Tracing the historical origins of knowledge management issues through referenced publication years spectroscopy (RPYS)

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Abstract

Purpose – *This study, using a new method called Referenced Publication Years Spectroscopy (RPYS), aims to examine the most important historic works written in the area of knowledge management (KM).*

Design/methodology/approach – *Preliminary data of this study have been extracted from Web of Science through scientometric methods. The references used in all the papers in the core journals in this field since 1980 to the end of 2014 were studied.*

Findings – *The distribution of resources in the area of KM based on the publication year indicates that this field of study, during time intervals 1900 to 1980, has seen eight major mutations. A considerable influence of such fields as economics, business, social networks analysis, organizational learning and economic sociology on the realm of KM is evident. The association of Polanyi with the mutations of 1958, 1962 and 1967 suggests his obvious influence on the evolution of KM. The ratio of articles to books among the whole documents detected by RPYS was 2-13 which could direct us to the point that the channel for information transformation in KM is more focused on books than on articles.*

Originality/value – *None of the few studies done by scientometric methods in the realm of KM has been seen through the issue of the historical origins of this area. This piece of research, using a new scientometric method, can be considered the first study in which the origins of KM over time have been studied.*

Keywords *Citation analysis, Knowledge management, Bibliometrics, Referenced publication years spectroscopy*

Paper type *Research paper*

1. Introduction

Citation analysis can show the formation of knowledge, creation of new ideas and discoveries through the passage of time. Because citations function as linkage between scientific works, citation records provide an opportunity to detect the most influential works on a specific topic or a field of study (Comins and Hussey, 2015a, 2015b). Most studies of citation analysis focus on the cited approach instead of the citing approach, but it should be noted that by citing perspective one can confine citation analysis to some particular research areas. Of course, to do this, one must first select the relevant publications and then analyze their references as well. This method provides a good way to detect the most effective previous works which have left tremendous impacts on one or several fields of study (Bornmann and Marx, 2013).

One of the new techniques of scientometrics, which is concerned with the reference analysis of articles and can provide access to the above objective, is "Referenced Publication Years Spectroscopy" (RPYS). This quantitative approach, which is one of the

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> **"Docility becomes a vital tool in individual learning and increasing competitive fitness as a knowledge sharing and advice giving tool."**

subareas of scientific historiography, has recently been introduced by Marx *et al.* (2014) and benefits from citing perspective. According to the pioneers, this approach can be used to identify the historical roots of different research areas and contemplate the impacts of these historical origins on current studies by a scientific approach. In other words, RPYS is one of the scientometric methods that can identify effective scientific mutations in a given field of study.

RPYS method is based on frequency analysis of the references which have been cited in the scientific publications of a particular area based on their publication years. By this method, the origins can be mapped in the form of swaying curves that their mutations represent the year in which the works have been cited frequently. After identifying these years, which have played an important role in the formation of the relevant area, works should be explored regarding to each year separately and their contribution to the formation of area under investigation should also be considered (Marx *et al.*, 2014). Admittedly, it should be noted that these works and their historic contribution should be carefully reviewed by those who are experts in the field.

Given above considerations and the possibility of RPYS in gaining a better understanding of the historical origins in different disciplines, the objective of this study is to examine, identify and analyze the most important and influential works in the history of knowledge management (KM) with a scientific approach. As mentioned above, applying RPYS can pave the way for achieving these goals. These results could be useful for KM researchers and practitioners to gain a better awareness of seminal works in the origin of the field.

The remainder of this article is organized as follows. Section 2 offers a literature review of the related works. The next section outlines the methodology. Research findings and discussion of the analysis are presented in Section 4. The paper ends with the limitations of the approach, a number of implications and conclusions drawn from this study.

2. Literature review

"KM publications in general focus on knowledge in organizations, knowledge-based, theory of the firm, strategy, and knowledge creation. Even though KM discipline is relatively a new research discipline, it has already boasted a number of scientometrics research with the purpose of gaining better understanding of its identity" (Sedighi and Jalalimanesh, 2014). Using an author co-citation analysis, Ponzi (2002) studied the intellectual structure and interdisciplinary breadth of KM in its early stage of development during 1994-1998. Results indicated that the interdisciplinary breadth surrounding KM mainly occurs in the discipline of management. Empirical evidence suggests that the discipline of Computer Science is not a key contributor as originally hypothesized. Serenko *et al.* (2011) investigated the presence of the superstar (or Matthew) effect in the knowledge management and intellectual capital (KM/IC) scholarly discipline. Findings revealed that the KM/IC discipline represents a very young, attractive academic field that welcomes contributions from a variety of academics and practitioners. Lee and Chen (2012) investigated the intellectual structure of KM by examining a total of 10,974 publications in the field from 1995 to 2010. The results of their study reflected that the coverage of key KM papers has expanded into a broad spectrum of disciplines.

Ribiere and Walter (2013) provided a keyword frequency and content analysis of all 235 journal articles published in the journal of *Knowledge Management Research & Practice* (*KMRP*) between 2003 and 2012. Results of keyword analysis revealed a continuing strong interest in research topics related to knowledge sharing, case studies, IC, knowledge creation and transfer, organizational learning and KM strategy. Findings of text mining tool (Leximancer) uncovered the main themes as follows: organizational knowledge, strategic KM, operational KM, social KM, KM systems development, KM systems implementation, KM projects, groups and people. In continuation of previous research, Walter and Ribiere (2013) conducted a citation and co-citation analysis of 10 years of KM theory and practices. They studied all the 256 articles published in the journal of *KMRP*. Results indicated the most cited articles in KM. Moreover, the co-citation analysis of the 100 most cited articles in *KMRP* publications showed that four groups of topics emerged, one around communities and situated learning, the second group around networks, knowledge transfer and research methods, a third group around the foundations of KM and a fourth group around intellectual capital. In a more recent study, Sedighi and Jalalimanesh (2014) identified the research trend in the field of KM by presenting a systematic and analytical scientometrics approach based on data from the Web of Science (WoS). The co-word occurrence analysis for mapping KM research topics showed that the structure of fundamental subject areas within the field of KM has changed and expanded dynamically during 2004-2010. There are other KM studies using scientometric methods, including Chauvel and Despres (2002); Serenko and Bontis (2004, 2009); Nonaka and Peltokorpi (2006); Guo and Sheffield (2008); Serenko *et al.* (2010) and Dwivedi *et al.* (2011).

On the other hand, because the method RPYS has recently been proposed, there is paucity of research using it, but, even during this short period of time, a few studies have been carried out mainly by the designers of this method which has been published in prestigious journals. These pioneer studies are mentioned here. Leydesdorff *et al.* (2014) using RPYS explored the documents in the field of scientometrics indexed in WoS. Their results led to identification of several basic works in the realm of scientometrics. More specifically, the survey results indicated that scientometrics has its primitive roots in the period between 1920s and 1950s, especially under the influence of scholars such as Lotka in 1926; and it was then then shaped intellectually by confluence of topics such as the history of science (Derek de Solla Price), bibliographic coupling (Michael Kessler), and "citation indexing" (Eugene Garfield).

Wray and Bornmann (2014) have used RPYS in the core journals of the philosophy of science. They came to conclusion that the most influential works in the field, unlike the disciplines of pure sciences, have emerged in the form of books. Their research led to the identification of seven mutations during 1900-1970. Marx *et al.* (2014), also using the same method, conducted a similar study on the solar cells' scientific productions and identified and analyzed the most important works in the area. Using RPYS, Marx and Bornmann (2014) tried to reveal the origin of a scientific legend named "Darwin finches". Their results showed that a book written in 1947 by Sulloway is the most cited early work within the relevant literature and, scientifically, is the origin of the phrase "Darwin finches".

"In practice, docility elevates learning processes, through in-house training programs that cultivate strong social interaction and knowledge sharing, while diminishing knowledge barriers, silos and frictions, to address attention scarcity."

> **"Knowledge organizations must go well beyond balancing the technical needs of physical assets and machinery with conventional workforce systems like recruiting employees with superior formal education."**

Barth *et al.* (2014) using RPYS method examined the historical origins of the Higgs boson. Their results revealed that the major works in this realm were formed in the 1960s, so that seven works were conducted during this period of time. Using RPYS, Soheili and Khasseh (2015) investigated the historical roots of information behavior research based on WoS records. Results uncovered six peaks during 1900-1969 in the field of information behavior in 1948, 1954, 1957, 1960, 1965 and 1967. The researchers concluded that information behavior research has been shaped intellectually by fields such as psychology, quantitative and qualitative methodologies, etc.

Comins and Hussey (2015, 2015b) on the basis of a study performed by RPYS examined a ranked normalization method to summarize the multiple results of RPYS in to a single and standing indicator. They believed that rank transformation can increase the efficiency of this method through paving the way for simultaneous analysis of the results gained by RPYS. Cummins and Hussey (2015) in another study examined the impact of works in the area of Global Positioning System by RPYS. They found that this quantitative method plays a very important role in identifying the impact of financial institutions, universities and organizations for the promotion of specific research areas. Cummins and Hussey in their research, besides the emphasis on the importance of RPYS, focused on the point that the use of subject expert's opinions could promote the value of such studies.

3. Research methodology

Preliminary data of this study, conducted to investigate the historical roots of research methods topics, have been extracted from WoS database. Because of the necessity for a full understanding of the scope of KM by RPYS, the references used in all documents from 1980 to the end of 2014 published in core journals of this field of study were analyzed. The reason for selecting this period of time was because of the access restrictions to WoS. Initial investigations showed that, at present, there are two core journals in KM covered by WoS, which are not old enough to be included in our analysis. Naturally, the records contained in these two journals could not be a good scale for data gathering. For this reason, all the articles published in Thomson citation indexes with a focus on "knowledge management" were retrieved by the following search strategy:

TOPIC: ("knowledge management")

Time span: 1980-2014. Indexes: SCI-EXPANDED, SSCI, CPCI-S, CPCI-SSH.

This search strategy resulted in retrieving 15,305 records. Then, the corrected data were analyzed using an application peculiar to RPYS (Leydesdorff, 2015). Next, two files titled ≪rpys.dbf≫ and ≪median.dbf≫ were produced. The former refers to the numbers of cited references per year and can be used to map data spectroscopy. The latter refers to the deviation of the number of cited references in each year from the median in a five-year period. After designing both curves in the Excel, the years with mutations were identified and the number of references to works published in these years were extracted and then analyzed by subject specialists.

4. Research findings

4.1 Period 1900-1950

The Figure 1 below shows the distribution of references in the records of KM on the basis of their publication dates. According to the Figure 1, between 1900 and 1950, the area of KM has witnessed three distinct peaks which occurred in 1934, 1945 and 1949, respectively.

The results and details of any of the historical mutations detected are summarized in Table I.

As comes from Table I, three out of four most referred works related to the period 1900-1950 are books. RPYS suggests that historically the year 1934, with the publication of Schumpeter's work named "*The Theory of Economic Development*", is an important milestone in the history of KM issues and entrepreneurship as well. Joseph Schumpeter (1883-1950) is one of the most influential economical figures of the twentieth century, whose book, despite the passage of more than 80 years since the release of the English version, continues to be one of the most famous and influential works of the world's economy. Schumpeter, in his book, which is actually one of his central works, has emphasized the need to distinguish between internal and external factors affecting the development cycle. He believed that economic growth and development in a system would be possible when people in other sections of society carry out innovation with a risk approach and, in this way, replace new and efficient methods and solutions with the previous inefficient solutions. Therefore, the development, in the vision of Schumpeter, comes more from initiatives than external factors (Schumpeter, 1934, p. 36). He looked at "innovation" as the driving force and the main axis of developing economics, and, perhaps, that is why MacCrow in his work has called Schumpeter as "Prophet of Innovation" (McCraw, 2007). Knowledge, in

Figure 1 Results of RPYS analysis in the realm of knowledge management (period 1900-1950)

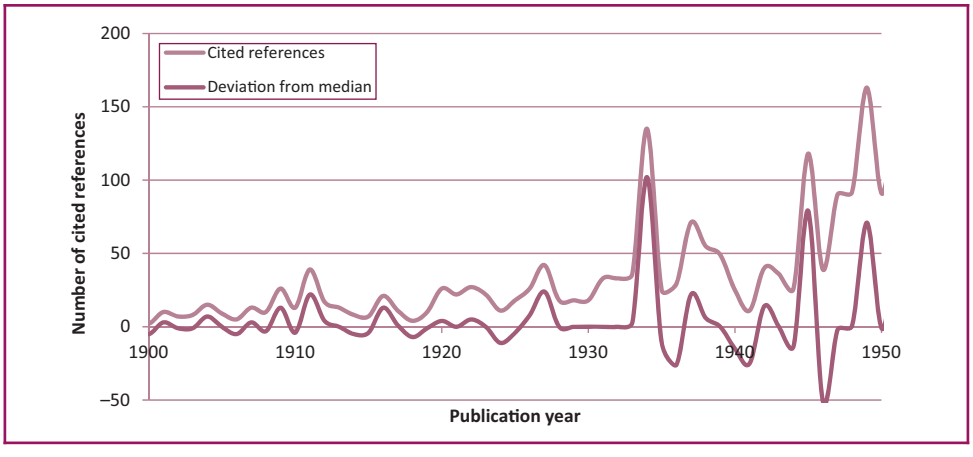

Table I Historical mutations in the realm of knowledge management, with the most cited works between 1900 and 1950

Intervals	*Total references*	*Most referred works*	*No. of references per each document*	*Type of document*
1934	135	Schumpeter (1934)	89	Book
1945	118	Hayek (1945)	59	Article
1949	163	Shannon and Weaver (1949)	53	Book
		Ryle (1949)	43	Book

Schumpeter's view, acts as an internal factor which stems from the individual and collective experiences of people within the companies (Pakbaz *et al.*, 2014). Schumpeter noticed the role of knowledge in innovation and economic dynamism and introduced it as a basis for entrepreneurship and economic development.

The second historic leap, as the first one, is linked with the name of an Austrian economist. Friedrich Hayek (1899-1992), the winner of the Nobel Prize for Economics in 1974, gained a great reputation for his works on "The Theory of Money" and "economic fluctuations". He, in a very important and historical article entitled "The Use of Knowledge in Society", published in the journal of *American Economic Review*, investigated the relationship between economic order and knowledge. "Dispersed knowledge" and "spontaneous order" were among the key concepts in his 1945 article. From the Hayek's point of view, the knowledge required is no way centralized or consolidated, but the knowledge that people have is sporadic in different sectors of the society (Hayek, 1945). Considering the distinction between scientific and non-scientific knowledge, Hayek believes that there are series of important but unorganized knowledge that, in the common sense, cannot be called scientific. Unscientific knowledge emphasized by Hayek is unique and can vary from person to person. Therefore, to apply this kind of knowledge in a society, people must actively participate in the decisions process (Hayek, 1945). Hayek's article was chosen by the *American Economic Review* journal in 2011, as one of the top 20 articles of the journal over the past 100 years (Arrow *et al.*, 2011).

As can be seen in Table I, 53 out of 163 total references in 1949 mutation are dedicated to Shannon and Weaver's book titled *Mathematical Theory of Communication* and Gilbert Ryle's book entitled *The Concept of Mind* (with 43 frequencies). Shannon (1916-2001), the American mathematician and electrical engineer, is known as "the father of information theory" because of conducting basic studies in the field of transfer of information. The book *Mathematical Theory of Communication* is the most famous work of Shannon. From the perspective of Shannon, information is a set of encoded messages which can be conveyed through a special communication channel between the transmitter and receiver. The importance of communication has often been neglected in the field of KM literature (Kimble, 2013). KM, over the years, has created different schools of thought one of which is information theory (McInerney, 2002).

Gilbert Ryle (1900-1976), a well-known philosopher of the twentieth century, in his most cited work of the 1949 and also his most important work, has discussed the analysis of the philosophy of mind. Philosophy of mind, as one of the important philosophical schools of the twentieth century, attributes a major part of philosophical problems to the improper use of language. Ryle, in his book *The Concept of Mind*, distinguishes between two different kinds of knowledge: propositional or factual knowledge (knowing that) and practical knowledge (knowing how) (Ryle, 1949, p. 16). The former type of knowledge is theoretical, but the latter is experimental. This kind of categorization somehow inspires Michael Polanyi's distinction between tacit and explicit knowledge which will be referred to in the following lines. The main purpose of Ryle's book, as Copleston (1951) states, was not providing new information about the human mind, but his aim was to reform the state of knowledge that was previously painted in the minds of human beings.

4.2 Part II: the period 1951-1980

Figure 2 shows the distribution of references in the field of KM on the basis of their publication year in the period 1951-1980.

As can be seen in the graph below, the period 1951-1980 is accompanied with five mutations in the field of KM which have accrued, respectively, in 1958, 1962, 1967, 1973 and 1978.

As Table II shows, three out of five historical mutations are germane to Michael Polanyi, and this influential figure has made up the highest number of references in historical mutations of 1958, 1962 and 1967. Although KM as a field of study was welcomed in the early 1990s

Figure 2 Results of RPYS analysis in the realm of knowledge management (1951-1980)

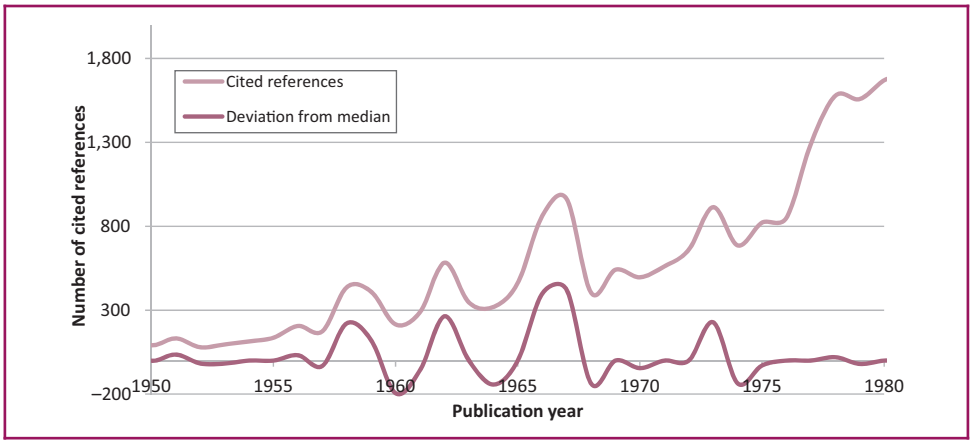

Table II Historical mutations in the realm of knowledge management, with the most cited works between 1951 and 1980

Intervals	*Total references*	*Most referred works*	*No. of references per each document*	*Type of document*
1958	437	Polanyi (1958)	170	Book
		March and Simon (1958)	73	Book
1962	583	Polanyi (1962)	138	Book
1967	963	Polany (1966)	208	Book
		Glaser and Strauss (1967)	142	Book
		Thompson (1967)	74	Book
		Lawrence and Lorsch (1967)	57	Book
1973	914	Granovetter (1973)	159	Article
1978	1,578	Argyris and Schon (1978)	262	Book

and a large body of scientific literature was written in this period (Sorenko and Bontis, 2004), it is clear that most of the references of this area are related to documents that were published about 50 years before that date. The results of Sorenko and Bontis' research on the field of KM from the beginning to 2003 showed that Polanyi, owing to writing two books entitled *Personal Knowledge* and *Tacit Dimension*, is the second most cited author in the field of KM. Polanyi (1891-1976), in his short introduction to the book *Personal Knowledge*, has stated the purpose of writing the book was to explore the nature and grounds of scientific knowledge under the influence of Gestalt psychology.

He looked at knowledge as an active understanding of objects through the use of special skills and believed that all human knowledge is, in fact, rooted in personal feelings and commitments (Polanyi, 1958, p. 4). However, he stressed the need to make a distinction between personal knowledge and tacit knowledge. As Table II shows, Polanyi's revised work in 1962 has been referred 138 times out of total references of this year. Tacit knowledge is among the most important issues to the field of KM. This type of knowledge, according to Nonaka and Takeuchi, is a personal knowledge derived from personal experiences, which may be conditioned by intangible factors such as personal belief, intellectual perspective and value system (Nonaka and Takeuchi, 1995). The triggering point for introducing this concept by Polanyi in 1950 was the assumption that he had mentioned in the opening pages of the book *Tacit Dimension*: "We know more than we can tell"(Polanyi, 1966). Although Polanyi's two books are among the most cited works in the field of KM, some experts believe that the lack of a detailed study into the views of Polanyi by citing authors has led to misperceptions

about the nature of tacit knowledge, compared to what Polanyi considered himself (Grant, 2007), so that Haldin–Herrgard, during their review of articles and books published in the field of KM in the period 1956 to 2002, identified 23 different definitions of the term "tacit knowledge" (Haldin-Herrgard, 2004).

The second most referred work of 1958 mutation is related to the seminal work of James March and Herbert Simon entitled "*Organizations*". According to the statistics of Google Scholar, this book, among other works of March, with a total of 21,251 citations, is in second place after the book *A behavioral theory of the firm*. March, as a management expert and economist, in collaboration with people like Herbert Simon (1916-2001), the winner of the Nobel Prize for Economics in 1978, opened new perspectives to the field of organizational studies, in particular, topics such as organizational behavior and learning. Common views of Simon and March about the importance of decision-making process within organizations, led to the creation of a book that is now regarded as a reference book by the experts of different disciplines, including KM. The two in their book decided to summarize and evaluate the classical models of decision-making while introducing a new model in this regard. In the context of KM and organizational learning, Herbert Simon's theory of "*bounded rationality*" is of great reputation. Simon, in an article with the same title, has enumerated three basic qualities for the work force associated with knowledge creation in organizations: employee motivation, employee rotation and the level of human capital (Simon, 1991).

Two out of four mutations in 1967, similar to the work of March and Simon, are directly related to the "organizations" with a total of 131 referrals. Thompson (1920-1973), the American sociologist, authored "*Organizations in action*" in which he introduced an influential work on the issue of organizations that is known currently as a classic work both in organizational learning and organizational knowledge. Thompson in this work emphasized 95 different propositions on the performance of organizations, regardless of the nature of environment in which they operate. This book was published in a period that the attention of most organizational theorists, rather than the organizations themselves, was focused on the behavior of individuals within organizations.

As Table II shows, "The Strength of Weak Ties" by the American sociologist Granovetter, is the most cited article in the period 1958 to 1978 in the field of KM (The number of citations to this article, according to Google Scholar till July 26, 2015, was 34,364). This work, in terms of its emphasis on the necessity of social networks, is of great importance in the realm of knowledge sharing. The main reason for the importance of Granovetter's article in the field of KM is the insights he has stated into developing information among social networks. Liao and Xiong (2011), in a study inspired by the sociological method of social network analysis and its extension to the scope of knowledge sharing, found that strong ties lead to facilitating the transfer of tacit knowledge and weak ties lead to facilitating the transfer explicit knowledge. On the other hand, Hansen (1999) survey showed that weak ties cannot succeed in transferring complex knowledge.

The mutation of 1978 has been accompanied with the joint work of Argyris and Schon entitled *Organizational learning*, which, since its release, according to Google Scholar, has received 15,397 citations. The two in this work laid the formation of a concept called "*Learning Organization*". Organizational learning, in addition to KM, has a direct relationship with discussions such as organizational communication, organizational behavior and organizational psychology. Knowledge is one of the main indicators of organizational learning and learning within the organization, basically occurs when a change happens in the knowledge level of the components of that organization. Argyris and Schon (1978) focused on two types of learning: single-loop learning and double-loop learning. Over the next years, thinkers such as Daft and Weick (1984); Huber (1991); Nonaka and Takeuchi (1995) and Pawlowsky (2001) expanded other steps of organizational learning.

5. Summary and conclusion

Recently, the study of Shiau *et al.* (2015) uncovered that KM is one of the key issues being studied in leading *Management Information Systems* journals. The effort of this study was to trace the historical origins of KM issues by utilizing a new method called RPYS. The results of investigations on 13 most effective documents in 1900 to 1980 showed that KM issues are rooted in the areas of economics, marketing, social networks analysis, organizational learning and economic sociology, so that specialists of these areas have played a significant role in the formation of basic concepts of KM. The linkage of Michael Polanyi name to the mutations of 1958, 1962 and 1967, with a total of 516 referrals, shows his clear influence on the evolution of KM issues during the years under investigation. The interesting point among the findings of this study lies in the fact that the origin of the theoretical foundations of the emerging areas of research, such as KM, with less than 40 years old, can be hidden in the works published many years before that date. The results clearly confirm this fact that authors and experts of KM in their writings often have referenced to the works which were published more than 50 years ago. Based on the findings, books play an important role in the formation of theoretical aspects of KM in as much as only 2 out of 13 effective works detected by the use of RPYS are dedicated to the article. Finally, 5 of 13 documents studied were written by joint authorship.

5.1 Practical recommendations

Academic researchers should notice that theoretically, many intellectual approaches to KM issues may be rooted in the works published in previous years. Although KM is not very old, as an interdisciplinary field may be influenced by various fields of study. KM practitioners can exploit the operational capabilities of scientometrics as a useful tool to advance their goals. Scientometrics provides an appropriate basis for KM practitioners to identify trends and patterns hidden behind large volumes of unstructured data, converting data into knowledge in a systematic manner.

5.2 Research limitations

Because this is a historical study, using records from WoS may limit the study's results. Although many scientometric studies use records indexed in the WoS, but the limited coverage of WoS in the humanities may affect the results. However, according to the search strategy used to obtain preliminary records, it was tried to include the most appropriate records in the analysis process as much as possible. In addition, although the journals indexed in WoS are international in nature, less non-English articles are indexed in this database, and this can limit results as well.

5.3 Future research

Because this is the first study on KM history, using RPYS, KM researchers can broaden the scope of result achieved by this study to the other citation databases to gain a comprehensive perspective of the historical roots of KM and then compare their results to this one. The researchers should notice that much of the condition ruling the present realm of KM may be rooted in the events and arguments of many years ago. The research provides practitioners with the fact that knowledge-based organizations are more relying on books than articles, and this is a fact that may affect the practice of knowledge sharing in different areas.

It is possible to expand RPYS technique to the other related fields such as information management and then compare its historical roots with KM to uncover a comprehensive perspective about the origins of related areas. Moreover, it is possible to expand the research time span to recent years. It seems to be useful doing a similar study using records indexed in the Scopus, a more comprehensive database than WoS as a subject for future research.

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