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Research Paper

Evolution of the Socio-cognitive Structure of Knowledge Management (1986–2015): An Author Co-citation Analysis

Carlos Luis González-Valiente[1†], Magda León Santos[2], Ricardo Arencibia-Jorge[3]

[1]Biblioteca Nacional de Cuba "José Martí", ave. Independencia, # 257 e/ 20 de Mayo y Aranguren, Plaza de la Revolución, La Habana, Cuba
[2]Facultad de Comunicación, Universidad de la Habana, San Pedro entre Ermita y Avenida Independencia, Plaza de la Revolución, Cuba
[3]Empresa de Tecnologías de la Información, Calle 18 # 4310, Miramar, Playa. La Habana, Cuba

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Abstract

Purpose: The evolution of the socio-cognitive structure of the field of knowledge management (KM) during the period 1986–2015 is described.

Design/methodology/approach: Records retrieved from Web of Science were submitted to author co-citation analysis (ACA) following a longitudinal perspective as of the following time slices: 1986–1996, 1997–2006, and 2007–2015. The top 10% of most cited first authors by sub-periods were mapped in bibliometric networks in order to interpret the communities formed and their relationships.

Findings: KM is a homogeneous field as indicated by networks results. Nine classical authors are identified since they are highly co-cited in each sub-period, highlighting Ikujiro Nonaka as the most influential authors in the field. The most significant communities in KM are devoted to strategic management, KM foundations, organisational learning and behaviour, and organisational theories. Major trends in the evolution of the intellectual structure of KM evidence a technological influence in 1986–1996, a strategic influence in 1997–2006, and finally a sociological influence in 2007–2015.

Research limitations: Describing a field from a single database can offer biases in terms of output coverage. Likewise, the conference proceedings and books were not used and the analysis was only based on first authors. However, the results obtained can be very useful to understand the evolution of KM research.

Practical implications: These results might be useful for managers and academicians to understand the evolution of KM field and to (re)define research activities and organisational projects.

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† Corresponding author: Carlos Luis González-Valiente (E-mail: carlos.valiente89@gmail.com).

Originality/value: The novelty of this paper lies in considering ACA as a bibliometric technique to study KM research. In addition, our investigation has a wider time coverage than earlier articles.

Keywords Knowledge management; Bibliometrics; Author co-citation analysis; Knowledge domain visualization; Social network analysis; Intellectual structure

1 Introduction

Knowledge management (KM) as a scientific field emerged in the mid-1980s (Ruggles, 1998; Wiig, 1999) from the significance of knowledge in organisations (Blackler, 1995; Earl, 2001; Sağsan, 2007) and as a response to the social and economic trends of the time (Prusak, 2001). The contradiction in KM's origin (Jasimuddin, 2006) is due to the different intellectual roots coming from a broad range of disciplinary spaces like epistemology, psychology, economics, sociology and organisational science (Lambe, 2011; Prusak, 2001; Wiig, 1999). Nevertheless, many academicians agree that the mid-1990s meant the popularity stage of KM since the coming out of iconic books written by figures like Ikujiro Nonaka, Thomas H. Davenport, Dorothy Leonard-Barton, Etienne C. Wenger, and Karl M. Wiig, among others (Jasimuddin, 2006; Lambe, 2011; Spender, 2015).

Across the literature, it is not possible to find a consensus definition of KM since, for instance, economists, organisational theorists, information scientists and information technologists have different ideas about the theory and practice of KM (Spender & Scherer, 2007). The lack of agreement about the definition of the concept of knowledge management (Earl, 2001; Jasimuddin, 2006) originates from the fragmented character of the field (Spender, 2015), as each discipline find its own reasons to study and apply the principles of KM.

KM has more than thirty years of existence as a concept. It has called the attention of professionals from different social sectors worldwide (Heising, 2015), becoming a permanent field because of the management developments (Ponzi & Koenig, 2002). Although many researchers have rejected the KM term, based on the premise that knowledge cannot be managed (Kakabadse et al., 2003; Wilson, 2002), KM has attracted large attention among academicians and practitioners (Martin, 2008). Empirical findings show a growing number of contributions on the topic (e.g. Gu, 2004; Harman & Koohang, 2005; Kumar & Mohindra, 2015; Ponzi, 2002; Qiu & Lv, 2014). Such increasing production patterns have influenced and strengthened the idea of considering KM as a formalized discipline (Jennex & Croasdell, 2007; Sağsan, 2007; Serenko & Bontis, 2013b; Wiig, 1999).

In this article, we propose to describe how KM research has evolved and developed according to the most influential thinkers using author co-citation analysis (ACA).

ACA studies the cognitive and social affinities between pairs of cited authors (White, 2003). This procedure is commonly employed to understand the intellectual structure of a field (Börner, Chen, & Boyack, 2003). This paper aims at complementing previous historical studies of KM (e.g. Day, 2001; Lambe, 2011; Prusak, 2001; von Krogh et al., 2013; Wiig, 1997, 1999), given that a different evolutionary perspective of the field will be provided. This paper is written with the following research questions (RQs) in mind:

RQ 1: How did the socio-cognitive structure of KM evolve in terms of research areas represented by co-cited first authors?
RQ 2: How do co-cited communities of KM authors relate to each other over time?

1.1 Literature review

KM field has been largely benefited with the principles of bibliometrics and scientometrics. A meta-review conducted by Serenko (2013) in relation to scientometric literature on KM research determined the following phases:

1. the initiation of scientometric research (1997–2001);
2. the early development of scientometric research (2002–2006); and
3. the rigor and consolidation of scientometric research (2007–2012).

Most of the previous scientometric studies on KM have focused on the following areas:

1. Analysing the classical and core literature in the field (Serenko & Bontis, 2013b; Serenko & Dumay, 2015a,b; Wallace et al., 2011);
2. studying the collaboration patterns between researches and countries (Dattero, 2006; Qiu & Lv, 2014),
3. describing the thematic structure and topical composition of the field (Fteimi & Lehner, 2016; Harman & Koohang, 2005; Ponzi, 2002; Sedighi & Jalalimanesh, 2014);
4. discussing ranking systems for KM journals (Bontis & Serenko, 2009; Serenko & Bontis, 2013a); and
5. a broad diversity of output patterns (Akhavan et al., 2016; Gu, 2004; Muzzammil & Asad, 2016; Qiu & Lv, 2014).

According to the aforementioned antecedents, even the most recent bibliometrics papers on KM have ignored the study of its intellectual base, as they have mainly focused on detecting the research front (Akhavan et al., 2016; Qiu & Lv, 2014). Co-citation analysis, as the appropriate way to describe the intellectual base (Persson, 1994), used only 5% of the bibliometric research in KM, up to 2012 (Serenko, 2013). This demonstrates the little use of this technique for the study of KM

literature. For example, Lee and Chen (2012) mapped the structure of KM using document co-citation analysis with the purpose to visualize the evolution and future developments of the field. After analysing 10,974 publications derived from the Microsoft Academic Search database from 1995 to 2010, they concluded that KM is a field under evolution, as it has not reached a high level of maturity. Similarly, Walter and Rivière (2013), focused on a single journal, the Knowledge Management Research & Practice (KMRP), studying 100 articles from that journal using co-citation analysis to analyse the emergence of KM topics. They identified four thematic groups: (1) communities and situated learning, (2) networks, knowledge transfer and research methods, (3) foundations of knowledge management, and (4) intellectual capital.

With respect to ACA specifically, Ponzi (2002) applied this technique to explore the intellectual structure and interdisciplinary character of the field. By covering five years (1994–1998) of academic literature contained in the Science Citation Index and Social Science Citation Index databases, it was shown that KM emerged from conceptions related to organisational learning, knowledge-based theories, and tacit knowledge.

Thus, having reviewed some key antecedents on our topic of interest, in this article we propose to cover a wider period compared to the aforementioned studies. Hence, a more complete view on influential researchers and their relations across the time will be provided.

2 Methodology

2.1 Data source and extraction

Given the international and mainstream science nature of the Web of Science (WoS) database, it was used as source for record extraction. Many bibliometric studies on KM have been conducted from the coverage of specific KM-centric journals (e.g. Handzic, 2015; Ramy et al., 2018; Ribière & Walter, 2013; Serenko & Bontis, 2013a; Serenko & Dumay, 2015a; Walter & Ribière, 2013); however, we thought that a broader overview of the evolution of KM would be offered by retrieving datasets from this multidisciplinary database.

We selected the source documents in the indexes Science Citation Index-Expanded (SCI), Social Science Citation Index (SSCI), and Arts and Humanities Index (A&HI). The search query was performed by typing the term ‘knowledge management’ as TOPIC for the standard citable document typologies (article and review) during the years 1980–2015. We notice that the term ‘knowledge management’ was employed, as it is the most precise to label the field according to previous bibliometric studies on this line (e.g. Lee & Chen, 2012; Ma & Yu, 2010;

Ponzi, 2002). No records were retrieved from 1980 to 1985 and 7,089 publications were found between 1986–2015. To trace the evolution, we applied a longitudinal perspective. Bibliometric studies lack a standard formula to divide broad periods into smaller year-based units. Some authors use, indistinctly, periods of 5 years, 10 years, etc. In this study we broke down the 29 years in three sub-periods as uniformly as possible, thus defining three general periods: 1986–1996 (11 years), 1997–2006 (10 years), and 2007–2015 (9 years). The number of source documents per sub-periods were 63 (1986–1996), 2,368 (1997–2006), and 4,658 (2007–2015).

2.2 Data analysis and visualization

We manually disambiguated the authors' names in the entire dataset. Since the number of source documents varied significantly from one sub-period to another, we mapped the 10% most cited authors in each time slice, leading to 20 authors in 1986–1996, 39 authors in 1997–2006, and 152 authors in 2007–2015. VOSviewer (v. 1.6.6), a well-known software for science mapping, was employed for the network construction and visualizations of first authors only. This software groups the nodes as networks derived from co-citation measures using the visualization of similarities (VOS) method (Waltman, van Eck, & Noyons, 2010). To interpret the clusters, we examined scholarly output of co-cited authors. Given that the research interests of authors vary in time, we took into consideration their scientific contributions limited to each of the periods analysed. Some statistical values derived from social network analysis (SNA) were obtained to analyse the internal structure of the networks across the periods. Finally, networks constructed in VOSviewer were imported to Pajek (v. 5.05), to visualize more clearly and understand better the relations among communities of authors.

3 Results

3.1 RQ 1: How did the socio-cognitive structure of KM evolve in terms of research areas represented by co-cited first authors?

3.1.1 1986–1996

The co-citation network derived from this first sub-period consists of 20 authors. As visualized in Figure 1, four communities (clusters) are identified in the map. A first cluster composed by 6 red nodes is labelled as (1) *Knowledge-based theory* (K-based theory) since its authors are representatives of this topic (e.g. Nelson, RR; Nonaka, I; Spender, JC). The green cluster (6 authors) is named (2) *Knowledge-based systems* (K-based systems) as the clustered authors have provided relevant contributions in this area, including Skuce, D; Boose, J; and Gaines, BR. The blue cluster of five authors is labelled (3) *Technology-based strategy*, as it groups some

economists whose contributions are referred to the development of technology focused on social, cognitive and behavioural aspects of individuals in organisations, including Simon, HA; Von Hippel, E; Kogut, B; Clark, KB; and Sanchez, R. Finally, the fourth cluster, in yellow, contains three authors oriented to the research on (4) *Decision support systems* (DSS).

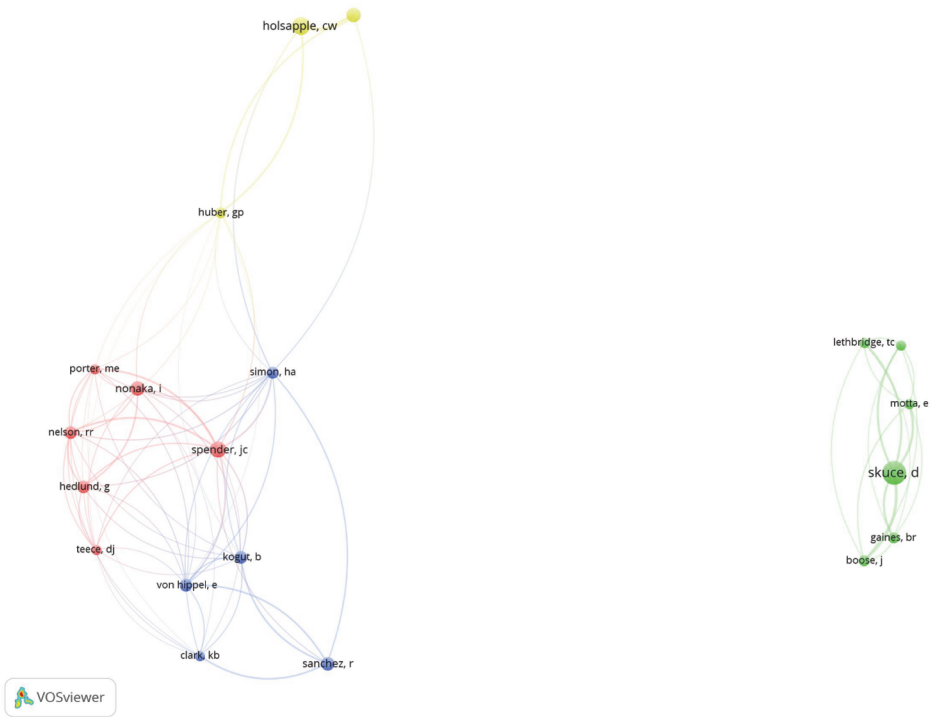

Figure 1. Co-citation map of authors, 1986–1996.
Note. Colors indicate different clusters and node size indicates citation weights.

3.1.2 1997–2006

The co-citation map of the second sub-period was built with 39 authors grouped in four clusters (see Figure 2) as well. We provide a consecutive numbering of clustering. The fifth cluster, located in the red zone, is labelled (5) *Strategic management* given that important strategists are present in that cluster. This is the largest cluster in the network containing 11 authors focused on topics like competitive advantage, strategic management, corporate strategy, innovation, organisational capability, and some others (e.g. Grant, RM; Teece, DJ; Kogut, B; Spender, JC; Cohen, WM). The green cluster, of 10 authors, is named (6) *K-based theory*, a cluster that was also identified during the first sub-period. The two most cited

authors in this cluster are devoted to knowledge theories, like Nonaka, I (1128 citations in the network), who introduced notions on knowledge creation, and Polanyi, M (320 citations in the network), who firstly emphasized the study of tacit knowledge. The remaining authors in cluster 6 are related to a wide range of innovation-related topics including knowledge management, technology strategy, new product and process design, and organisational change, among others (e.g. Leonard-Barton, D; Brown, JS; Hansen, MT; Wenger, EC; Orlikowski, WJ).

The blue cluster, consisting of nine authors, represent the topic of (7) *Organisational learning and behaviour*. Some of the researchers highlighted in this cluster are Senge, PM; Argyris, C; Weick, KE; Eisenhardt, KM; Argote, L; and Walsh, JP. Finally, we labelled the yellow cluster of nine authors as (8) *KM foundations*, since some foundational contributors and developers of KM-specific notions are present including Davenport, TH; Wiig, KM; Alavi, M; and Zack, MH.

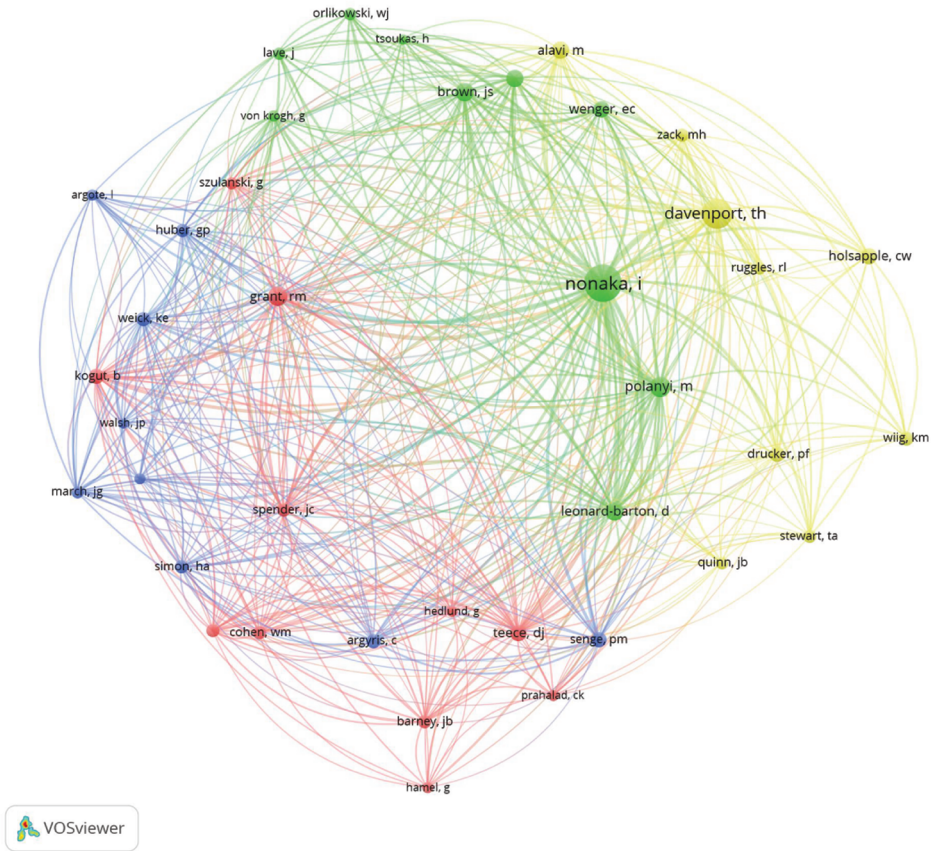

Figure 2. Co-citation map of authors, 1997–2006.
Note. Colors indicate different clusters and node size indicates citation weights.

According to citation weights, the top five important figures of KM during this second sub-period are Nonaka, I (1,128 citations); Davenport, TH (714 citations); Polanyi, M (320 citations); Grant, RM (298 citations); and Leonard-Barton, D (275 citations).

3.1.3 2007–2015

152 authors were mapped in the co-citation network of the third sub-period, forming 7 communities (Figure 3). The red cluster, of 41 authors, is labelled as (9) *Strategic management*. Distinguished researchers devoted to strategic topics are contained in cluster 9, including Grant, RM; Teece, DJ; Barney, JB; Eisenhardt, KM; and Porter, ME. Likewise, we detect several organisational theorists (e.g. March, JG; Chesbrough, HW; Hitt, MA; Edlund, G; Powell, WW), as well as some scholars of innovation in organisations (e.g. Cohen, WM; Gupta, AK; Von Hippel, E; Chesbrough, HW; Tushman, ML; Dougherty, D). (10) *Marketing strategy* is the tenth cluster located in the green area, a cluster not visualized previously. The following authors have a strong orientation to marketing topics: Hair, JFJ; Bagozzi, RP; Anderson, JC; Darroch, J; and Hult, GTM. We note that in this cluster 10 there are a couple of authors oriented as much to psychological issues as to the study of consumers (e.g. Fornell, C; Nunnally, JC; Bagozzi, RP; Anderson, JC; Baron, RM).

The eleventh cluster is a standing topic, (11) *KM foundations*, located in the blue zone of the map. Out of the 23 authors, Nonaka, I; Davenport, TH; Drucker, PF; Zack, MH; Wiig, KM, among others are the most crucial names. In this cluster, we also find figures related to research about intellectual capital like Bontis, N; Edvinsson, L; and Stewart, TA. The yellow cluster with 22 authors represents the topic of (12) *KM systems and technology*. In this cluster, the following authors are clustered: Alavi, M; Bock, GW; Wasko, MM; Kankanhalli, A; Markus, ML; Venkatesh, V; Hofstede, G; Jarvenpaa, SL.

Authors oriented to the study and applications of theories within the organisational framework are grouped in the thirteenth cluster (purple area). Some of these theories (e.g. knowledge-based theories, social learning theories, critical theories, and many other sociological and organisational theories) are typified by authors like Wenger, EC; Polanyi, M; Tsoukas, H; Spender, JC; Yin, RK; Alvesson, M; Blackler, F. For that reason, we label this community as (13) *Organisational theories*. The blue light area of 12 nodes is represented by the topic of (14) *Networks and knowledge transfer*. Here we observe some authors oriented to the study of social networks, collaboration and knowledge transfer within the organisational realm as well (e.g. Hansen, MT; Argote, L; Szulanski, G; Nahapiet, J; Burt, RS; Granovetter, MS; Cross, RL). The last cluster in the network was also identified in the second period, (15) *Organisational learning and behaviour*. It is located in the blue light zone

totalling nine authors (e.g. Pfeffer, J; Walsh, JP; Daft, RL; Crossan, MM; Senge, PM; Argyris, C).

We also detect the permanence of clusters referred to themes like strategy, innovation, organisation, organisational learning, organisational behaviour, and KM foundations. Nevertheless, the *KM systems and technology* community is more emphasized now, while the focus on *marketing strategy* emerges. Appendix 1 displays summarized information derived from clustering by sub-periods.

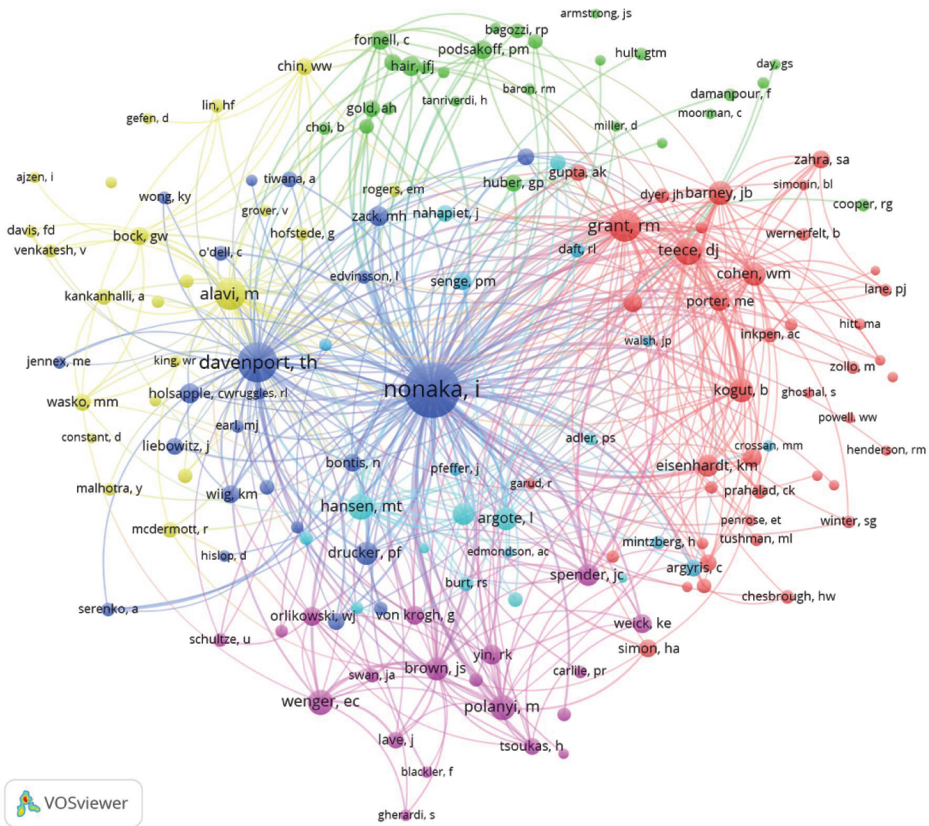

Figure 3. Co-citation map of authors, 2007–2015.
Note. Colors indicate different clusters and node size indicates citation weights.

3.2 RQ 2: How do co-cited communities of KM authors relate each other over time?

Table 1 shows statistical information obtained from each network. The increasing number of nodes and edges between nodes indicates a field of strong development. The average degree of nodes in networks represents the level of importance that

authors have been reaching over the time; regardless of the dynamics of citation as time goes by (McCain, 1990). Appendix 2 displays the ten most important authors by sub-periods in terms of citation weights, highlighting the influence of experts coming from the economics, business, management, and computer science arenas over the whole period here examined.

Table 1. Statistical description of the KM network.

Network measures	1986–1996	1997–2006	2007–2015
Nodes	20	39	152
Edges	79	741	11,186
Average degree	4	19	74
Diameter	3	1	2
Density	0.2	0.5	0.5
Average clustering coefficient	0.5	0.5	0.5

The values of network diameter, density and average clustering coefficient indicate how compact the co-citation networks are, showing a considerable homogeneity of the KM field. Using the network shrinking operation provided by Pajek, we visualize how co-cited communities connect to each other (see figures 4a, b, c). In sub-period 1986–1996, clusters (1) *K-based theory* and (3) *Technology-based strategy* are the most important in the network, according to node size (see Figure 4a), and are the most connected ones in the network. At the same time, (2) *K-based systems* is a cluster with zero connections and low representativeness. However, top co-cited authors according to link strength (ls) measures are present in this cluster 2, highlighting Skuce, D and Boose, J (ls: 76), Skuce, D and Motta, E (ls: 52), Skuce, D and Lethbridge, TC (ls: 44), Skuce, D and Meyer, I (ls: 44), and finally Skuce, D and Gaines, BR (ls: 44).

In sub-period 1997–2006, communities are even more connected, despite the introduction of new groups of authors less oriented to systems and technology, as previously observed. We note that major relatedness of communities is given between clusters (5) *Strategic management* and (6) *K-based theory* (see Figure 4b). This connection among strategists and knowledge theorists was a pattern already visualized in 1986–1996. Most co-citation relations are commonly established with the foundational author Nonaka, I, as for example: Nonaka, I and Davenport, TH (ls: 797), Nonaka, I and Polanyi, M (ls: 531); Nonaka, I and Grant, RM (ls: 451); Nonaka, I and Leonard-Barton, D (ls: 440); and Nonaka, I and Brown, JS (ls: 332).

During the final sub-period (2001–2015), the relatedness between clusters (9) *Strategic management* and (11) *KM foundations* stand out (see Figure 4c). Here, we notice a common trend as observed from sub-period 1-3, since strategic communities and foundational KM thinkers are more strongly linked. Likewise, major citation linkages are produced with Nonaka, I as for instance: Nonaka, I and Davenport, TH

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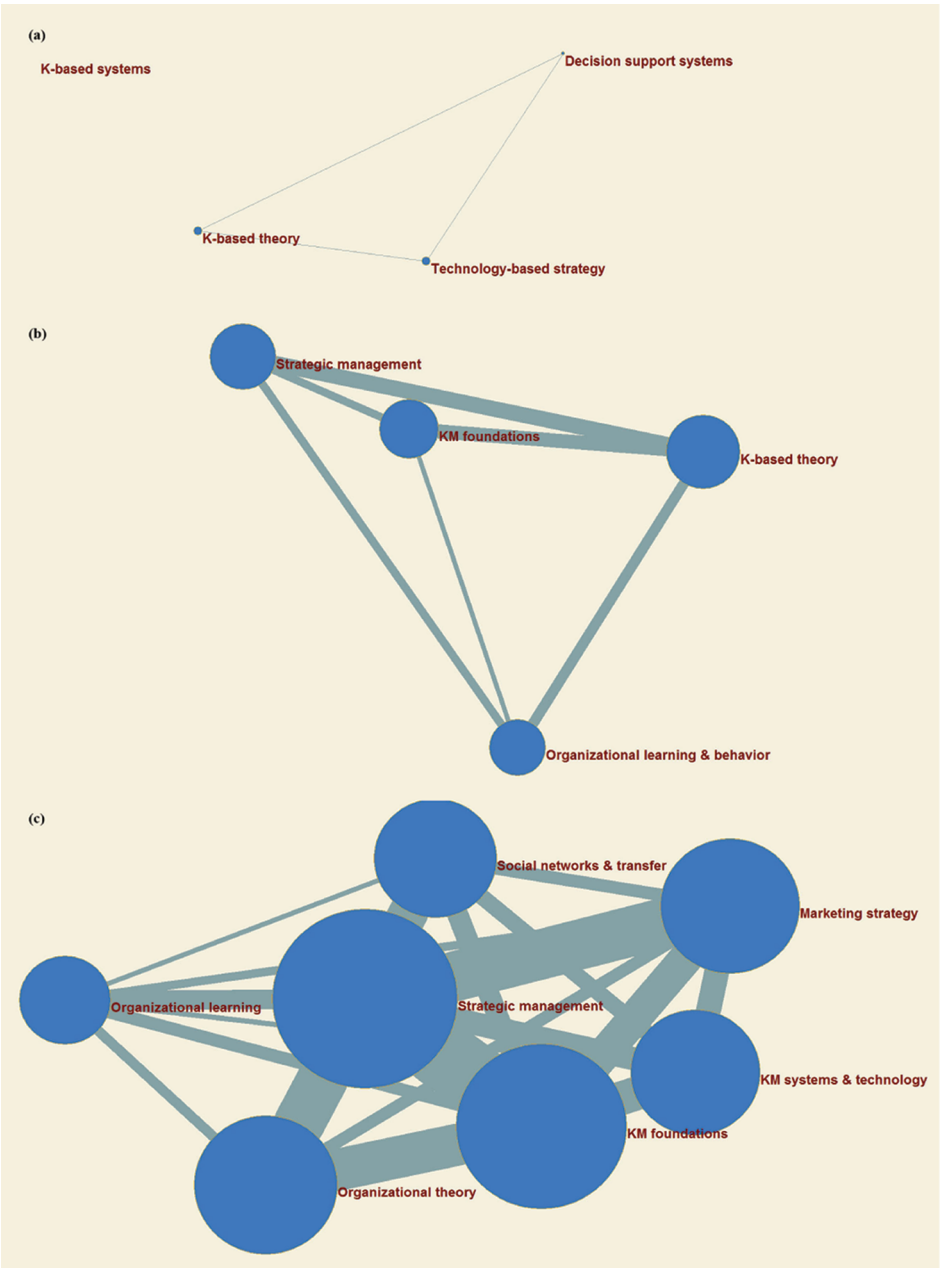

Figure 4. Relations among KM communities using network-shrinking operation in *Pajek*; (a): 1986–1996, (b): 1997–2006; and (c): 2007–2015.

(ls: 1543); Nonaka, I and Grant, RM (ls: 1353); Nonaka, I and Polanyi, M (ls: 1045); Nonaka, I and Alavi, M (ls: 948); Nonaka, I and Teece, DJ (ls: 817). Only one isolated cluster was formed during the period covered by our research, namely during sub-period 1 (cluster 2).

4 Discussion

The ACA here performed has provided clear insights into the evolution of the socio-cognitive structure of KM field. The 1980s was a crucial period around the world, events derived from post-industrial society like globalization, technological shifts and economic changes affected the entire social, scientific, political, technological, and economic environment. During the 1980s, 'knowledge' and 'information' became core resources for organisations. A key predecessor of KM was the knowledge-based practices (Wiig, 1997). Having that in mind, we hoped to map the KM field since the year 1980, which is why our search strategy in WoS framed the period 1980–2015. To our surprise, the first document recovered was published in 1986; matching exactly with the year in which, according to Wiig (1997), the concept of knowledge management was introduced.

4.1 1986 to 1996. The emergence of KM field: the technological influence

During the first sub-period (1986–1996), we detect the influence of IT and computer-related researchers, confirming once again the existence of a first generation in which the techno-centric view of knowledge processes prevailed (Serenko, 2013). Prusak (2001) states that IT adoption within firms and the consequences of ubiquitous computing were some of the trends that boosted KM. Undoubtedly, and as we already mentioned in the introductory section, technological shifts produced around the organisational environment in the mid-1980s favoured enormously the knowledge practices. Largely, most authors composing the socio-intellectual structure of KM in this early stage have had economics, information systems and computer science background, and their contributions have been mainly focused on artificial intelligence, knowledge technologies, knowledge representation and acquisition, and data management.

On top of that, major connected communities are devoted to K-based theories and technology-based strategies, highlighting besides the strategic nature of KM. Nevertheless, from 1986 to 1996 the top co-cited pair of authors were contained in an isolated cluster oriented to K-based systems. When Ponzi (2002) performed an ACA of KM literature from 1994 to 1998, he did not find evidence with respect to contributions of IT theorists. Such a hypothesis was later validated in the study of Lee and Chen (2012), after analysing the coverage 1995–2012. However, as we proposed to examine publications before 1994, it is clearly noted that during these

early years, authors devoted to technological and computational topics were detonators in KM. We also notice that the respective cluster (2) K-based systems represents a disciplinary community coming from the artificial intelligence area, which was intellectually disconnected from the knowledge theorists and strategists, forming an independent disciplinary space. This cluster 3 is represented by research on expert systems, a theme that arose during the 1980s and 1990s (Russell & Norvig, 2003). Despite that this school of thought is currently ignored in KM literature (Serenko, 2013), we cannot discard its early effect in the construction of the field.

4.2 1997 to 2006. The configuration of KM field: the strategic influence

From sub-period 1-2, interesting shifts are observed. Yet, 99% of authors in the co-citation network are also included in the third sub-period (2007–2015), thus indicating a field with solid and well-established core thinkers. All co-cited communities are more connected and no isolated clusters or authors were found. The technological emphasis is less appreciated now since some technology-centred researchers are grouped in communities not fully focused on this research area. For example, authors like Leonard-Barton, D; Brown, JS, and Orlikowski, WJ are in cluster 6 (K-based theory); while Huber, GP; Simon, HA; Eisenhardt, KM are in cluster 7 (Organisational learning & behaviour); and some others like Alavi, M and Holsapple, CW are in cluster 8 (KM foundation). That is, not a single community on information systems, IT or computer science-related themes is well-structured, but its authors are dispersed in the network.

The strong relations among knowledge theorists and strategists is a common pattern in the co-citation networks and is even more delineated during this second stage. Obviously, this is favoured by the significant growth rates of KM literature from 1997 to 2006. Joined to the decline of technologists in the network, another interesting finding is the expansion towards organisational learning and behaviour themes (cluster 7). In the 1990s, strategic management was highly influenced by behavioural research in organisations, such as organisational and cognitive psychology (Ferreira, Fernandes and Ratten, 2016). In that sense, Senge, PM; Argyris, C and Weick, KE are some of the figures whose contributions have served as conceptual frameworks to develop learning strategies and study the behaviour of people in organisations.

4.3 2007 to 2015. Diversification of KM field: the social influence

Over 2007–2015, a steading tendency stands out, the strong relations among knowledge theorists and strategists (cluster 9 and cluster 11). As in the second stage (1997–2006), Ikujiro Nonaka is still playing an essential role in the co-citation network according to citation weights and link strengths values. Its linkage to other

authors means one of the strongest paths among research communities, including *strategic management*, *organisational theory*, *KM systems and technology*, and *marketing strategy*. The high influence of Nonaka has been previously visible in other empirical studies on KM (e.g. Edwards et al., 2003; Walter & Ribière, 2013). Undoubtedly, his notions on knowledge creation, knowledge spiral, and the concept of '*ba*' (i.e. a shared space of emerging relationships) since the 1990s onwards, make of him a current guru within the KM realm. Joined to Nonaka, we find eight remaining authors who appear in the three co-citation maps like Hedlund, G; Nelson, RR; Porter, ME; Spender, JC; Teece, DJ; Kogut, B; Simon, HA; Von Hippel, E; Holsapple, CW; and Huber, GP. White and McCain (1998) call these as 'canonical authors'. They constitute the most classical and influential authors, whose contributions have served to set the body of knowledge of KM over the years.

From sub-period 1-2, a declining trend of the technological community became apparent, however, in sub-period 3 a major representativeness of KM systems and technology community (cluster 12) is observed, led by Myriam Alavi with her classical paper "Knowledge management systems: Conceptual foundations and research issues" (Alavi & Leidner, 2001). This IT and systems theme became a dominant approach sustaining KM research and practice (Wolfe, 2003). Since 1997, Karl Wiig envisioned the future potentialities of IT in KM to discover and generate knowledge (Wiig, 1997). Likewise, our findings display a strong connection in 2007–2015 between the IT community and the foundational authors, theorists and strategists. Thus, we can affirm the current existence of an IT-based dimension in KM as Kakabadse et al. (2003), and Mehrizi and Bontis (2009) have previously pointed out.

Beyond the dominant role of strategists in KM, the intellectual structure in 2007–2015 is beside widely influenced by notorious researchers devoted to the study of social and sociological themes including social learning theories, social psychology, social influence, social power, social responsibility, social capital, social networks, social media, and many others. Authors representing this dimension in KM are mainly grouped in cluster 14 (Networks and knowledge transfer), and in cluster 10 (marketing strategy), and 12 (KM systems and technology). They might be the cognitive background of the 'socialization school' as identified and labelled by Mehrizi and Bontis (2009) when they mapped the dimensions of KM from a content-related perspective.

In another sense, as indicated in prior studies, intellectual capital is a theoretical ground in which KM has been built (Dattero, 2006; Lambe, 2011; Serenko et al., 2010). Although some empirical findings have demonstrated the prominence of this topic in KM research (Ramy et al., 2017), we notice that few authors focus on this topic, and no community dealing with intellectual capital has been formed. Besides,

we notice that previous studies focused on publication trends have demonstrated the fragmented character of KM (Dattero, 2006). Nevertheless, by examining cited authors using social network analysis, we observe a field with homogeneous features. Network properties and co-citation relations by sub-periods are clear evidence of this statement. In our opinion, fragmentation should not be understood as a diversity of thematic areas but as a disconnection between them. Thus, this low fragmentation in the intellectual structure of KM might be considered as a positive sign around this evolutionary process, which, could be even interpreted as a kind of academic maturity (Serenko et al., 2010; Serenko & Dumay, 2015a).

5 Concluding notes

In conclusion, this paper represents the first examination of the evolution of KM employing ACA. As a young field, KM may lack theoretical gaps and epistemological maturity, but through the evolution of its socio-cognitive structure, we observed a knowledge field with coherence and integration. There is a core community of influential authors, through which the strategic nature of the KM is proven. Despite that this strategic dimension has been a constant in the intellectual structure of the field, other dimensions cannot be discarded. In the end, major tendencies around the evolution of KM evidence a technological dimension very influential in the first sub-period, a strategic one strengthened in the second sub-period, and a social one during the last period analysed. In general, the results obtained here are very consistent with historical and empirical findings that have been found in earlier literature.

Methodologically speaking, bibliometrics offers techniques and tools that can enrich the empirical evidence from new data, variables and indicators. In that sense, we motivate the academic community to develop future research in order to enrich KM's body of knowledge.

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Author Contributions

Carlos Luis González-Valiente (carlos.valiente89@gmail.com) proposed the research idea, designed the research, drafted and revised the manuscript. Magda León-Santos (magdaleon@fcom.uh.cu) and Ricardo Arencibia-Jorge (ricardo.arencibia@eti.biocubafarma.cu) performed the research and revised the manuscript.

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Appendixes

Appendix 1. Cluster descriptions by sub-periods.

Sub-period	Cluster name	Size (colour)	Top author	ACC
1986–1996	(1) K-based theory	6 (red)	Spender, JC	8
	(2) K-based systems	6 (green)	Skuce, D	9
	(3) Technology-based strategy	5 (blue)	Sanchez, R	7
	(4) Decision support systems	3 (yellow)	Holsapple, CW	11
1997–2006	(5) Strategic management	11 (red)	Grant, RM	156
	(6) K-based theory	10 (green)	Nonaka, I	286
	(7) Organizational learning and behaviour	9 (blue)	Senge, PM	134
	(8) KM foundations	9 (yellow)	Davenport, TH	229
2007–2015	(9) Strategic management	41 (red)	Grant, RM	229
	(10) Marketing strategy	26 (green)	Hair, JFJ	168
	(11) KM foundations	23 (blue)	Nonaka, I	382
	(12) KM systems and technology	22 (yellow)	Alavi, M	202
	(13) Organizational theories	19 (purple)	Wenger, EC	275
	(14) Networks and knowledge transfer	12 (cyan)	Hansen, MT	251
	(15) Organizational leaning and behaviour	9 (light blue)	Pfeffer, J	174

Note. Top author was selected according to the highest citation weight. ACC: average citation in cluster.

Appendix 2. Top 10 authors by sub-periods.

	Author	Discipline	Affiliation	RCFq*
1986–1996	Skuce, D	Computer science	Ottawa Univ	0.165
	Holsapple, CW	Management science	Univ Kentuchy	0.094
	Spender, J-C	Management	Kozminski Univ	0.076
	Nonaka, I	Business administration	Hitotsubashi Univ	0.065
	Bonczek, RH	Computer science	Illinois Univ	0.065
	Sanchez, R	Technology Strategy	Copenhagen Bus Sch	0.053
	Nelson, RR	Economics	Univ Manchester	0.047
	Hedlund, G	Economics	Stockholm Sch Econ	0.047
	Von Hippel, E	Economics	MIT Sloan Sch Manag	0.047
	Kogut, B	Management	Univ Penn	0.047
1997–2006	Nonaka, I	Business administration	Hitotsubashi Univ	0.144
	Davenport, TH	Management; Business	Harvard Univ	0.091
	Polanyi, M	Physical chemistry	Manchester Univ	0.041
	Grant, RM	Economics	Georgetown Univ	0.038
	Leonard-Barton, D	Business administration	Harvard Univ	0.035
	Brown, JS	Computer and Communication Sciences	Xerox Corp	0.034
	Alavi, M	Information systems; Computer Science	Emory Univ-Atlanta	0.031
	Hansen, MT	Business administration	Univ Calif Berkeley and Berkeley National Lab	0.029
	Teece, DJ	Economics	Univ Calif	0.028
	Wenger, EC	Artificial inteligence	Social Capital Grp	0.027
2007–2015	Nonaka, I	Business administration	Hitotsubashi Univ	0.074
	Davenport, TH	Management; Business	Harvard Univ	0.037
	Grant, RM	Economics	Georgetown Univ	0.025
	Alavi, M	Information systems; Computer Science	Emory Univ-Atlanta	0.024
	Teece, DJ	Economics	Univ Calif	0.018
	Hansen, MT	Business administration	Univ Calif Berkeley and Berkeley National Lab	0.017
	Wenger, EC	Artificial inteligence	Social Capital Grp	0.016
	Polanyi, M	Physical chemistry	Manchester Univ	0.015
	Kogut, B	Management	Univ Penn	0.014
	Barney, JB	Sociology; Administrative Sciences	Ohio State Univ	0.014

Note. Information on disciplines and affiliations were obtained from online profiles. Latest academic degrees and affiliations were considered. *RCFq: relative citation frequency.