes that organisational knowledge creation occurs in a spiral. Subsequently, Davenport and Prusak (1998) introduce the processes of knowledge generation and transfer, exploiting systems of interpersonal relationships. Von Krogh (1998) analyses knowledge from two perspectives (cognitivist and constructionist), identifying four processes of knowledge creation: capturing, transacting, bestowing and indwelling. Later, Andrews and Delahaye (2000) underline the psychological filters influencing the knowledge process in organisational learning. Bhatt (2001) divides the process of knowledge management into five phases (knowledge creation, knowledge validation, knowledge presentation, knowledge distribution and knowledge application activities), and analyses the relationships among technologies, techniques and people. Nevertheless, almost all these contributions derive from Nonaka's model, analysing the concept of knowledge from the epistemological and ontological perspectives, so these dimensions have become cornerstones for both academicians and practitioners. Although there is a wealth of literature offering a variety of methodologies and interpretative models to support the process of knowledge management, the issue of alignment between an enterprise's knowledge and its KMSs still seems to have been neglected, with very few contributions appearing to address the topic even today.

The concept of alignment was firstly analysed by Carayannis (1999), who assumed that KM plays a pivotal role in achieving a synergistic symbiosis between information and communications technology (ICT) and the organisational practices used by an enterprise. In line with Carayannis, Bhatt (2001) introduces the concept of triadic alignment. He investigates how the alignment of technologies (tools), techniques (organisational practices) and people (knowledge) allows an organisation to manage its knowledge effectively. Tseng (2009) highlights that an enterprise should align its KMSs to the nature of its knowledge to be efficient and effective. In fact, the use of efficient and effective KMSs leads to correct alignment between the nature of an enterprise's knowledge and the KMSs it uses, which is, in itself, a factor that may have a positive effect on KM adoption (or else may form a barrier to KM adoption). Although these contributions all deal with the issue of alignment between an enterprise's knowledge and its KMSs, they only develop conceptual frameworks to analyse the interaction of technologies, techniques, and people, without proposing practical approaches to support managerial decisions. Nevertheless, they highlight the importance of investigating this topic, which has a number of implications. First, correct alignment of an enterprise's knowledge with the KMSs it adopts is in itself a factor that could positively affect the KM process (though it could also constitute an obstacle) (Tseng, 2009). Second, any misalignment between an enterprise's knowledge and its KMSs may lead to problems of inefficiency (e.g. underutilisation of a KMS) and ineffectiveness (e.g. the use of unsuitable KMSs), which in turn affect the efficient and effective creation, storage, sharing and implementation of knowledge (Bhatt, 2001; Tseng, 2009). The motivations affecting knowledge management adoption in SMEs depend on both the different channels adopted and the type of knowledge. Factors motivating SMEs to share knowledge are, directly or indirectly, connected to the following aspects (Desouza and Awazu, 2006; Egbu *et al.*, 2005; Frey, 2001; McAdam and Reid, 2001; Pillania, 2006; Pillania, 2008; Sparrow, 2001; Wong, 2005; Wong and Aspinwall, 2005):

- In SMEs, the nature of knowledge is mainly human embedded.
- In SMEs, there is a sort of common knowledge, which is a knowledge shared by all members of the organisation.

In the case of enterprises operating as suppliers, any inefficiency and ineffectiveness will, in turn, affect the entire supply chain (Esposito and Passaro, 2009). Third, over the past 20 years, ICTs have constantly proposed low cost, easy-to-use KMSs offering an increasingly favourable performance/price ratio (Antonelli *et al.*, 2000; Del Giudice and Della Peruta,

2016; Esposito and Mastroianni, 2001; Garrigos-Simon *et al.*, 2012; Intezari and Gressel, 2017; Matlay and Westhead, 2005).

This paper therefore aims to answer the following research question:

RQ1. What is the level of misalignment between an enterprise's knowledge and the KMSs adopted in SMEs?

In this paper, we assume that the concept of enterprise knowledge may be considered from three perspectives: stock, flow and process. Knowledge as stock may be considered as one of an enterprise's assets incorporated into specific components, namely, hardware, human resources, documents and organisational culture (Jones *et al.*, 2006). On the other hand, knowledge as flow is the dynamic aspect and identifies the process of knowledge transfer between a firm and the external environment (Newell, 1982). In addition, knowledge as flow is continually transformed into knowledge as stock, and vice versa. From this perspective, knowledge may also be considered a process of transformation as individuals interpret the data and information available, expand their personal knowledge and apply it to the organisation's needs (Alavi and Leidner, 2001). These three perspectives (i.e. stock, flow and process) are therefore strictly correlated.

KMSs are divided into two categories for the purposes of this study:

1. knowledge management practices (KM-Practices), which may be defined as the set of methods and techniques to support the processes of knowledge management; and
2. knowledge management tools (KM-Tools), which may be defined as the specific IT-based systems supporting KM methods and techniques (Alavi and Leidner, 2001; Centobelli *et al.*, 2017; Fink and Ploder, 2009).

According to this definition of KMSs, different KM-Tools and KM-Practices supporting the different phases of KM process (knowledge creation, knowledge storage and knowledge transfer) have been analysed in the body of literature.

As for KM-Practices, Shih *et al.* (2010) analyse the adoption of brainstorming as a very usual team-oriented KM-Practice improving knowledge creation phase. Hutchinson and Quintas (2008) underline that SMEs are more likely to adopt informal processes to manage knowledge. Conversely, other authors (du Plessis, 2008; Durst and Wilhelm, 2012; Levy *et al.*, 2003) suggest the importance of more formal practices and methods (e.g. casual mapping, knowledge mapping, balance scorecard, formal manual), while Navarro *et al.* (2010) and Aljuwaiber (2016) suggest to establish a chief knowledge officer and adopt a variety of people-centred practices such as focus groups, meetings, seminars, communities of practice, communities of sharing, informal networks, project teams, storytelling, interactions with customers, interactions with suppliers, interactions with partners, job rotation and training.

With regard to KM-Tools, Perez-Araos *et al.* (2007) illustrate the necessity to adopt innovative tools to facilitate the creation of SME networks and manage efficiently and effectively the created knowledge. Lockett *et al.* (2009) and Chhim *et al.* (2017) examine the adoption of knowledge database and knowledge repositories to facilitate the processes of knowledge storage and knowledge reuse. Edvardsson (2009) and Rosu *et al.* (2009) suggest a knowledge-based architecture based on the use of enterprise resource planning system (ERP), customer relationship management, document management systems (DMS), data mining and data warehouse. Grace (2009), Razmerita and Kirchner (2011) and Bolisani and Scarso (2016) show the opportunity offered by wikis. Choudhary *et al.* (2013) analyse the use of communication and collaborative tools. Similarly, Dotsika and Patrick (2013), Pee and Min (2017) and Scuotto *et al.* (2017a, 2017b) illustrate some specific online knowledge sharing tools (email, blog, content management system) and collaborative tools (social media).

Within this scenario, an answer to the research question underpinning this paper may be provided by the application of a fuzzy logic methodology to evaluate the level of misalignment between an enterprise's knowledge and the KMSs it adopts. The next section shows how the methodology is implemented.

3. Research methodology

This section proposes a methodology based on the fuzzy set theory (FST) to analyse the level of alignment between an enterprise's knowledge and its KMSs. This approach allows us to integrate the rigour of logic with natural language and common-sense reasoning (Michellone and Zollo, 2000; Tanaka, 1996; Zadeh, 1965; Zimmermann, 2001). Fuzzy logic is a powerful tool that is particularly suitable for handling linguistic variables (Zadeh, 1965), whose values are expressed through fuzzy numbers to take into account uncertainty arising from a variety of causes such as personal judgements, incomplete information, variation and approximation of data and the dynamics of the problem. Unlike classical set theory, it allows a membership value ranging from 0 to 1 to be assigned to each element by adopting membership functions (e.g. triangular or trapezoidal fuzzy numbers). However, the traditional manner of representing fuzzy sets, with one dimension for the universe of discourse and the other representing degrees of membership, is not sufficient to handle two-perspective analysis. Therefore, the proposed approach is based on a 3D fuzzy set representation showing enterprise knowledge and KMSs at the same time from both the epistemological and ontological perspectives. The use of 3D fuzzy representation has been suggested in management studies as a way of addressing the two aspects simultaneously (Ahmad and Simonovic, 2011).

This methodology section is divided into three subsections: first subsection shows the details of how enterprise knowledge is mapped. The second subsection shows the mapping for the KMSs, and finally, the three indices showing the alignment between the enterprise's knowledge and its KMSs are presented in the third subsection.

3.1 Mapping enterprise knowledge

The first step in mapping enterprise knowledge is to identify the dimensions to be mapped. In line with Nonaka (1994), two knowledge dimensions were taken into account in our study: the epistemological and the ontological. The epistemological dimension concerns the nature of knowledge, namely, tacit knowledge and explicit knowledge. Tacit knowledge resides in the human mind and entails a body of perspectives, perceptions, beliefs and values and is difficult to access without engaging continuously with the knowledge holder. Explicit knowledge is set out, codified and communicated in symbolic form, and/or natural language and may be accessed and used even in the knowledge creator's absence.

The ontological dimension concerns the level of knowledge sharing (whether individual, group, organisational, inter-organisational, open to partners or fully open). This choice is governed by three main factors:

1. The taxonomy proposed by Nonaka considers the nature and degree of knowledge sharing at the heart of the process of knowledge management.
2. This taxonomy is by far the most commonly used among scholars and practitioners in the field of knowledge management.
3. These dimensions are easily understood by technicians and managers and are thus easy to use in a field analysis.

To draw up an enterprise knowledge map reflecting both the ontological and epistemological perspectives, each enterprise was divided into five macro-areas:

1. *Planning* (i.e. the planning and design department, the office deputed to drawing up technical documents);
2. *Production* (i.e. all the departments involved in the realisation and management of products or services, including production, production planning, inventory control and maintenance);
3. *Organisation* (i.e. human resources, quality control, information technology and research and development);
4. *Market* (i.e. all the sales functions regarding the "4Ps" – product, price, promotion and place – as well as market trends analysis, customer support and post-sales activities); and
5. *Strategic relationships* (i.e. hiring functions, partnerships with suppliers and participation in research projects).

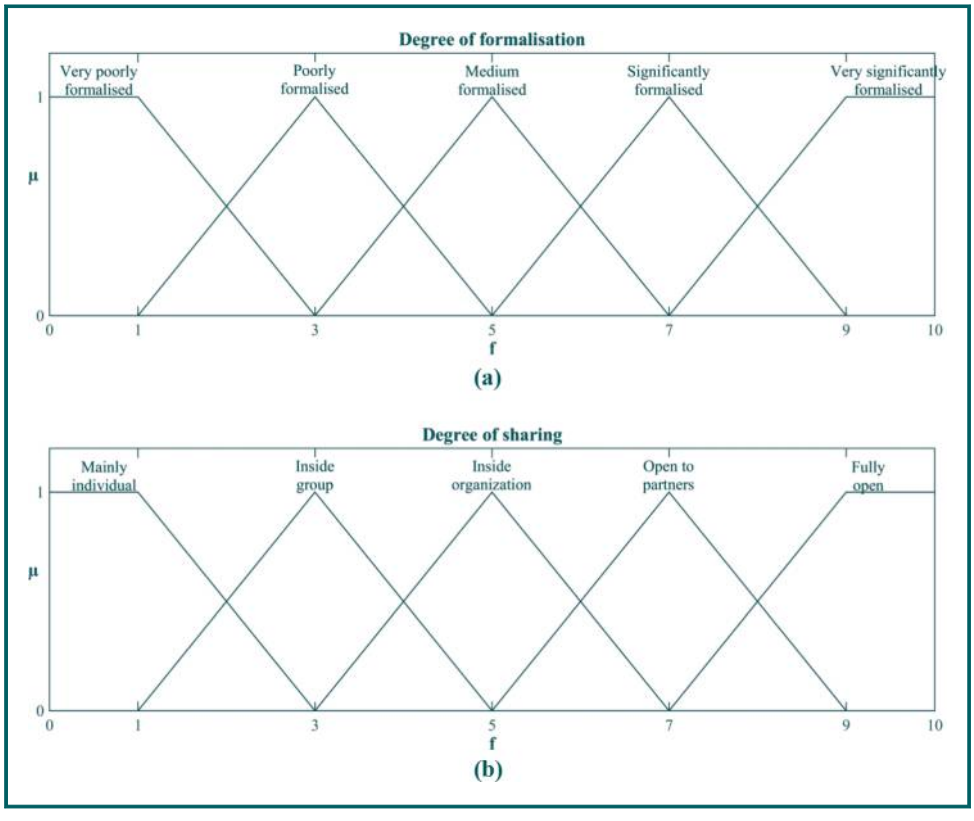
These macro-areas are in line with the organisational structure (organisation), market structure (market), industry structure (planning and production) and cross-firm integration (strategic relationships) identified by Teece *et al.* (1997) and Teece (1998, 2007).

Two managers from each enterprise were involved in identifying the degree of formalisation and sharing of enterprise knowledge for each of the five macro-areas along a five-level scale. Specifically, the epistemological and ontological dimensions of enterprise knowledge for each macro-area were identified as described in the following five steps:

1. A *first term set* of five judgements ("very poorly formalised" – VPF, "poorly formalised" – PF, "medium formalised" – MF, "significantly formalised" – SF, "very significantly formalised" – VSF) was defined to categorise a given enterprise's knowledge according to its degree of formalisation (epistemological dimension).
2. A *second term set* of five judgements ("mainly individual" – MI, "inside group" – IG, "inside organisation" – IO, "open to partners" – OP, "fully open" – FO) was defined to categorise the enterprise's knowledge per degree of sharing (ontological dimension).
3. During the semi-structured interviews, managers provided two judgements (adopting the five-level scales defined in Steps 1 and 2) for the epistemological dimension (ED) and ontological dimension (OD) of their enterprise's knowledge used in each of the five macro-areas identified.
4. Each pair of judgements was codified into the corresponding fuzzy number (Figure 1). The results for the sixty-one surveyed SMEs are presented in Appendix A.
5. These fuzzy judgements make it possible to draw up a fuzzy knowledge map for each enterprise, with an epistemological dimension and an ontological dimension. The data were processed using the *KM-Alignment Evaluation Systems* (*KM-AES*) software designed by the authors. Fuzzy 3D term sets were used to represent enterprise knowledge on a 3D plot. The *x*-axis and *y*-axis show the degree of formalisation (epistemological dimension) and the degree of sharing (ontological dimension) respectively, whereas the *z*-axis is the fuzzy membership function. In particular, each pair of judgements associated with the degree of formalisation and the degree of sharing of the enterprise knowledge used in one of the five macro-areas is represented by a 3D fuzzy set that may be either a pyramid or a truncated square pyramid.

To clarify the way FST was applied here, Figure 2 illustrates the mapping of the enterprise knowledge of one of the SMEs (S21). SME S21's knowledge is significantly formalised and is shared with partners in the planning and production areas. In the organisation area, knowledge is medium formalised and shared inside the organisation. In the market relationships area, knowledge is medium formalised and shared inside the group, and in

Figure 1 Fuzzy term set for the (a) degree of formalisation (epistemological dimension) and (b) degree of sharing (ontological dimension)



the strategic relationships area, knowledge is significantly formalised and shared inside the group.

3.2 Mapping knowledge management systems

The epistemological and ontological dimensions of the KMSs adopted by the SMEs were mapped in three steps:

1. proposing a clear definition of KMSs;
2. identifying the KMSs used by the SMEs investigated; and
3. mapping KMSs from the epistemological and ontological perspectives.

The literature review and a desk analysis of the KMSs enabled us to select an initial list of KM-Tools and KM-Practices for the KMSs adopted by the participating SMEs. This first list was included in the semi-structured questionnaire to be used during the field analysis. It was then possible, owing to the face-to-face interviews, to select a definitive list of KM-Tools and KM-Practices, including only the KMSs adopted by at least 1 enterprise out of the 61 in the sample. The results are shown in Tables I and II.

Starting from the complete list of KMSs adopted by each of the 61 SMEs in the sample, two senior IT consultants and one researcher identified the epistemological and ontological dimensions of the KM-Tools and KM-Practices. A Delphi panel was set up to converge the answers returned by the expert group (Okoli and Pawlowski, 2004; Hsu and Sandford, 2007). During the meetings, the three experts agreed upon a pair of shared judgements

Figure 2 Mapping the enterprise's knowledge of SME S21

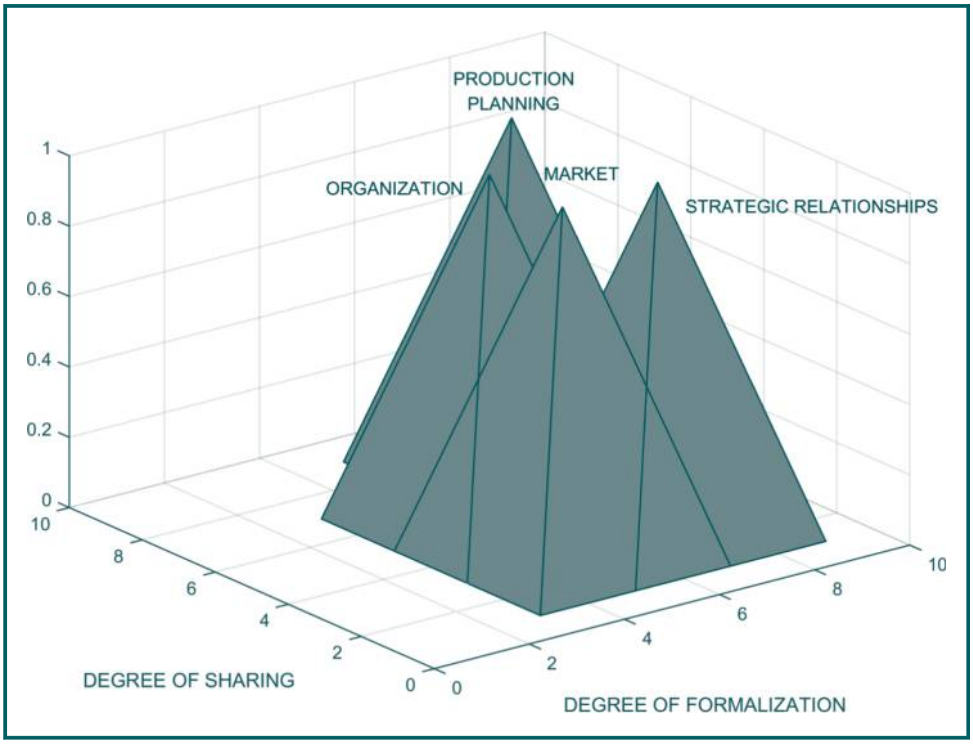


Table I List of KM-tools adopted by the sample SMEs

KM-TOOLS	
Audio conference/video conference	E-mail
Blogs	ERP systems
Business process management systems	Expert systems
Chat	Learning management systems
Cloud computing	Mash-up
Collaborative filtering	Peer-to-peer resource sharing
Configuration management systems	Podcasting/videocasting
Content management systems	Prediction and idea markets
Conversational technologies	Product data management systems
Crowdsourcing systems	Product lifecycle management systems
Database	Social data mining
Data management systems	Social media
Data mining	Syndication systems
Data visualisation	Text mining
Data warehouse	Trust and reputation systems
Decision support systems	Wiki
Document management systems	

about the epistemological and ontological dimensions (using a five-level scale) for each KM-Tool and KM-Practice. Each pair of judgements was codified into two corresponding fuzzy numbers as in Figure 1. The results are shown in Tables III and IV.

These fuzzy judgements allowed us to create a map of KM-Tools and a map of KM-Practices used for each of the SMEs from the epistemological and ontological perspectives. To clarify how FST is applied in this context, Figure 3 illustrates the mapping of the KM-Tools

Table II List of KM-practices adopted by the sample SMEs

KM-Practices	
After action review	Knowledge elicitation interview
Balance scorecard	Knowledge filtering
Benchmarking	Knowledge mapping
Best practice	Knowledge modelling
Brainstorming	Knowledge office
Case-based reasoning	Learning by doing
Casual mapping	Lesson learned
Coaching/mentoring	Meeting/task force
Communities of practice	Problem solving
Communities of sharing	Process mapping
Contextual inquiry	Project teams training
Facilitated discussion	Rating
Focus groups	Seminars
Ideas competition	Social network analysis
Informal networks	Storytelling
Job rotation	Work groups
Knowledge cafes	

Table III Fuzzy numbers attributed to KM-Tools

	Fuzzy numbers	
KM-Tools	*Degree of formalisation (Epistemological dimension)*	*Degree of sharing (Ontological dimension)*
Audio conference/video conference	VPF = (0,0,1,3)	OP = (5,7,7,9)
Blogs	VPF = (0,0,1,3)	FO = (7,9,10,10)
Business process management systems	SF = (5,7,7,9)	IO = (3,5,5,7)
Chat	VPF = (0,0,1,3)	FO = (7,9,10,10)
Cloud computing	MF = (3,5,5,7)	OP = (5,7,7,9)
Collaborative filtering	PF = (1,3,3,5)	OP = (5,7,7,9)
Configuration management systems	MF = (3,5,5,7)	IG = (1,3,3,5)
Content management systems	PF = (1,3,3,5)	FO = (7,9,10,10)
Conversational technologies	VPF = (0,0,1,3)	FO = (7,9,10,10)
Crowdsourcing systems	VPF = (0,0,1,3)	FO = (7,9,10,10)
Database	SF = (5,7,7,9)	IG = (1,3,3,5)
Data management systems	SF = (5,7,7,9)	IG = (1,3,3,5)
Data mining	VSF = (7,9,10,10)	IO = (3,5,5,7)
Data visualisation	VSF = (7,9,10,10)	IO = (3,5,5,7)
Data warehouse	SF = (5,7,7,9)	IG = (1,3,3,5)
Decision support systems	VSF = (7,9,10,10)	IG = (1,3,3,5)
Document management systems	PF = (1,3,3,5)	IG = (1,3,3,5)
E-mail	VPF = (0,0,1,3)	FO = (7,9,10,10)
ERP systems	MF = (3,5,5,7)	IO = (3,5,5,7)
Expert systems	VSF = (7,9,10,10)	IO = (3,5,5,7)
Learning management systems	PF = (1,3,3,5)	IO = (3,5,5,7)
Mash-up	PF = (1,3,3,5)	FO = (7,9,10,10)
Peer-to-Peer resource sharing	MF = (3,5,5,7)	FO = (7,9,10,10)
Podcasting/videocasting	VPF = (0,0,1,3)	FO = (7,9,10,10)
Prediction and idea markets	VPF = (0,0,1,3)	FO = (7,9,10,10)
Product data management systems	SF = (5,7,7,9)	IG = (1,3,3,5)
Product lifecycle management systems	SF = (5,7,7,9)	IG = (1,3,3,5)
Social data mining	VSF = (7,9,10,10)	FO = (7,9,10,10)
Social media	VPF = (0,0,1,3)	FO = (7,9,10,10)
Syndication systems	PF = (1,3,3,5)	FO = (7,9,10,10)
Text mining	PF = (1,3,3,5)	IO = (3,5,5,7)
Trust and reputation systems	VPF = (0,0,1,3)	FO = (7,9,10,10)
Wiki	PF = (1,3,3,5)	FO = (7,9,10,10)

Table IV Fuzzy numbers attributed to KM-Practices

KM-Practices	Fuzzy numbers: Degree of formalisation (Epistemological dimension)	Fuzzy numbers: Degree of sharing (Ontological dimension)
After action review	PF = (1,3,3,5)	IO = (3,5,5,7)
Balance scorecard	SF = (5,7,7,9)	IG = (1,3,3,5)
Benchmarking	VSF = (7,9,10,10)	IG = (1,3,3,5)
Best practice	MF = (3,5,5,7)	IO = (3,5,5,7)
Brainstorming	VPF = (0,0,1,3)	IG = (1,3,3,5)
Case-based reasoning	VPF = (0,0,1,3)	IG = (1,3,3,5)
Casual mapping	SF = (5,7,7,9)	IO = (3,5,5,7)
Coaching/mentoring	VPF = (0,0,1,3)	MI = (0,0,1,3)
Communities of practice	VPF = (0,0,1,3)	FO = (7,9,10,10)
Communities of sharing	VPF = (0,0,1,3)	FO = (7,9,10,10)
Contextual inquiry	PF = (1,3,3,5)	IO = (3,5,5,7)
Facilitated discussion	VPF = (0,0,1,3)	IG = (1,3,3,5)
Focus groups	VPF = (0,0,1,3)	OP = (5,7,7,9)
Ideas competition	PF = (1,3,3,5)	FO = (7,9,10,10)
Informal networks	VPF = (0,0,1,3)	IO = (3,5,5,7)
Job rotation	VPF = (0,0,1,3)	MI = (0,0,1,3)
Knowledge cafes	VPF = (0,0,1,3)	IO = (3,5,5,7)
Knowledge elicitation interview	PF = (1,3,3,5)	OP = (5,7,7,9)
Knowledge filtering	VSF = (7,9,10,10)	IO = (3,5,5,7)
Knowledge mapping	SF = (5,7,7,9)	IO = (3,5,5,7)
Knowledge modelling	VSF = (7,9,10,10)	IO = (3,5,5,7)
Knowledge office	MF = (3,5,5,7)	FO = (7,9,10,10)
Learning by doing	VPF = (0,0,1,3)	MI = (0,0,1,3)
Lesson Learned	PF = (1,3,3,5)	IG = (1,3,3,5)
Meeting/task force	VPF = (0,0,1,3)	OP = (5,7,7,9)
Problem solving	MF = (3,5,5,7)	IG = (1,3,3,5)
Process mapping	SF = (5,7,7,9)	IO = (3,5,5,7)
Projects team training	VPF = (0,0,1,3)	IG = (1,3,3,5)
Rating	VSF = (7,9,10,10)	IG = (1,3,3,5)
Seminars	VPF = (0,0,1,3)	OP = (5,7,7,9)
Social network analysis	VSF = (7,9,10,10)	FO = (7,9,10,10)
Storytelling	MF = (3,5,5,7)	OP = (5,7,7,9)
Work groups	VPF = (0,0,1,3)	IG = (1,3,3,5)

used by a specific SME (S21). SME S21 uses *e-mail*, a very poorly formalised and fully open tool, suitable for mainly human embedded knowledge, as well as *ERP System*, medium formalised tool suited to knowledge sharing inside the organisation, and *Database*, both of which are significantly formalised tools, suited to sharing formalised knowledge within a specific group.

Figure 4 shows that SME S21 uses the following KM-Practices: *Learning by doing*, i.e. very poorly formalised practices suited to human embedded knowledge, with *Brainstorming*, also very poorly formalised and suited to sharing knowledge within a group. It also uses *After Action Review*, a medium formalised practice suited to sharing knowledge inside the organisation, and *Problem Solving* which is a medium formalised practice suited to sharing knowledge inside a group, as well as *Process Mapping*, a significantly formalised practice useful for sharing knowledge inside the organisation.

3.3 The alignment indices

The alignment evaluation addressed in this paper pertains the adoption of appropriate KMSs to manage the specific knowledge of the enterprise. The methodology is based on the hypothesis that each KMS is better suited to manage knowledge in some context than

Figure 3 Mapping the KM-tools used by SME S21

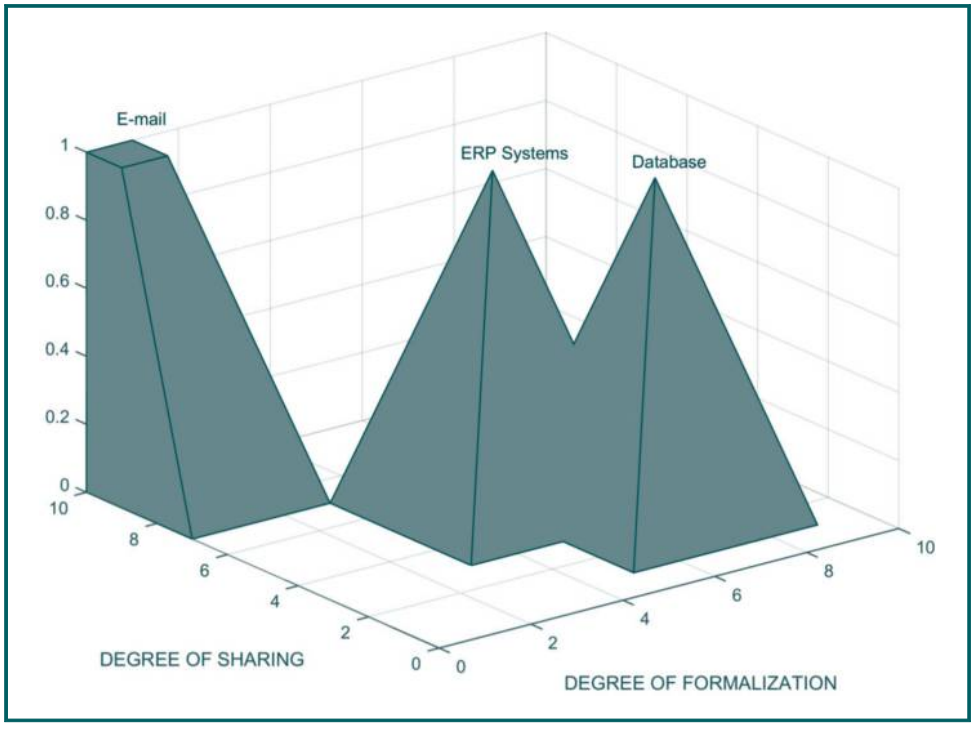
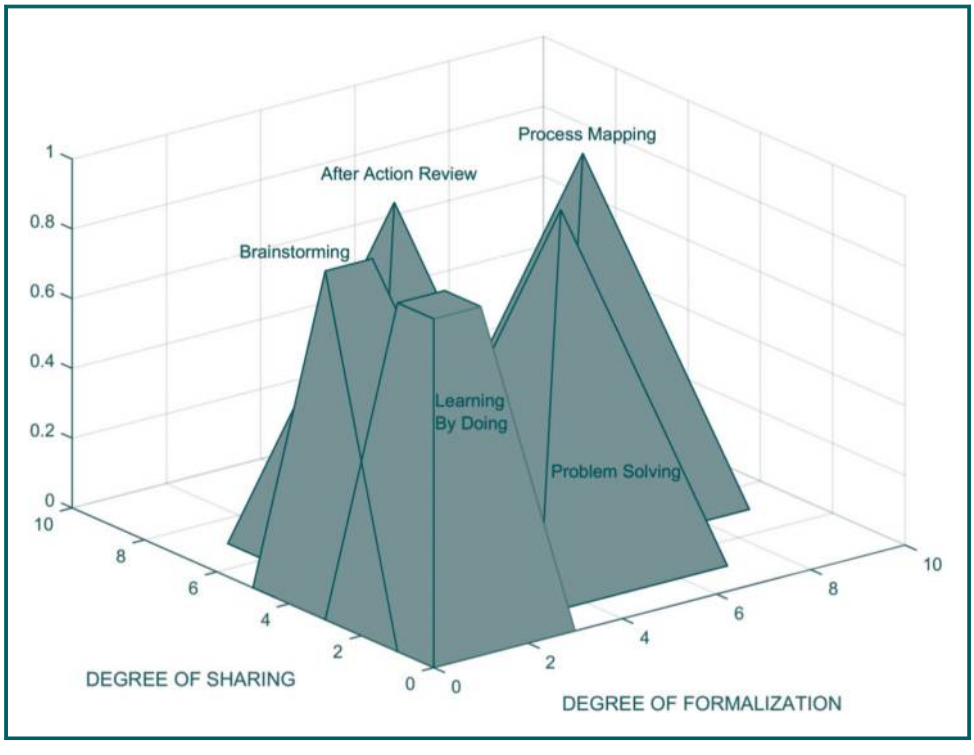


Figure 4 Mapping the KM-practices used by SME S21



others (e.g. small groups, organisations or networks) and the selection of appropriate KMSs improves the efficiency and effectiveness performance of the SMEs.

Therefore, this section proposes three indices to assess the degree of alignment between an enterprise's knowledge, its KM-Tools and its KM-Practices:

$$TKA = T \cap K / T \cup K$$

$$TPA = T \cap P / T \cup P$$

where K = the enterprise's knowledge, namely, the union of five 3D fuzzy sets attributed to the enterprise's knowledge in the five macro-areas of planning, production, organisation, market and strategic relationships (Figure 2); T = KM-Tools, namely, the union of 3D fuzzy sets attributed to the individual KM-Tools adopted by the enterprise (Figure 3); P = KM-Practices, i.e. the union of 3D fuzzy sets attributed to the individual KM-Practices used by the enterprise (Figure 4).

The intersection of membership functions corresponds to the Boolean logic operator "AND", whereas the union corresponds to the Boolean logic operator "OR".

The hypothesis is that the higher the intersection/union ratio between the 3D fuzzy sets, the higher the level of alignment.

Each index ranges from 0 to 1 depending on the value of the intersection/union ratio between the two variables used for the specific index.

The TKA index measures the degree of alignment between KM-Tools and an enterprise's knowledge from the epistemological and ontological perspectives. The index is 0 if the fuzzy 3D term sets associated with T and K are disjointed (case A in Figure 5). In this case, no KM-Tool is suited to the characteristics of the enterprise's knowledge. This means that the enterprise uses inadequate KM-Tools in its knowledge management process. Conversely, the TKA index is 1 if T coincides with K (case C in Figure 5). This means that all the KM-Tools used are aligned with the enterprise's knowledge. Hence, the enterprise uses suitable KM-Tools. Case B in Figure 5 represents a context in which only some of the KM-Tools are aligned with the enterprise's knowledge: in other words, only a part of its knowledge is covered by suitable KM-Tools.

The PKA index identifies the degree of alignment between an enterprise's KM-Practices and its knowledge from the epistemological and ontological perspectives. The index is 0 if the fuzzy 3D term sets associated with P and K have no intersection (case A in Figure 5). In this case, no KM-Practice is aligned to the characteristics of the enterprise's knowledge. It follows that such an enterprise uses inadequate KM-Practices in its knowledge management processes. The PKA index is 1 if P and K have total intersection (case C in

Figure 5 Alignment indices from 3D fuzzy term sets

CASE	3D TERM SETS	TKA	3D TERM SETS	PKA	3D TERM SETS	TPA
A		0		0		0
B		]0, 1[		]0, 1[		]0, 1[
C		1		1		1

Figure 5). In this case, all the KM-Practices are aligned with the enterprise's knowledge. This means that the enterprise uses adequate KM-Practices. Case B in Figure 5 represents a situation where only some of the enterprise's knowledge is covered by suitable KM-Practices: only a part of the KM-Practices is aligned with the enterprise's knowledge.

The TPA index measures the degree of alignment between KM-Tools and KM-Practices from the epistemological and ontological perspectives. The index is 0 if the fuzzy 3D term sets attributed to T and P are disjointed (case A in Figure 5), and consequently, no KM-Tool is aligned with KM-Practices. It follows that such an enterprise uses inadequate KM-Tools in its knowledge management processes. The TPA index is 1 if T coincides with P (case C in Table V). This means that all the KM-Practices are supported by appropriate KM-Tools. Case B in Table V represents a situation where only some of the KM-Tools are aligned with the KM-Practices: in other words, only a part of the KM-Practices is supported by suitable KM-Tools.

To summarise, case A represents a situation of complete misalignment, case C shows complete alignment, and case B shows partial alignment.

Figures 6 to 8 show, by way of example, the intersection and the union between the enterprise's knowledge and KM-Tools, between the enterprise's knowledge and KM-Practices, and between the KM-Tools and the KM-Practices of a specific SME (S21).

The next section shows the results of implementing the proposed methodology.

Table V Classification of the sample enterprises

Enterprise category	*Number of SMEs*	*(%)*
Micro	9	15
Small	30	49
Medium	22	36
Total	61 SMEs	

Figure 6 Intersection and union between the enterprise's knowledge and KM-tools – S21

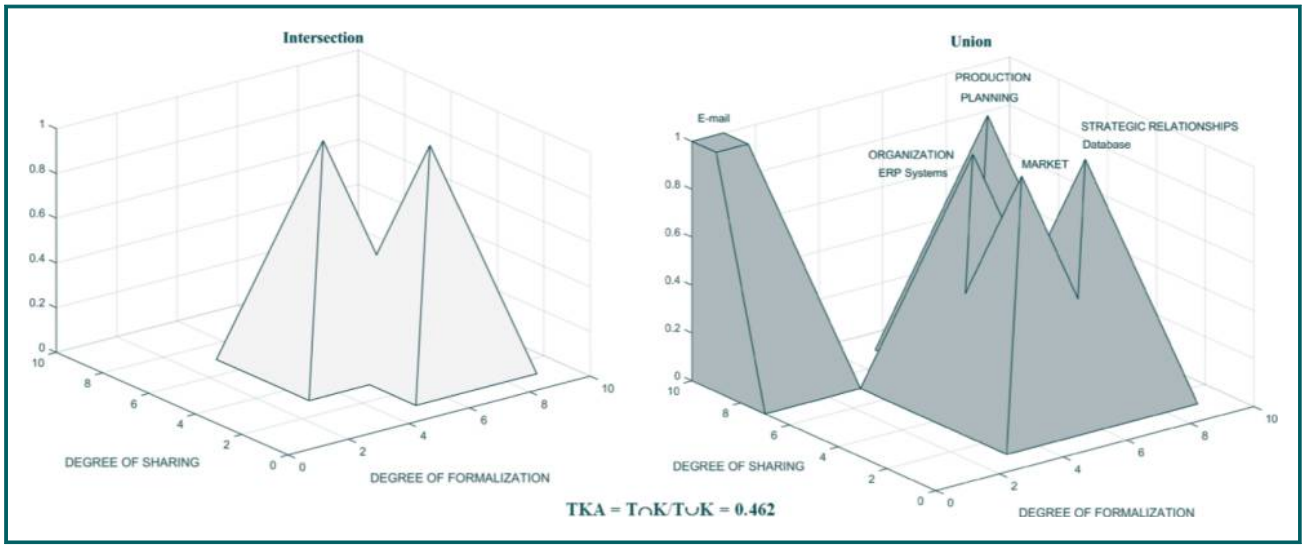


Figure 7 Intersection and union between the enterprise's knowledge and KM-practices – S21

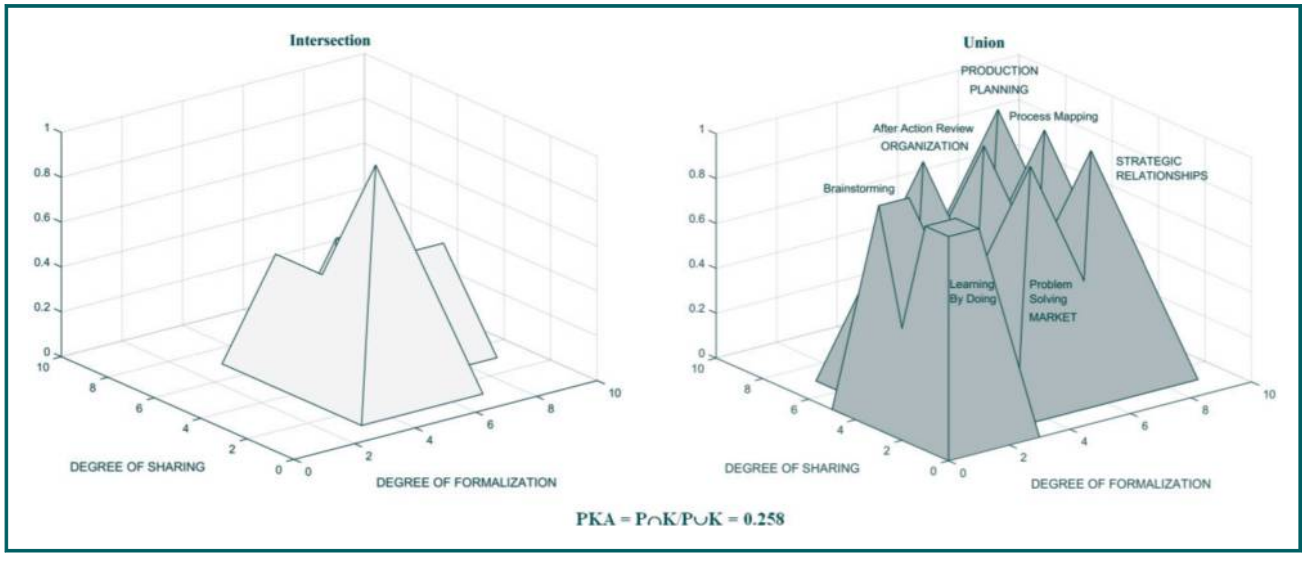
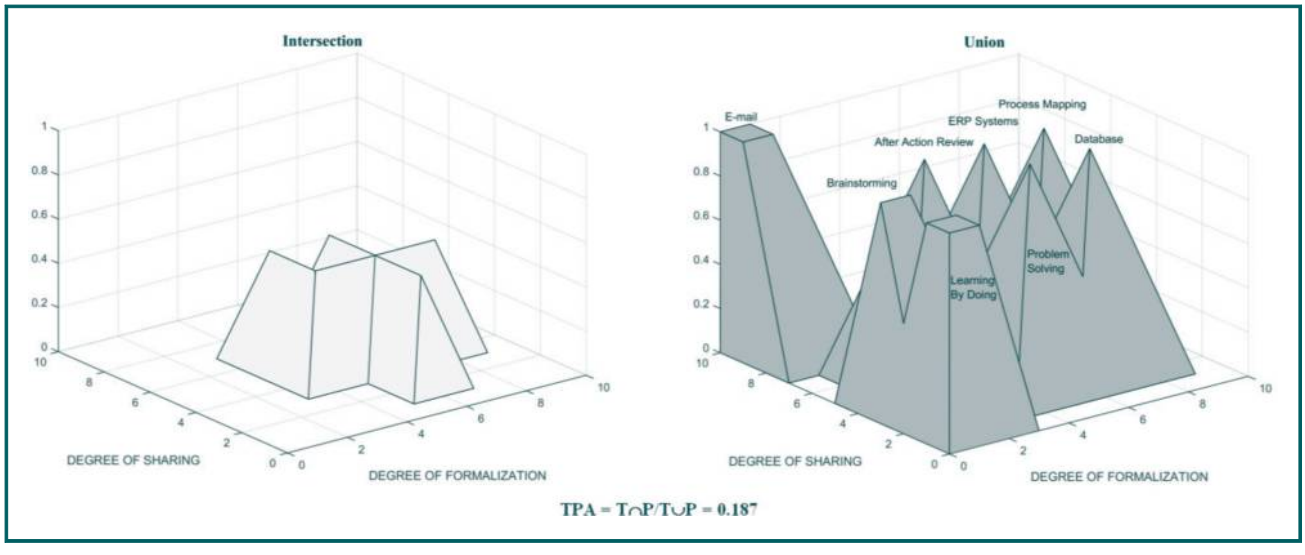


Figure 8 Intersection and union between KM-tools and KM-practices – S21



4. Field analysis

4.1 Data collection procedure

The field analysis was based on semi-structured face-to-face interviews – a method with two specific advantages (Qu and Dumay, 2011):

1. the interviews are not limited to a set of predefined answers, which makes it possible to pick out weak signals that would otherwise not emerge using predetermined questions; and
2. the use of predetermined questions provides uniformity to the investigation.

The questionnaire was divided into two main sections:

1. the first providing information about the company (e.g. the name of the SME, number of employees, and annual turnover); and
2. the second providing data concerning knowledge management (e.g. the degree of sharing and formalisation of enterprise knowledge, and details about the KMSs adopted).

There were six phases to the field analysis:

1. Preparation of the draft semi-structured questionnaire. In this phase, a draft version of the semi-structured questionnaire was prepared to reflect the general aims of the investigation.
2. Setting up a focus group. In this phase, a focus group involving academics, entrepreneurs/managers of enterprises, and consultants operating in the field of KM was set up in three stages. First, the topic to be investigated was presented so the participants would be conversant with it. Second, the draft semi-structured questionnaire was submitted to the panelists for useful feedback and comments. Finally, the panelists' remarks were discussed in a plenary session[1].
3. Re-focusing the semi-structured questionnaire. The semi-structured questionnaire was revised and finalised on the basis of the feedback received during discussion.
4. Testing the semi-structured interview. During this stage, the final version of the semi-structured questionnaire was tested in pilot interviews with representatives of three enterprises[2].
5. Final version of the questionnaire. Suggestions emerging during the pilot interviews were included in the final version[3].
6. Implementing the field analysis.

Once the interviews were over, two researchers transcribed the managers' responses

4.2 Context of investigation

The participating SMEs were selected according to the following two main criteria:

1. All the SMEs operate in high-tech and/or complex manufacturing or service industries where knowledge is a critical factor and knowledge management plays an important role.
2. They are part of important networks of enterprises operating in high-tech and/or complex manufacturing or service industries that have a critical impact on the territorial development of an Italian region that is a long-established leader in producing complex components for the aerospace and automotive industries.

Initially, the sample included 78 SMEs located in the south of Italy and operating in high-tech and/or complex industries. The semi-structured questionnaire was submitted during face-to-face interviews involving at least two managers with different skills and roles. More specifically, the Chief Executive Officer (CEO) and Chief Technology Officer (CTO) were interviewed to guarantee both the strategic and operational perspectives of each enterprise. This choice is governed by the fact that the CEO and CTO have a comprehensive overview of all the operational and strategic processes of an SME. Sixty-one pairs of managers belonging to the same enterprise stated their willingness to conduct a face-to-face interview. The total number of respondents was thus 61 of 78 enterprises, with a response rate of 78.2 per cent. Information from supplementary sources (e.g. company

websites, company reports and industrial magazines) was collected and examined to obtain a more complete picture of the sample.

The sample includes medium enterprises (36 per cent), small enterprises (49 per cent) and micro enterprises (15 per cent) as shown in Table V. This classification takes into account the enterprise's size in terms of staff headcount and annual turnover (or annual balance sheet total) to classify the sample SMEs (European Commission, 2016).

Table VI shows that 61 per cent of the SMEs operate in manufacturing industries (i.e. aerospace, automotive and engineering), whereas the remaining 39 per cent operate in service industries (i.e. information and communications technology, management consulting and research and development).

5. Results and discussion

This section presents the main findings for the three alignment indices evaluated for the 61 SMEs in the sample to provide a taxonomy of enterprise behaviour and highlight how the proposed methodology may be used as a decision-making tool to identify the specific position of an individual enterprise and suggest appropriate changes to improve its level of alignment.

5.1 Alignment indices

This section highlights the differences and similarities among the participating SMEs and shows the degree of alignment of the enterprises' knowledge, KM-Tools and KM-Practices (Table VII).

The enterprises' knowledge (K) and KM-Tools (T) show a degree of TKA alignment ranging from 0.000 to 0.463, with a mean of 0.237 and a coefficient of variation of 0.476 (Table VII). The low mean value of the index of alignment of KM-Tools in relation to the enterprise's knowledge highlights the fact that only a part of the enterprise's knowledge is covered by suitable KM-Tools. Moreover, the high value of the range (0.463) and the coefficient of variation of TKA (0.476) indicate a large variety of situations. On the one hand, there are some completely disjointed enterprises with a TKA of 0, so no KM-Tool is really suited to the characteristics of the enterprises' knowledge. On the other hand, there are enterprises with a TKA far above the mean value; in this case, most of the KM-Tools are aligned with the enterprises' knowledge.

In relation to enterprise's knowledge (K) and KM-Practices (P), the degree of PKA alignment ranges from 0.040 to 0.420 with a mean of 0.249 and a coefficient of variation of 0.389 (Table VII). Also in this case, the low value of the mean index of alignment of KM-Practices in relation to enterprise knowledge highlights that only a part of an enterprise's knowledge is covered by appropriate KM-Practices. Also in this case, the high value of the range (0.420) and the coefficient of variation of the PKA (0.389) highlight a broad variety of behaviours.

Table VI Enterprise 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	

Table VII The alignment indices

SMEs	TKA	PKA	TPA
S1	0.333	0.310	0.374
S2	0.230	0.274	0.583
S3	0.293	0.414	0.187
S4	0.254	0.333	0.433
S5	0.206	0.320	0.308
S6	0.106	0.403	0.307
S7	0.000	0.067	0.000
S8	0.354	0.389	0.453
S9	0.275	0.302	0.445
S10	0.266	0.118	0.182
S11	0.238	0.144	0.286
S12	0.219	0.147	0.429
S13	0.280	0.271	0.576
S14	0.287	0.175	0.265
S15	0.158	0.129	0.270
S16	0.227	0.304	0.583
S17	0.264	0.287	0.533
S18	0.151	0.190	0.431
S19	0.403	0.213	0.586
S20	0.333	0.310	0.374
S21	0.462	0.258	0.187
S22	0.277	0.265	0.308
S23	0.000	0.290	0.000
S24	0.321	0.355	0.445
S25	0.208	0.309	0.286
S26	0.044	0.044	0.407
S27	0.376	0.400	0.600
S28	0.271	0.151	0.493
S29	0.390	0.163	0.493
S30	0.380	0.204	0.558
S31	0.393	0.236	0.594
S32	0.188	0.331	0.312
S33	0.237	0.263	0.397
S34	0.183	0.329	0.303
S35	0.330	0.153	0.505
S36	0.105	0.420	0.233
S37	0.191	0.196	0.300
S38	0.239	0.244	0.275
S39	0.158	0.208	0.389
S40	0.167	0.141	0.440
S41	0.333	0.246	0.377
S42	0.445	0.398	0.400
S43	0.337	0.267	0.239
S44	0.250	0.222	0.412
S45	0.094	0.126	0.212
S46	0.036	0.205	0.093
S47	0.271	0.254	0.350
S48	0.139	0.040	0.393
S49	0.299	0.299	0.223
S50	0.085	0.227	0.225
S51	0.190	0.172	0.297
S52	0.059	0.368	0.112
S53	0.147	0.157	0.528
S54	0.232	0.196	0.576
S55	0.203	0.100	0.202

(*continued*)

Table VII

SMEs	*TKA*	*PKA*	*TPA*
S56	0.235	0.288	0.239
S57	0.200	0.250	0.325
S58	0.398	0.372	0.430
S59	0.070	0.379	0.121
S60	0.463	0.385	0.532
S61	0.160	0.169	0.453
Mean values	*0.237*	*0.249*	*0.359*

There are enterprises where K and P are strongly misaligned, and others with numerous KM-Practices aligned with their knowledge.

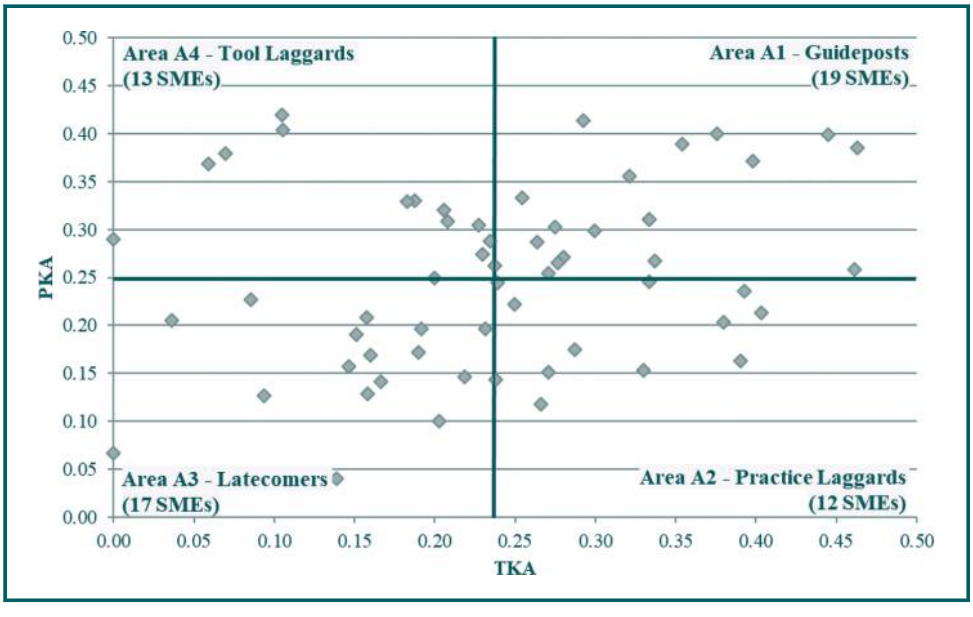
As for alignment between KM-Tools (T) and KM-Practices (P), the TPA ranges from 0.000 to 0.600, the mean is 0.359, and the coefficient of variation is 0.416 (Table VII). Thus, the mean TPA (0.359) value is higher than the mean TKA (0.237) and PKA (0.249) values. This means that the alignment between KM-Tools and KM-Practices is greater than the alignment between KM-Tools and knowledge, and between KM-Practices and knowledge. Nevertheless, also in this case, the high value of the range and the coefficient of variation highlight a broad variety of situations.

To sum up, the results of the field analysis indicate that in general there is a low degree of alignment between an enterprise's knowledge, KM-Practices and KM-Tools. Nevertheless, there is much diversification. In some enterprises, the problem is the KM-Tools; in some, it is the KM-Practices, and in others, both the KM-Tools and the Practices are inappropriate.

5.2 A taxonomy of enterprise behaviour

By superimposing the two indices of alignment (TKA and PKA), it is possible to identify four areas based on the value of their averages (Figure 9). High-right located SMEs (Area A1)

Figure 9 The relationship between TKA and PKA



have a higher TKA and PKA than the mean value of the SMEs considered. SMEs located in this area may be termed *Guideposts*, as the alignment of knowledge, KM-Tools and KM-Practices is high. The SMEs located in this area have the perception of the strategic role of the knowledge management processes and therefore completely exploit the potential of both KM-Tools and KM-Practices. Figure 9 shows that 19 of 61 SMEs (31.1 per cent) are located in this area.

SMEs situated at the bottom right (Area A2) have a high level of alignment between their knowledge and their KM-Tools, but there is very little alignment between their knowledge and KM-Practices. These SMEs may be termed *Practice Laggards*. The SMEs located in this area are well aware of the opportunities derived from the adoption of KMSs, but they are not able to exploit them in full. It emerges that these SMEs invest into appropriate tools and have a great potential for growth if they introduce also the proper practices. There are 12 (19.7 per cent) SMEs in this area.

Low-left located SMEs (Area A3) shows a low level of alignment between their knowledge and their KM-Tools and KM-Practices. For this reason, they may be termed *Latecomers*. The Latecomers are SMEs completely unaware of the importance of the knowledge management and do not invest into the acquisition or adoption of proper KMSs. Figure 9 shows that there are 18 (29.5 per cent) SMEs in this area.

SMEs at the top left (Area A4) have a higher PKA than the mean value of the sample, but their TKA is lower than average. This implies that there is a high level of alignment between their knowledge and KM-Practices but a low level of alignment between their knowledge and KM-Tools. These SMEs may be identified as *Tool Laggards*, as they perceive the importance of investing resources in the field of KM and introduced practices suitable to manage their knowledge. On the contrary, they do not have the appropriate technological infrastructure to manage such knowledge. Figure 9 shows that there are 12 (19.7 per cent) SMEs in this area.

5.3 How to support decision-making to reduce misalignment

Figure 9 shows an operational taxonomy that may be used to identify the specific position of an enterprise and support decision-making geared towards the introduction of appropriate changes (Figure 10). Practice Laggards could improve their position and slide towards the A1 area benefiting of a *put in* effect that can be translated into the adoption of KM-Practices more in line with their knowledge. Similarly, Tool Laggards could benefit of the put in effect and improve their position by moving towards the A1 area through the introduction of KM-Tools better aligned with their knowledge. Finally, to move towards the A1 area, Latecomer SMEs need to implement more drastic changes that will allow them to adopt KM-Tools and KM-Practices better suited to their knowledge. In this case, the put in effect may be not enough to improve the situation of these SMEs. They have to take into consideration the opportunity to replace some KMSs with other ones exploiting also the *pull out* effect.

Three example case studies may serve to show how the proposed taxonomy may be used to identify the specific weaknesses of an individual enterprise and suggest suitable changes to reduce the level of misalignment.

5.3.1 First case study: Enterprise S29. Enterprise S29 is located in the Practice Laggards area (A2) (Figure 11). This SME manages a knowledge which is shared inside the group for some macro-areas and with the environment in other ones. The degree of formalisation is not homogeneous, it is particularly formalised in some macro-areas and poorly formalised in other ones (Appendix A). This means that the enterprise should use a heterogeneous set of tools and practices. The KM-Practices adopted are after action review, brainstorming, coaching/mentoring, communities of practice, job rotation, knowledge filtering, knowledge mapping, learning by doing, meeting/task force, problem solving and work groups. In view of the state of the enterprise's knowledge, if it adopts additional KM-Practices eligible to

Figure 10 Decision-making strategies to reduce misalignment

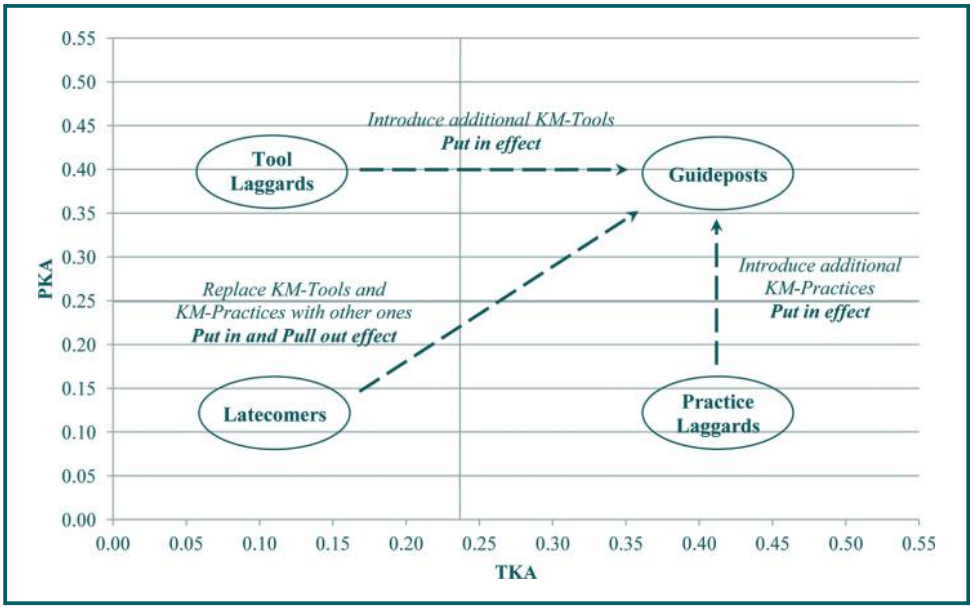
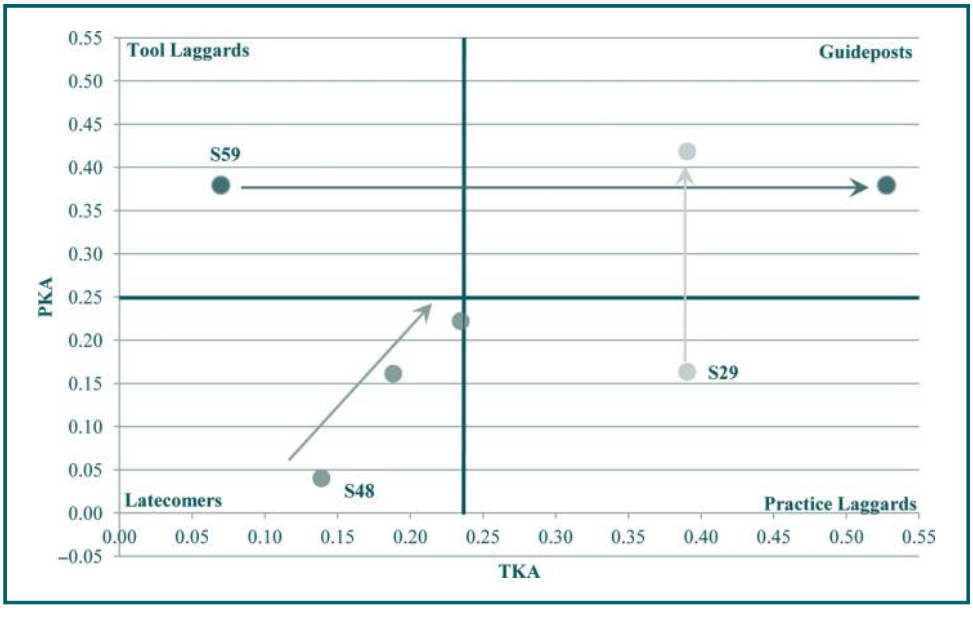
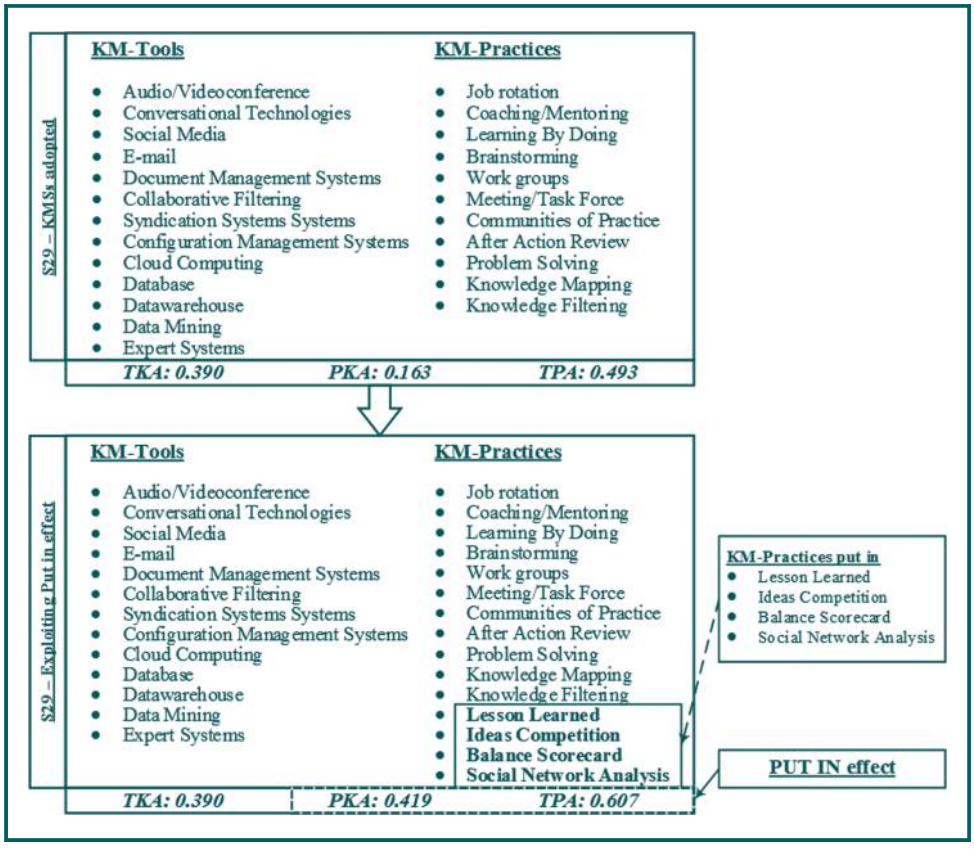


Figure 11 Examples of decision-making strategies



manage a significantly formalised knowledge to be shared with the environment (e.g. social network analysis) or practices more suitable for poorly formalised knowledge, such as lesson learned, ideas competition and balance scorecard, it could increase (put in effect) both PKA (from 0.163 to 0.419) and TKA (0.493 to 0.607) (Figure 12). In this way, it could improve its position by sliding from the Practice Laggards area to the Guidepost area and could also increase the level of alignment between KM-Tools and KM-Practices.

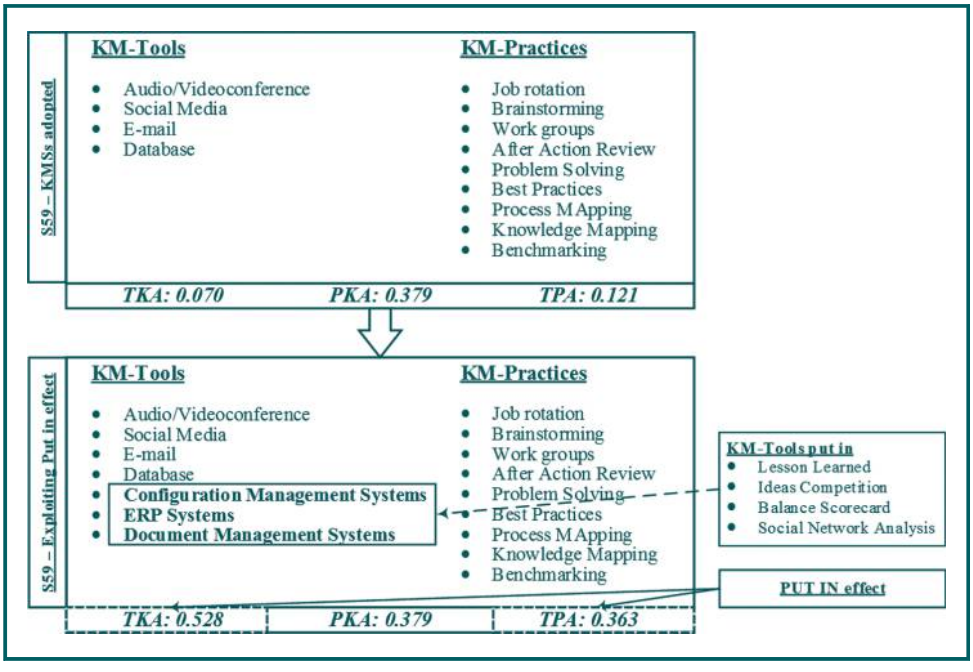
Figure 12 KM-Tools and KM-Practices: put in effect – case S29



5.3.2 Second case study: Enterprise S59. SME S59 is located in the Tool Laggards area (Figure 11). This enterprise has a knowledge with a medium level of formalisation and mainly shared inside the organisation. (Appendix A). Figure 13 shows that this enterprise adopts appropriate KM-Practices to manage such knowledge (e.g. best practice, brainstorming and work groups), but it uses KM-Tools that are not wholly suited to its knowledge. Considering the state of the enterprise's knowledge (Appendix A), the adoption of configuration management systems, ERP Systems and DMS could have two positive effects: greater alignment of the enterprise's knowledge and its KM-Tools (TKA), moving from 0.070 to 0.528, and increased alignment between the KM-Tools and KM-Practices, increasing the TPA from 0.121 to 0.363 (Figure 13). In this way, they could shift from the Tool Laggards area to the Guideposts area.

5.3.3 Third case study: Enterprise S48. SME S48 is situated in the Latecomers area. This SME manages a medium formalised knowledge shared exclusively inside the group (Appendix A). Figure 14 shows the KM-Tools and KM-Practices adopted by this SME. In view of the state of the enterprise's knowledge, they could replace some of their KM-Tools (e.g. cloud computing, peer-to-peer resource sharing) with others such as configuration management systems. In terms of KM-Practices, instead of storytelling, benchmarking and knowledge filtering, they could adopt problem solving. In doing so, it could benefit from a put in and pull out effect with three positive results: obtaining a better alignment between KM-Tools and knowledge (the TKA index increases from 0.139 to 0.235); increasing the level of alignment between KM-Practices and knowledge (the PKA index increases from 0.040 to 0.222), and improving the alignment between KM-Tools and KM-Practices (the TPA index increases from 0.393 to 0.481) (Figure 14).

Figure 13 KM-Tools and KM-Practices: put in effect – case S59



6. Conclusions

This paper has proposed a new 3D fuzzy logic methodology that can be used to evaluate the level of alignment between an enterprise's knowledge and its KMSs to provide an answer to this research question: what is the level of misalignment between the enterprise's knowledge and the KMSs adopted in SMEs?

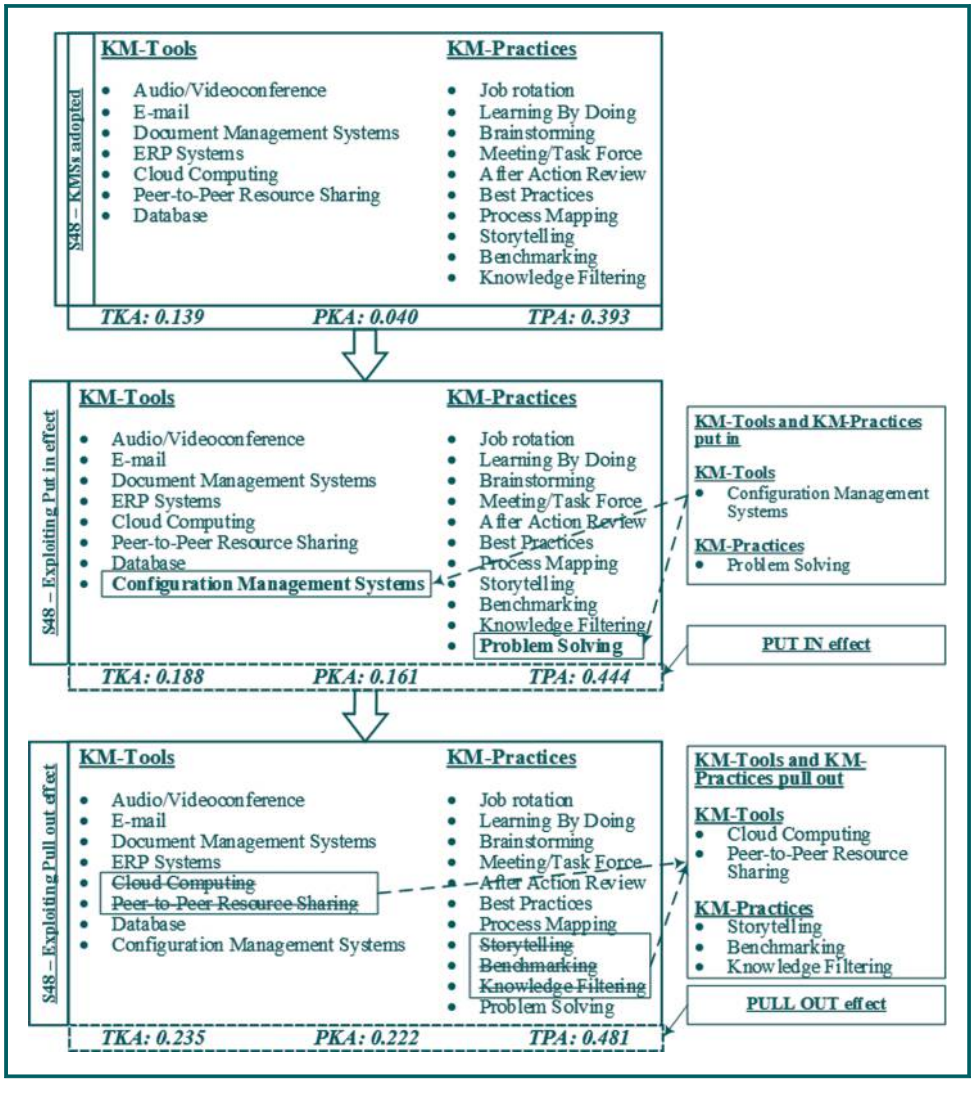
The relevance of this topic is justified by the fact that the literature has paid attention to the concept of knowledge as an asset but not knowledge as a liability which is created when the organisation mismanages knowledge or when the organisation adopts KMSs that are misaligned with the enterprise's knowledge and risks to make decisions that reduce the value of assets.

Two knowledge dimensions were considered: the epistemological and the ontological. The choice of these two dimensions depends on three main factors. First, the epistemological and ontological dimensions represent the nature and degree of knowledge sharing that form the heart of the process of knowledge management. Second, the taxonomies based on these two dimensions are by far the most commonly used by scholars and practitioners in the field of knowledge management. Finally, they are familiar to entrepreneurs, technicians, and managers and are thus easy to use in a field analysis.

The KMSs were divided into two groups: knowledge management practices (KM-Practices), namely, methods and techniques to support the processes of knowledge management, and knowledge management tools (KM-Tools), i.e. the specific IT-based systems supporting KM methods and techniques.

To identify the level of alignment between an enterprise's knowledge and its KMSs from the epistemological and ontological perspectives, three indices were defined. The first index (TKA) measures the degree of alignment of KM-Tools with the enterprise's knowledge; the second (PKA) measures the degree of alignment of KM-Practices with the enterprise's knowledge and the third (TPA) measures the degree of alignment between KM-Tools and KM-Practices.

Figure 14 KM-Tools and KM-Practices: put in and pull out effects – case S48



The proposed methodology was implemented through a field analysis based on semi-structured face-to-face interviews involving a sample of 61 SMEs operating as suppliers in high-tech and/or complex industries.

As for the alignment of KM-Tools with an enterprise's knowledge, the field analysis highlights that there is generally a low level of alignment, but there are a broad variety of situations. On the one hand, there are some completely disjointed enterprises where no KM-Tool is really suited to the characteristics of the enterprise's knowledge. On the other hand, there are enterprises with a high level of alignment, where the majority of the KM-Tools are aligned with their knowledge.

In terms of alignment between KM-Practices and an enterprise's knowledge, the low mean value of the index also highlights that only some of the KM-Practices are aligned with the enterprise's knowledge. Nevertheless, even in this case, there are a broad variety of behaviours. There are some enterprises with significant misalignment and others where most of the KM-Practices are aligned with the enterprise's knowledge.

Turning now to the alignment between KM-Tools and KM-Practices, it emerges that the alignment between KM-Tools and KM-Practices tends to be greater than the alignment between KM-Tools and the enterprise's knowledge, and between KM-Practices and the enterprise's knowledge.

Taking the indices of alignment as a starting point, it was possible to identify a taxonomy encompassing the possible typologies of SMEs in terms of the alignment between knowledge and KM-Tools, and between an enterprise's knowledge and its KM-Practices. Specifically, four typologies of enterprises were identified: *Guideposts*, *Practice Laggards*, *Tool Laggards* and *Latecomers*. *Guideposts* are enterprises whose knowledge shows a high level of alignment with both KM-Tools and KM-Practices. The *Practice Laggards* have a high level of alignment between their knowledge and KM-Tools, but there is a little alignment between knowledge and KM-Practices. The *Tool Laggards* are enterprises with a high level of alignment between their knowledge and KM-Practices but a low level between their knowledge and KM-Tools. Finally, the *Latecomers'* knowledge has a low level of alignment with both KM-Tools and KM-Practices.

The paper also highlights that the process of alignment between the enterprise's knowledge and the KMSs (KM-Tools and KM-Practices) adopted by an SME goes beyond a simple dyadic alignment between its knowledge and KM-Tools, or between its knowledge and its KM-Practices. It is a more complex process of triadic alignment. In reality, it is an alignment process involving three components (enterprise knowledge, KM-Tools and KM-Practices), and any changes in one component are reflected in the level of alignment with the other two.

In conclusion, the paper has shown that SMEs adopt a large variety of KM-Tools and KM-Practices to support the process of knowledge management. It seems to be of little concern that SMEs have scarce human and financial resources to invest in the area of knowledge management. This could be the result of the process of innovation in the field of information and communication technologies (ICTs), increasingly offering SMEs new low-cost opportunities (not requiring significant financial investment) and ease-of-use solutions (needing no specific skills). But if the human and financial barriers that stop SMEs from improving the KM process are weakened, where does the problem lie? The results of this paper suggest that the real issue is the misalignment of an enterprise's knowledge with the KM-Tools and KM-Practices adopted. In the end, the problem is not one of investing in human and financial resources but in the ability to invest in the specific KM-Tools and KM-Practices best able to support the KM process. In these terms, the methodology proposed in this paper provides an operative tool that may be used to identify the specific position of an individual SME and support decision-making geared towards selecting appropriate changes able to increase the level of alignment between an enterprise's knowledge and its KM-Tools and KM-Practices, and then improve their process of knowledge management.

In the light of these conclusions, some future research opportunities and implications for managers emerge, as follows.

6.1 Future research

The focus of this paper was SMEs operating in high-tech and/or complex manufacturing or service industries, so the results obtained are representative of this specific context. Consequently, further investigations should be addressed to identifying industrial or territorial specificities.

Second, future research could examine the relationship between an enterprise's level of alignment and its performance. Any research in this area should test the hypothesis that the higher the level of alignment of an enterprise's knowledge with its KM-Tools and Practices, the higher the enterprise's performance.

A third line of inquiry may be the effect of alignment and misalignment on supply chain performance, and, more generally, on the performance of the network in which SMEs operate. In this case, the unit of analysis has to shift from the SME to the supply chain or to the SME network.

Although this research contributes to the body of literature on KM in SMEs, it has a number of limitations, so several areas for future research to make the findings more generally applicable emerge. While the size of the sample seems enough to identify specific policies to support the competitiveness of the local innovation ecosystem in which the selected SMEs operate, a larger sample size would allow the findings to be extended. A comparative study of firms operating in other local systems and/or industries would be an interesting additional area of research.

6.2 Implications

The proposed methodology provides an operational tool for both SMEs and policy makers. It may be used in SMEs as a decision-making tool to identify appropriate changes to KM-Tools and KM-Practices and increase the level of alignment with the enterprise's knowledge, thus improving the knowledge management process.

To draw up an enterprise knowledge map reflecting both the ontological and epistemological perspectives, each enterprise has been divided into five macro-areas:

1. planning (i.e. the planning and design department, the office deputed to drawing up technical documents);
2. production (i.e. all the departments involved in the realisation and management of products or services, including production, operations management, inventory control and maintenance);
3. organisation (i.e. human resources, quality control, information technology and research and development);
4. market (i.e. all the sales functions regarding the "4Ps" – product, price, promotion and place – as well as market trends analysis, customer support and post-sales activities); and
5. strategic relationships (i.e. hiring functions, partnerships with suppliers and participation in research projects).

These macro-areas are in line with the organisational structure (organisation), market structure (market), industry structure (planning and production) and cross-firm integration (strategic relationships) identified by Teece *et al.* (1997) and Teece (1998, 2007), and can be supported by two main categories of capabilities:

1. managerial capabilities concerning the use of appropriate KM-Practices; and
2. technological capabilities related to the adoption of appropriate KM-Tools.

The proposed methodology may also help policy makers to identify enterprises' weaknesses and consequently identify specific policies to support the competitiveness of local systems by improving their management processes and the circulation of knowledge among enterprises. In fact, this study shows that the selected SMEs share a low level of alignment between their knowledge and their KMSs, possibly because the SMEs do not have the dedicated resources to monitor and follow the innovation processes that affect knowledge management. Nowadays, however, the development of new KMSs that do not need significant human and financial investments allows SMEs to overcome the barriers preventing the spread of knowledge management. There is thus a need for policies to reduce the cultural distance between enterprises and KMS providers, which is a particularly important issue if we consider that SMEs represent a crucial economic driver in modern industrial systems.

Notes

1. Although the participants in the focus group were fully conversant with the topic of KM, it was necessary to explain during the first phase that knowledge is considered from three different perspectives: stock, flow and process, in this research project.
2. It emerged from the pilot interviews that the questionnaire had to be administered in face-to-face mode.
3. The managers involved in the pilot study suggested including a clear definition of the KM-Tools named in the list (Appendix B). As the pilot interviews provided additional suggestions to improve the questionnaire, and this issue could have biased the results, the data collected during the three pilot interviews have not been included in the analysis.

References

Ahmad, S. and Simonovic, S. (2011), "A three-dimensional fuzzy methodology for flood risk analysis", *Journal of Flood Risk Management*, Vol. 4 No. 1, pp. 53-74.

Alavi, M. and Leidner, D.E. (2001), "Review: knowledge management and knowledge management systems: conceptual foundations and research issues", *MIS quarterly*, Vol. 25 No. 1, pp. 107-136.

Aljuwaiber, A. (2016), "Communities of practice as an initiative for knowledge sharing in business organisations: a literature review", *Journal of Knowledge Management*, Vol. 20 No. 4, pp. 731-748.

Andrews, K.M. and Delahaye, B.L. (2000), "Influences on knowledge processes in organizational learning", *Journal of Management Studies*, Vol. 37 No. 6, pp. 797-810.

Antonelli, C., Geuna, A. and Steinmueller, W.E. (2000), "Information and communication technologies and the production, distribution and use of knowledge", *International Journal of Technology Management*, Vol. 20 Nos 1/2, pp. 72-94.

Bagnoli, C. and Vedovato, M. (2014), "The impact of knowledge management and strategy configuration coherence on SME performance", *Journal of Management & Governance*, Vol. 18 No. 2, pp. 615-647.

Bhatt, G.D. (2001), "Knowledge management in organizations: examining the interaction between technologies, techniques, and people", *Journal of Knowledge Management*, Vol. 5 No. 1, pp. 68-75.

Bolisani, E. and Scarso, E. (2016), "Factors affecting the use of wiki to manage knowledge in a small company", *Journal of Knowledge Management*, Vol. 20 No. 3, pp. 423-443.

Caddy, I. (2000), "Intellectual capital: recognizing both assets and liabilities", *Journal of Intellectual Capital*, Vol. 1 No. 2, pp. 129-146.

Calvo-Mora, A., Navarro-García, A., Rey-Moreno, M. and Periañez-Cristobal, R. (2016), "Excellence management practices, knowledge management and key business results in large organisations and SMEs: a multi-group analysis", *European Management Journal*, Vol. 34 No. 6, pp. 661-673.

Cantú, L.Z., Criado, J.R. and Criado, A.R. (2009), "Generation and transfer of knowledge in IT-related SMEs", *Journal of Knowledge Management*, Vol. 13 No. 5, pp. 243-256.

Carayannis, E.G. (1999), "Fostering synergies between information technology and managerial and organizational cognition: the role of knowledge management", *Technovation*, Vol. 19 No. 4, pp. 219-231.

Carayannis, E.G., Depeige, A. and Sindakis, S. (2014), "Dynamics of ultra-organizational co-opetition and circuits of knowledge: a knowledge-based view of value ecology", *Journal of Knowledge Management*, Vol. 18 No. 5, pp. 1020-1035.

Centobelli, P., Cerchione, R. and Esposito, E. (2017), "Knowledge management systems: the hallmark of SMEs", *Knowledge Management Research and Practice*, Vol. 15 No. 2, pp. 294-304.

Chawinga, W.D. and Chipeta, G.T. (2017), "A synergy of knowledge management and competitive intelligence: a key for competitive advantage in small and medium business enterprises", *Business Information Review*, Vol. 34 No. 1, pp. 25-36.

Chhim, P.P., Somers, T.M. and Chinnam, R.B. (2017), "Knowledge reuse through electronic knowledge repositories: a multi theoretical study", *Journal of Knowledge Management*, Vol. 21 No. 4, pp. 741-764.

Choudhary, A.K., Harding, J., Camarinha-Matos, L.M., Lenny Koh, S.C. and Tiwari, M.K. (2013), "Knowledge management and supporting tools for collaborative networks", *International Journal of Production Research*, Vol. 51 No. 7, pp. 1953-1957.

Davenport, T.H. and Prusak, L. (1998), *Working Knowledge: How Organisations Manage What They Know*, Harvard Business School Press, Cambridge, MA.

Del Giudice, M. and Della Peruta, M.R. (2016), "The impact of IT-based knowledge management systems on internal venturing and innovation: a structural equation modeling approach to corporate performance", *Journal of Knowledge Management*, Vol. 20 No. 3, pp. 484-498.

Desouza, K.C. and Awazu, Y. (2006), "Knowledge management at SMEs: five peculiarities", *Journal of Knowledge Management*, Vol. 10 No. 1, pp. 32-43.

Dotsika, F. and Patrick, K. (2013), "Collaborative KM for SMEs: a framework evaluation study", *Information Technology & People*, Vol. 26 No. 4, pp. 368-382.

du Plessis, M. (2008), "The strategic drivers and objectives of communities of practice as vehicles for knowledge management in small and medium enterprises", *International Journal of Information Management*, Vol. 28 No. 1, pp. 61-67.

Durst, S. and Edvardsson, I.R. (2012), "Knowledge management in SMEs: a literature review", *Journal of Knowledge Management*, Vol. 16 No. 6, pp. 879-903.

Durst, S. and Wilhelm, S. (2012), "Knowledge management and succession planning in SMEs", *Journal of Knowledge Management*, Vol. 16 No. 4, pp. 637-649.

Edvardsson, I.R. (2009), "Is knowledge management losing ground? Developments among Icelandic SMEs", *Knowledge Management Research & Practice*, Vol. 7 No. 1, pp. 91-99.

Egbu, C.O., Hari, S. and Renukappa, S.H. (2005), "Knowledge management for sustainable competitiveness in small and medium surveying practices", *Structural Survey*, Vol. 23 No. 1, pp. 7-21.

Esposito, E. and Mastroianni, M. (2001), "Information technology and personal computers: the relational life cycle", *Technovation*, Vol. 22 No. 1, pp. 41-50.

Esposito, E. and Passaro, R. (2009), "Evolution of the supply chain in the italian railway industry", *Supply Chain Management*, Vol. 14 No. 4, pp. 303-313.

European Commission (2016), "User guide to the SME Definition".

Fink, K. and Ploder, C. (2009), "Knowledge management toolkit for SMEs", *International Journal of Knowledge Management*, Vol. 5 No. 1, pp. 46-60.

Frey, R.S. (2001), "Knowledge management, proposal development, and small businesses", *Journal of Management Development*, Vol. 20 No. 1, pp. 38-54.

Garrigos-Simon, F.J., Lapiedra, A., R. and Barbera Ribera, T. (2012), "Social networks and web 3.0: their impact on the management and marketing of organizations", *Management Decision*, Vol. 50 No. 10, pp. 1880-1890.

Grace, T.P.L. (2009), "Wikis as a knowledge management tool", *Journal of Knowledge Management*, Vol. 13 No. 4, pp. 64-74.

Hora, M. and Klassen, R.D. (2013), "Learning from others' misfortune: factors influencing knowledge acquisition to reduce operational risk", *Journal of Operations Management*, Vol. 31 Nos 1/2, pp. 52-61.

Hsu, C.C. and Sandford, B.A. (2007), "The Delphi technique: making sense of consensus", *Practical Assessment, Research and Evaluation*, Vol. 12 No. 10, pp. 1-8.

Hutchinson, V. and Quintas, P. (2008), "Do SMEs do knowledge management?: Or simply manage what they know?", *International Small Business Journal*, Vol. 26 No. 2, pp. 131-154.

Intezari, A. and Gressel, S. (2017), "Information and reformation in KM systems: big data and strategic decision-making", *Journal of Knowledge Management*, Vol. 21 No. 1, pp. 71-91.

Jones, M.C., Cline, M. and Ryan, S. (2006), "Exploring knowledge sharing in ERP implementation: an organizational culture framework", *Decision Support Systems*, Vol. 41 No. 2, pp. 411-434.

Kivits, R.A. and Furneaux, C. (2013), "BIM: enabling sustainability and asset management through knowledge management", *The Scientific World Journal*, Vol. 2013 No. 2013, art. no. 983721.

Lee, C.S. and Wong, K.Y. (2017), "A fuzzy logic-based knowledge management performance measurement system for SMEs", *Cybernetics and Systems*, Vol. 48 No. 4, pp. 277-302.

Lee, V.-H., Foo, A.T.-L., Leong, L.-Y. and Ooi, K.-B. (2016), "Can competitive advantage be achieved through knowledge management? A case study on SMEs", *Expert Systems with Applications*, Vol. 65, pp. 136-151.

Levine, S.S. and Prietula, M.J. (2012), "How knowledge transfer impacts performance: a multilevel model of benefits and liabilities", *Organization Science*, Vol. 23 No. 6, pp. 1748-1766.

Levy, M., Loebbecke, C. and Powell, P. (2003), "SMEs, co-opetition and knowledge sharing: the role of information systems", *European Journal of Information Systems*, Vol. 12 No. 1, pp. 3-17.

Lockett, N., Cave, F., Kerr, R. and Robinson, S. (2009), "The influence of co-location in higher education institutions on small firms' perspectives of knowledge transfer", *Entrepreneurship & Regional Development*, Vol. 21 No. 3, pp. 265-283.

Mariano, S. and Awazu, Y. (2017), "The role of collaborative knowledge building in the co-creation of artifacts: influencing factors and propositions", *Journal of Knowledge Management*, Vol. 21 No. 4, pp. 779-795.

Massaro, M., Handley, K., Bagnoli, C. and Dumay, J. (2016), "Knowledge management in small and medium enterprises: a structured literature review", *Journal of Knowledge Management*, Vol. 20 No. 2, pp. 258-291.

Matlay, H. and Westhead, P. (2005), "Virtual teams and the rise of e-entrepreneurship in Europe", *International Small Business Journal*, Vol. 23 No. 3, pp. 279-302.

Mcadam, R. and Reid, R. (2001), "SME and large organisation perceptions of knowledge management: comparisons and contrasts", *Journal of Knowledge Management*, Vol. 5 No. 3, pp. 231-241.

Michellone, G. and Zollo, G. (2000), "Competences management in knowledge-based enterprises", *International Journal of Technology Management*, Vol. 20 Nos 1/2, pp. 134-135.

Navarro, J.G.C., Dewhurst, F.W. and Eldridge, S. (2010), "Linking chief knowledge officers with customer Capital through knowledge management practices in the Spanish construction industry", *The International Journal of Human Resource Management*, Vol. 21 No. 3, pp. 389-404.

Newell, A. (1982), "The knowledge level", *Artificial intelligence*, Vol. 18 No. 1, pp. 87-127.

Nonaka, I. (1994), "A dynamic theory of organizational knowledge creation", *Organization Science*, Vol. 5 No. 1, pp. 14-37.

Okoli, C. and Pawlowski, S.D. (2004), "The Delphi method as a research tool: an example, design considerations and applications", *Information and Management*, Vol. 42 No. 1, pp. 15-29.

Patrice, M., Dimitri, G., Cecilia, C., Nuray, U.B. and Klitou, D. (2014) *Annual Report on European SMEs 2013-2014: A Partial and Fragile Recovery*, Brussels.

Pee, L.G. and Min, J. (2017), "Employees' online knowledge sharing: the effects of person-environment fit", *Journal of Knowledge Management*, Vol. 21 No. 2, pp. 432-453.

Perez-Araos, A., Barber, K.D., Munive-Hernandez, J.E. and Eldridge, S. (2007), "Designing a knowledge management tool to support knowledge sharing networks", *Journal of Manufacturing Technology Management*, Vol. 18 No. 2, pp. 153-168.

Pillania, R.K. (2006), "Leveraging knowledge for sustainable competitiveness in SMEs", *International Journal of Globalisation and Small Business*, Vol. 1 No. 4, pp. 393-406.

Pillania, R.K. (2008), "Creation and categorization of knowledge in automotive components SMEs in India", *Management Decision*, Vol. 46 No. 10, pp. 1452-1464.

Polanyi, M. (1966), *The Tacit Dimension*, Doubleday, Garden City, NY.

Qu, S.Q. and Dumay, J. (2011), "The qualitative research interview", *Qualitative Research in Accounting & Management*, Vol. 8 No. 3, pp. 238-264.

Razmerita, L. and Kirchner, K. (2011), "How wikis can be used to manage knowledge in SMEs: a case study", *Business Information Review*, Vol. 28 No. 3, pp. 175-178.

Rosu, S.M., Dragoi, G. and Guran, M. (2009), "A knowledge management scenario to support knowledge applications development in small and medium enterprises", *Advances in Electrical and Computer Engineering*, Vol. 9 No. 1, pp. 8-15.

Scuotto, V., Del Giudice, M. and Carayannis, E.G. (2017a), "The effect of social networking sites and absorptive capacity on SMES' innovation performance", *Journal of Technology Transfer*, Vol. 42 No. 2, pp. 409-424.

Scuotto, V., Del Giudice, M. and Obi Omeihe, K. (2017b), "SMEs and mass collaborative knowledge management: toward understanding the role of social media networks", *Information Systems Management*, Vol. 34 No. 3, pp. 280-290.

Serenko, A. (2013), "Meta-analysis of scientometric research of knowledge management: discovering the identity of the discipline", *Journal of Knowledge Management*, Vol. 17 No. 5, pp. 773-812.

Shih, K.H., Chang, C.J. and Lin, B. (2010), "Assessing knowledge creation and intellectual Capital in banking industry", *Journal of Intellectual Capital*, Vol. 11 No. 1, pp. 74-89.

Sparrow, J. (2001), "Knowledge management in small firms", *Knowledge and Process Management*, Vol. 8 No. 1, pp. 3-16.

Tanaka, K. (1996), *An Introduction to Fuzzy Logic for Practical Applications*, Springer-Verlag, New York, NY.

Teece, D.J. (1998), "Capturing value from knowledge assets: the new economy, markets for know-how, and intangible assets", *California Management Review*, Vol. 40 No. 3, pp. 55-79.

Teece, D.J. (2007), "Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance", *Strategic Management Journal*, Vol. 28 No. 13, pp. 1319-1350.

Teece, D.J., Pisano, G. and Shuen, A. (1997), "Dynamic capabilities and strategic management", *Strategic Management Journal*, Vol. 18 No. 7, pp. 509-533.

Tseng, S.M. (2009), "A study on customer, supplier, and competitor knowledge using the knowledge chain model", *International Journal of Information Management*, Vol. 29 No. 6, pp. 488-496.

von Krogh, G. (1998), "Care in knowledge creation", *California Management Review*, Vol. 40 No. 3, pp. 133-154.

Wallace, K., Ahmed, S. and Bracewell, R. (2005), "Engineering knowledge management", *Design Process Improvement: A Review of Current Practice*, Springer, New York, NY, pp. 326-343.

Wang, J., Ding, D., Liu, O. and Li, M. (2016), "A synthetic method for knowledge management performance evaluation based on triangular fuzzy number and group support systems", *Applied Soft Computing Journal*, Vol. 39, pp. 11-20.

Wee, J.C.N. and Chua, A.Y.K. (2013), "The peculiarities of knowledge management processes in SMEs: the case of Singapore", *Journal of Knowledge Management*, Vol. 17 No. 6, pp. 958-972.

Wong, K.Y. (2005), "Critical success factors for implementing knowledge management in small and medium enterprises", *Industrial Management & Data Systems*, Vol. 105 No. 3, pp. 261-279.

Wong, K.Y. and Aspinwall, E. (2005), "An empirical study of the important factors for knowledge-management adoption in the SME sector", *Journal of Knowledge Management*, Vol. 9 No. 3, pp. 64-82.

Zadeh, L.A. (1965), "Fuzzy sets", *Information and Control*, Vol. 8 No. 3, pp. 338-353.

Zimmermann, H. (2001), *Fuzzy Set Theory and its Applications*, Kluwer Academic Publishers, Boston.

Further reading

Lin, Y.C. and Ha, N.-H. (2015), "The framework for KM implementation in product and service oriented SMEs: evidence from field studies in Taiwan", *Sustainability*, Vol. 7 No. 3, pp. 2980-3000.

Watanabe, N. (1979), "Statistical methods for estimating membership functions", *Japanese Journal of Fuzzy Theory and Systems*, Vol. 5 No. 4, pp. 816-826.

Zack, M. (1999), "Managing codified knowledge", *Sloan Management Review*, pp. 45-58.

Corresponding author

Emilio Esposito can be contacted at: emilio.esposito@unina.it