Mobile Networks and Applications
https://doi.org/10.1007/s11036-019-01231-9

Mapping the Evolution of Intellectual Structure in Information Management Using Author Co-citation Analysis

Carlos Luis González-Valiente[1] · Magda León Santos[2] · Ricardo Arencibia-Jorge[3] · Ed Noyons[4] · Rodrigo Costas[4]

Abstract

The current big data era has placed new challenges for the study and application of information management (IM). In this paper we visualized how IM evolved over thirty-six years (1980–2015). An author co-citation analysis was applied to a dataset extracted from Web of Science Core Collection®. To map the evolution, a longitudinal perspective was carried out by partitioning three homogeneous sub-periods of twelve years (1980–1991, 1992–2003, and 2004–2015). The 10% of most cited authors in each sub-period were clustered in bibliometric networks and then labeled into research areas. Likewise, we constructed a strategic diagram in order to describe internal relations within clusters and their interactions. Our findings evidenced 14 clusters from 1980 to 2015, representing several topics like *management information systems*, *database systems*, *library automation*, *information management foundations*, *technology-based strategy*, *information technology management*, *health information management*, *personal information management*, and *motivated information management*. The socio-intellectual structure shows a transition from an organizational to an individual approach in the study and application of IM. Our findings also point to an evolution from a technological orientation towards an informational orientation, since in the last sub-period there are mostly information scientists related to the study of information behavior and information retrieval. This study is the most comprehensive bibliometric research oriented to visualize the overall evolution IM.

Keywords Information management · Author co-citation analysis · Social network analysis · Socio-intellectual structure · Science mapping

1 Introduction

Information management (IM) is a field endowed by a diversity of origins, caused by the interdisciplinary nature of informational problems [74]. Many authors trace the formal birth of IM term back to the US Federal Government, and the Paperwork Reduction Act of 1977 [4, 15, 32, 43, 80]. The assumption of information as an organizational resource in the late 1970s became the crucial point for the emergence of IM [43].

By looking at the early stages and development of IM, we find that primary interests of practitioners and academicians were mainly centred on providing conceptualizations, methodologies, practical procedures, and academic programs to establish the rising field [2, 76, 77, 80]. IM was firstly known as *information resource management* [31], a term whose scope was mainly oriented to data management [74]. Since then, its core controversy lies on the interchangeable use with some other concepts like the *management of information technology*, *information systems* or *information policies* [4, 8, 15]. The main reason for this controversy is that nearly

✉ Carlos Luis González-Valiente
carlos.valiente89@gmail.com

Magda León Santos
magdaleon@fcom.uh.cu

Ricardo Arencibia-Jorge
ricardo.arencibia@eti.biocubafarma.cu

Ed Noyons
noyons@cwts.leidenuniv.nl

Rodrigo Costas
rcostas@cwts.leidenuniv.nl

1 National Library of Cuba, Havana, Cuba

2 Department of Information Sciences, University of Havana, Havana, Cuba

3 Empresa de Tecnologías de la Información, Havana, Cuba

4 Centre for Science and Technology Studies (CWTS), Leiden University, Leiden, The Netherlands

Published online: 22 February 2019

every IM project requires the inclusion of information systems (IS) and information technologies (IT) to manage information. On the one hand, IT encompasses technical issues, while, on the other, IS encompasses physical entities and social systems [4].

Conceptualizing IM in a consistent way has been always a bone of contention across the literature [15, 40, 63, 65], particularly given the interplay of a large number of disciplines such as computer science, organizational behavior, strategic management, system analysis, information science, librarianship, and management [22, 30, 65, 72]. On top of that, it is a field whose core management object is "information", a truly ambiguous concept highly submitted to several definitions [85]. Such definitions differ according to the practical, academic and scientific context of certain disciplines, but their clarification will not be the aim of discussion in this paper. We accept the complexity of informational studies, which also affects IM.

Rowley [65] provides a disciplinary vision of IM, assuming that is "a practice-based discipline that has both technical, most broadly in the sense of systems based, and behavioral dimensions" (p. 361). Rowley's framework considers a structure of the knowledge, research and practice in the area, which has four basic study levels: information retrieval, information systems, information contexts, and information environments. In our opinion, relevance in Rowley's conceptual framework lies in its transversal character, as it conceives the wide spectrum in which IM can be applied. Nevertheless, IM concept is generally operationalized from a process-oriented perspective, considering those processes involved in the information lifecycle [8, 15, 58]. Although there is a lack of consensus regarding such information processes, Detlor [15] considers the following as predominant processes: "information creation, acquisition, organization, storage, distribution, and use" (p. 104). He also emphasizes three main perspectives of the study of IM: the organizational, library, and personal perspectives. The organizational perspective attempts to manage all processes in the information lifecycle in order to achieve the strategic objectives of the organization. The most relevant component in this perspective is the management of information technology. The library perspective deals with the management of information collections as the goal is to provide information services and products. Finally, the personal perspective is quite similar to the organizational perspective, but its interest is at the individual level [15].

More than three decades have passed since IM boomed and we encountered few studies focused on defining its socio-intellectual structure employing bibliometric techniques, and more specifically, author co-citation analysis (ACA). The purpose of this paper is to visualize how IM has evolved over thirty-six years (1980–2015), in terms of its most co-cited authors. The paper is structured as follows: this introductory section (1) continues with a literature review to explore some aspects regarding the application of bibliometric techniques to map the socio-intellectual structure of science and the potentiality of ACA for it. Besides, some antecedents and research questions are being discussed. In the methodological section (2), the procedures for data collection and data analysis are described. In the third section (3), the main results are discussed and subsequently, a discussion (4) of the findings is presented, including some final considerations (5).

1.1 Mapping the intellectual structure of science

Liu et al. [42] state that intellectual structure "refers to hierarchical knowledge system consisting of knowledge elements of a discipline and their interrelationships" (p. 738). This knowledge system is usually revealed using citation-based techniques. In bibliometric research, citation rates are processed to measure the impact of research. Moreover, their potential has been demonstrated to explore implicit patterns within the intellectual base or structure that represent the ideas contained in the literature produced. Along with that line, Olle Persson [55] describes a distinction between research front, composed by the citing documents and intellectual base, formed by the cited literature. Both perspectives of analysis require different mapping methods, as research front can be described by bibliographic coupling while intellectual base by co-citation techniques.

Citations, bibliographic coupling and co-citation analysis are useful procedures to map scientific research [5]. They enable us to reflect on the socio-cognitive structure and evolution of science [3]. Such analyses tend to map different units across the scientific literature like documents [68], disciplinary categories [48], journals [46], authors [78] and words [82]; manifesting the possibilities of these bibliometric techniques to visualize the thematic composition of science. At the time to select authors for the analyses, Zhao and Strotmann [84] refer that co-citation has been a dominant technique compared to bibliographic coupling. They also introduced the *author bibliographic-coupling analysis* (ABCA) as an effective approach to examine the intellectual structure of research fields. Nevertheless, our interest will only focus on the intellectual influences indicated by highly cited authors in IM and not in their producers.

1.2 Author co-citation analysis (ACA)

Two publications are co-cited when there is a third publication citing both publications. This notion was introduced at the beginning of the 1970s by Marshakova [45] and Small [68], researchers who made their explorations using individual documents. Later on, White and Griffith [78] pioneered the selection of authors as units of analysis by displaying the most cited researchers in Information Science and their classification in groups (or schools). Nowadays, the employment of this technique has increased in a wide diversity of research fields [36].

ACA is useful to visualize science field dynamics. In the construction of bibliometrics networks the more two authors are co-cited, the stronger the relatedness between the two authors [19]. ACA enables the identification of influential authors and their connections from the citation record [79]. That connection of pairs of authors used to be clustered on bibliometrics maps [78]. Hence, the clustering composition and structure aids us to reflect on the socio-cognitive structure of the explored area [3].

1.3 Antecedents and research questions

Many IM related topics have been subject to ACA with the intention to distinguish their intellectual structure, as for instance management information systems [11, 12], strategic management [38, 50], competitive intelligence [75], and knowledge management [59]. With respect to IM specifically, we find many bibliometric works centred on describing production and collaboration patterns supported by non-citation indicators [37, 43, 66]. Many others have been mostly oriented to reveal publication trends derived from IM journals such as: *SRELS Journal of Information Management* [44], *COLLNET Journal of Scientometrics and Information Management* [61], *Health Information Management* [23], *Journal of Enterprise Information Management* [17], *Trends in Information Management* [53], *International Journal of Information Management* [51], and *Information & Management* [52].

We note that IM research has not been widely examined with citation-based techniques as few papers are found. For instance, Schlögl [67] explored the dimensions of IM by means of ACA, evidencing two major author communities in the intellectual structure, the technology oriented and the information oriented. ACA results derived from Rodríguez and Martínez [64] research displayed a structure where top cited authors are focused on management and organizational studies, medical information systems, and anesthesia information systems. Likewise, Reis et al. [62] examined the evolution of social and intellectual networks in IM to understand the knowledge construction of the area. By building co-authorship and author co-citation networks, they displayed the social relationships and the intellectual structure of IM from 1997 to 2006. An interesting finding here is that, by comparing the mapping results of partitioned timeframes (1997–2001/2002–2006), they could not visualize an evolution in IM. Their co-citation networks exhibited topics completely different in both sub-periods. However, a limitation is that the Reis et al. [62] research was of local relevance as they focused on the Brazilian context only. In that regard, they used the proceedings of Enanpad (most relevant conference about management in Brazil) as data source. Compared to what we intend to examine in this article, the approach of Reis and colleagues was more focused on identifying relationships between researchers and their citation preferences.

Once explored previous literature about our topic of interest, throughout this paper the next research questions (RQ) will be answered:

> **RQ 1**. What research areas do IM authors represent for the sub-periods 1980–1991, 1992–2003 and 2004–2015?
> **RQ 2**. How did IM field evolve over the 1980–2015 period in terms of the research areas represented by authors?

2 Methods

2.1 Data collection

Web of Science Core Collection® was used as a source for data extraction. Given our interest to visualize the evolution of IM, a longitudinal perspective was applied to the study. Dyrby [18] considers the following historical stages as those that define the academic discourse of IM:

1. The 1980s: Introduction of new technological advances.
2. The 1990s: Market globalization and liberalization, fast advances of information technologies, and the introduction of internet in 1995.
3. The 2000s: Electronic economy, and emergence and dominance of online social networks.

Therefore, taking the Dyrby's subdivisions as background, we broke down the dataset in three sub-periods of 12 years (1980–1991, 1992–2003, and 2004–2015). By this procedure, the overlapped maps from different periods provided us with visualizations of what Leydesdorff [41] calls 'structural change in science'. Given the complexity of information related fields, for the search strategy, we considered generic keywords that demonstrate the scope of IM. We tried to include some specific processes of IM like *information creation*, *information acquisition*, etc. but the results were not satisfactory as we obtained many documents not related to the topic. We also found support from some anonymous experts from Cuba, Spain and Brazil involved in the study and practice of IM who discussed and agreed on the reliability of the terms. The query was executed on 10 November 2018 using the terms *information management*, *information resource management*, *data management*, *data resource management*, *information manager(s)*, *information lifecycle/life cycle*, and *information technology(ies) management* in the *TOPIC* field.

The data set was reduced to the indexes: Science Citation Index-Expanded (SCI-EXPANDED), Social Science Citation Index (SSCI), and Arts and Humanities Citation Index (A&HCI). We discarded not citable documents (meeting abstracts, editorials, corrections, book reviews etc.) as they lack bibliographical references, and we selected the standard document types such as *article*, *proceedings paper* and *review* for the period 1980–2015. Finally, we obtained 11, 517 source documents (see Fig. 1).

2.2 Data analysis

VOSviewer (v.1.6.9) a well-known bibliometric software that clusters entities based on similarities by means of VOS technique [20] was employed for the mapping. This bibliometric software automatically creates the co-citation matrix once the files downloaded from WoS are imported in VOSviewer. Our ACA approach was based on first-author co-citations as it provides an intellectual structure with more specialties compared to all-authors co-citation approach [83]. The sample selection consisted of the top 10% of most cited authors in each sub-period due that the number of publications per period varies significantly (see Fig. 1). These calculations were executed after performing a data cleaning and normalization process of author names. In author co-citation networks, names might represent scientific or scholarly specialities, schools of thought, communities of the mind, and even more [69]. Hence, each cluster by sub-period was labelled into research areas according to the research interest, academic background and scientific production of authors. This procedure enabled us to identify the influencing research fields of IM and provided a structure over time.

To reveal evolutionary trends in science, strategic diagrams are usually used as a tool to detect the temporal dynamics of the phenomenon studied. Hence, a strategic diagram was also constructed to describe what Law et al. [39] calls as the "global" and "local" contexts of research fields. The "local context" refers to the strength of links within the same cluster (density), while the "global context" refers to the strength of links between different clusters (centrality). According to Cambrosio et al. [7], *density* is a measure of the coherence of a research field, while *centrality* is a measure of the overall development of such field. Therefore, the higher the centrality of a cluster, the more important it is; while the greater the density of a cluster, the higher its potentiality for development [35].

This diagram is a two-dimensional graph representing the centrality in the horizontal axes and the density in the vertical axes [9, 10, 39]. It situates each research area within the two-dimensional spaces composed of four quadrants from the values of centrality and density of single clusters. This visualization is useful to reflect on the dynamic and evolution of IM. For this study, the diagram was drawn after measuring the mean value of centrality and density of clusters based on Freeman's [21] approach by using UCINET software. Thus, quadrant I (Q.I) grouped core research areas as both density and centrality values were the highest. Quadrant II (Q.II) represented isolated research areas as density values were high but of low centrality measures. Quadrant III (Q.III) displayed peripheral research areas with both lowest density and centrality values. Finally, quadrant IV (Q.IV) exhibited underdeveloped research areas as density values were low but of high centrality.

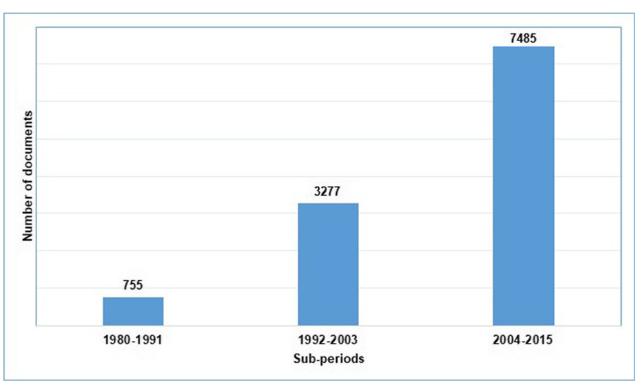


Fig. 1 Number of documents by sub-periods

3 Results

3.1 RQ 1. What research areas do IM authors represent for the sub-periods 1980–1991, 1992–2003 and 2004–2015?

As we stated in the methodological section, co-citation networks are built-up with the top 10% of co-cited authors in each sub-period. Nevertheless, we firstly identify the top 10 co-cited authors by sub-periods, who might be considered as the most representative persons in the IM arena (see Appendix Table 2). All of these authors have the highest citation weights. In terms of the advanced academic degrees, we appreciate a wide multidisciplinary composition being management, business, IS, economics, and computer science the major disciplines of IM figures (see Appendix Table 2).

Concerning the next mapping visualizations, clusters are differentiated by colors; while the edges reflect the relation between nodes of authors and the strength of such relation [19]. By default, VOSviewer assigns numbers to each cluster; however, we provide a consecutive clusters numbering. Likewise, we played with the different parameters of the software to show an adequate grouping of authors and visualizations. Information about the clustering results can be found in Appendix Table 3.

3.1.1 1980–1991 sub-period

The co-citation network in this first sub-period contains 32 authors (see Fig. 2). Four clusters are formed which are labeled and described as follows.

Cluster 1: *Management information systems* (MIS). This red cluster contains the largest community of authors totaling 16. Authors' backgrounds are oriented to the study and application of information systems in management and the strategic use of IT (e.g. Ives, B; McFarlan, FW; King, WR; Rockart, JF; Davis, GB, Dickson, GW). During the 1980s, all of these figures made a strong emphasis on IT and IS integration into the business process, organizational planning, and decision-making.
Cluster 2: *Library automation*. There are 7 authors in this green cluster, positioned at the right side. Authors in this cluster have emphasized the employment of databases, microcomputers and IT within the library context (e.g. Krasnoff, B; Dickinson, J; Saffady, W; Beiser, K; Pournelle, J).
Cluster 3: *IM foundations*. Seven authors contain this blue cluster in which Horton, FW; McFarlan, FW; Porter, ME; Martin, JK; Marchand, DA; Taylor, RS; and Koenig, MED are well-connected. These are the founders of IM, who envisioned information as an organizational resource to be managed in organizations.
Cluster 4: *Database systems*. This cluster in yellow contains two computer scientists (Nolan, RL and Stonebraker, M). These authors have a strong relation with database systems and data processing topics.

The top co-cited pairs within the network according to the link strengths (ls) values between nodes are Dickinson, J and Krasnoff, B (ls: 825); Krasnoff, B and Saffady, W (ls: 264); Krasnoff, B and Puglia, V (ls: 264) and Dickinson, J and Saffady, *W* (ls: 200). They are generally oriented to computational and technological areas. Regarding clusters, we appreciate a strong connection between cluster 1 (MIS) and cluster 3 (IM foundations). Oppositely, authors in cluster 2 (Library automation) have strong internal connections but external links to neighbour clusters are mostly given with the foundational authors (cluster 3) and not with the MIS (cluster 1) and database systems (cluster 4) communities (Appendix Table 3).

3.1.2 1992–2003 sub-period

Corresponding to this second sub-period five clusters are formed (see Fig. 3). For this timeframe, 67 authors are mapped. Their research interests are quite similar to the first sub-period. We visualize how from clusters 1 and 3 there are formed communities better delineated, in this case, devoted to IT management and organizational strategy in the business and management environment. Now, *Library automation* community tends to disappear and it emerges a new one related to health information management.

Cluster 5: MIS. Just as in the first sub-period, this stands as the largest cluster of the map (at left, in red), containing 26 authors. Authors like Benbasat, I; Davis, GB; Dickson, GW; Ein-Dor, P; Hamilton, S; Ives, B; King, WR; Lucas, HC; and Zmud, RW are still composing this community devoted to information systems research.

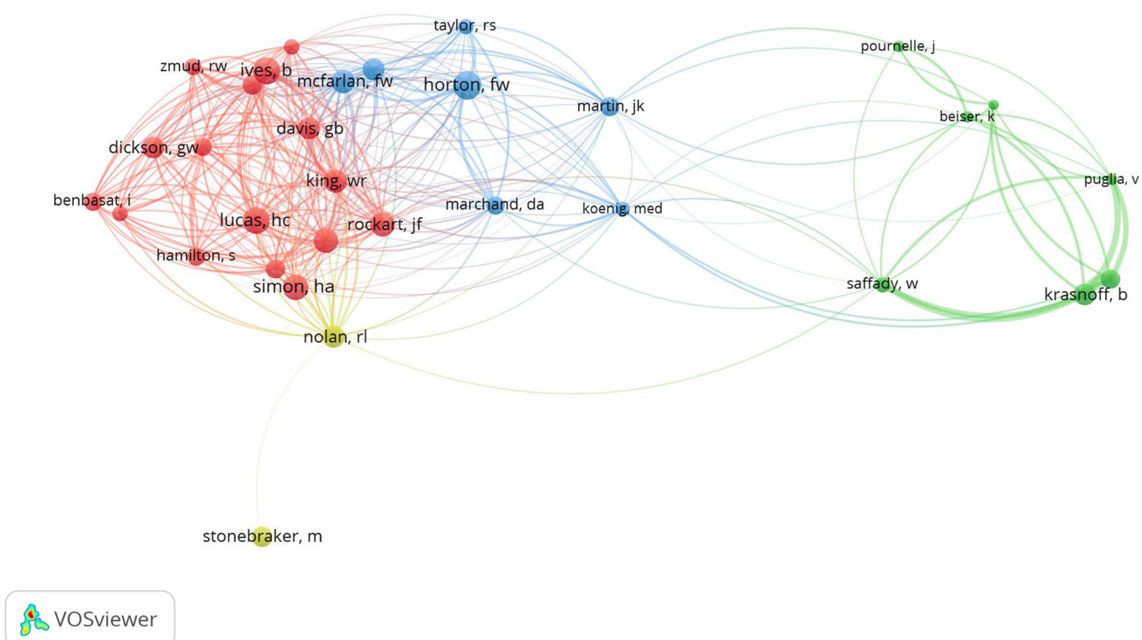


Fig. 2 Co-citation map of authors, 1980–1991. Note: Nodes size indicate citation weights. The minimum strength of links is 10 and the maximum number of links is 500

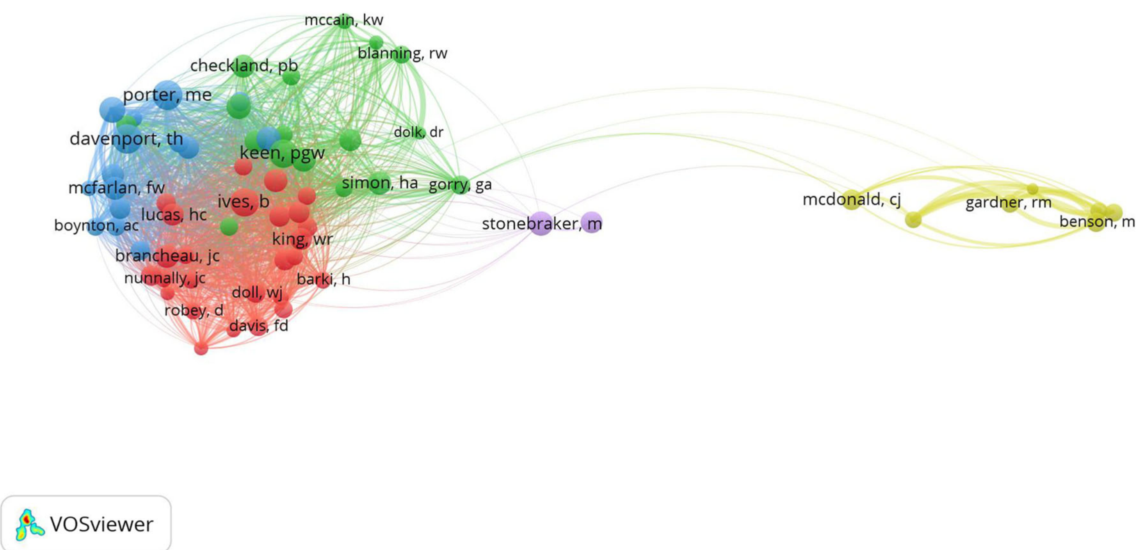


Fig. 3 Co-citation map authors, 1991–2003. Note: Nodes size indicate citation weights. The minimum strength of links is 10 and the maximum number of links is 500

However, new names are visualized like Benbasat, I; Brancheau, JC; Alavi, M; Markus, ML; and Ginzberg, MJ; just to mention a few.

Cluster 6: *MIS-Organizational*. This cluster is colored in green and it comprises 17 authors. This community is well connected with the MIS (cluster 5) and *Technology-based strategy* (cluster 7) communities. Here we find relevant business, management and organizational theorists including Mintzberg, H; Huber, GP; Argyris, C; and Daft, RL. This cluster was not visualized during the first sub-period, nevertheless, we observe some authors coming from cluster 1 (MIS, 1980–1991) who are now included in this group (e.g. Culnan, MJ; Keen, PGW; Mason, RO; and Simon, HA). This community is mostly oriented to topics like innovation, organizational change, organizational learning, organizational behavior, and decision making. It is worth noting that there is a small representation of information systems researchers as well (e.g. Checkland, PB; Sprague, RH; Ackoff, RL; Blanning, RW; Eom, SB). Thus, this cluster is the representation of an organizational approach toward information systems.

Cluster 7: *Technology-based strategy*. Authors within this cluster, at the left side in blue, represent a managerial community devoted to the use and application of IT for the strategic functioning of organizations, as for example Davenport, TH; Earl, MJ; Lederer, AL; Henderson, JC; Malone, TW; Goodhue, DL; Venkatraman, N; Boynton, AC; Cash Jr., JI; and Clemons, EK. This is a community better delineated compared to the first sub-period. By the way, some foundational authors coming from cluster 3 (1980–1991) are present in this technological group (e.g. McFarlan, FW; Nolan, RL; and Porter, EM).

Cluster 8: *Health information management* (HIM). Seven authors belong to this yellow cluster on the right side of the map. This is a completely new cluster representing the medical domain. These authors are focused on the development and application of medical informatics principles for managing information in the health and medical context (e.g. McDonald, CJ; Benson, M; Edsall, DW; Gardner, RM; Junger, A; Evans, RS; Shabot, MM). Their authors denote a different disciplinary domain since it has low connections with the remaining clusters. Most of the linkages are given with the computer scientists Gorry, GA and Simon, HA from cluster 6, and also with Stonebraker, M, an expert in database systems (cluster 9).

Cluster 9: *Database systems*. This is the smallest cluster in the map located in the purple zone. It contains only two authors (Stonebraker, M and Abiteboul, S) representing the research on database systems, just as visualized in the 1980–1992 sub-period. As it can be seen in Fig. 3, they are mostly connected with authors from the communities on MIS (cluster 5) and *MIS-Organizational* (cluster 6).

Summarizing, co-citation results derived from 1992 to 2003 evidence a high relatedness between authors focused on MIS, *MIS-Organizational*, and *Technology-based strategy*, on the left side. Oppositely, we visualize a strong community focused on medicine and anesthesiology, on the right side, but of certain disconnection with the managerial community (see Fig. 3). Major relatedness between authors of the managerial community is given between Blanning, RW and Dolk, DR (ls: 133), Checkland, PB and Argyris, C (ls: 91), and Earl, MG and Porter, ME (75). While Benson, M and Junger, A (ls:

151); and Benson, M and Evans, RS (ls: 132) are linked the most between the medical community.

3.1.3 2004–2015 sub-period

In this map, 115 authors are distributed in six clusters (see Fig. 4). The co-citation network of this third sub-period evidences that MIS is the most represented topic in IM. There is now a better delineation of a community oriented to the management of IT. Likewise, we observe the emergence of topics on personal information management and motivated information management.

Cluster 10: *MIS-Strategy*. This red cluster contains 54 authors, located at the bottom of the map. Over 1980 to 2015 this is the most stable and largest community in IM. In 1992–2003 we found two clusters devoted to MIS (cluster 5) and *MIS-Organizational* (cluster 6). During 2004–2015, these two groups seem to have merged. That is the reason why we label this cluster as *MIS-Strategy* since we find information system researchers (e.g. Davis, FD; Delone, WH; Benbasat, I; Alavi, M; Markus, ML; Chin, WW; Goodhue, DL) and also organizational strategists (e.g. Davenport, TH; Nonaka, I; Porter, ME; Choo, CW; Kaplan, RS; Barney, JB; Eisenhardt, KM; Grant, RM). Some sociologist and social scientists such as Nunnally, JC; and Yin, RK are composing this cluster as well.

Cluster 11: *IT management*. This green cluster contains 28 authors oriented to computer sciences. From 1980 to 2003 we find so many computer scientists, locating mostly in the clusters on MIS. However, it is in this last sub-period where we find a single community covering topics related to the management of IT (e.g. Foster, I; Agarwal, R; Berners-Lee, T; Brazma, A; Halevy, AY; Dean, J; Ratnasamy, S). Database researchers like Abiteboul, S and Stonebraker, M did not form an independent cluster in this sub-period but they are included in this group as well.

Cluster 12: *Personal information management* (PIM). This blue cluster has not been visualized before and it comprises figures with an academic background in the fields of computer science, informatics, human-computer interaction, and information retrieval; but their notorious publications are truly related with PIM. Examples of these authors are Jones, WP; Whittaker, S; Bergman, O; Barreau, DK, Boardman, R; Lansdale, M and Malone, TW. We also find a subgroup of authors whose research interests are on human information behavior including Wilson, TD, Dervin, B, Savolainen, R, and Case, DO.

Cluster 13: *Motivated information management* (MIM). This yellow cluster has 4 authors whose research interest centers on MIM studies, as for instance Afifi, WA; Smetana, JG; Kerr, M; and Bandura, A. This is a new cluster as well in which their authors are mainly connected with the communities on MIS-Strategy (cluster 10) and PIM (cluster 12).

Cluster 14: HIM. This purple cluster of 4 authors was previously visualized in 1992–2003 sub-period. The

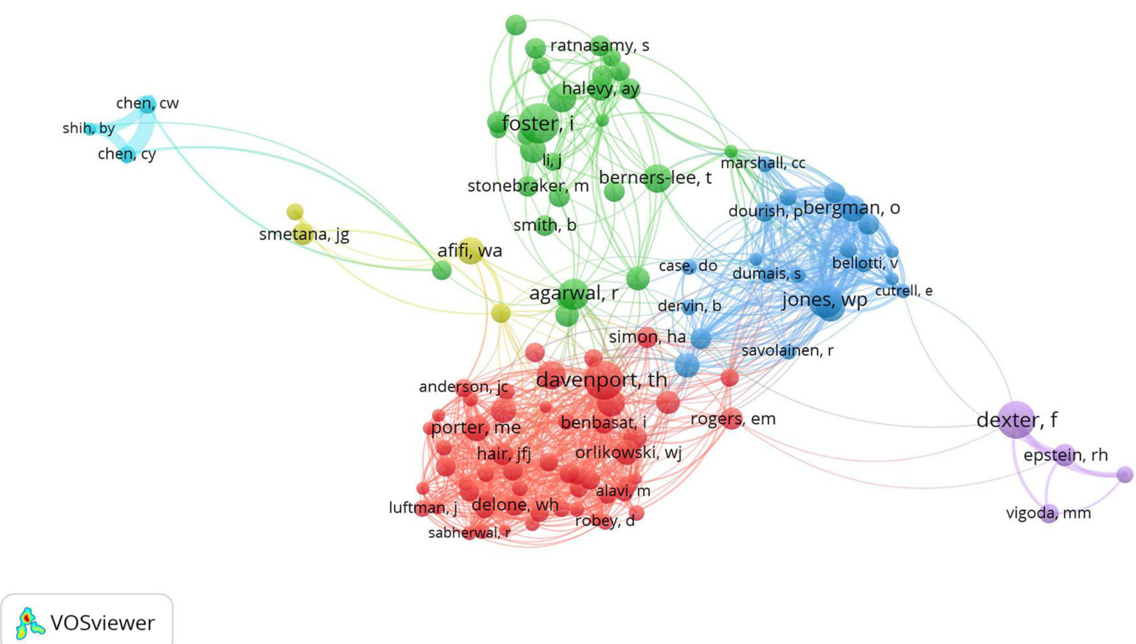


Fig. 4 Co-citation map of authors, 2004–2015. Note: Nodes size indicate citation weights. The minimum strength of links is 10 and the maximum number of links is 500

same pattern is detected as it is lacking of strong connections with the remaining communities. Dexter, F and Epstein, RH tend to be co-cited with authors from the groups on *MIS-Strategy* (cluster 10), *IT management* (cluster 11), and *PIM* (cluster 12).

Cluster 15. *Miscellaneous*. This blue light cluster of 3 authors is labeled as miscellaneous as their authors have different thematic orientations (e.g. Chen, CW; Chen, CY; Shih, BY).

The clustering results for this last sub-period (2004–2015) reveal that *MIS-Strategy*, *IT management* and PIM are the clusters with the strongest citation relations. In the network it is visualized that Wilson, TD plays an important role by connecting the *MIS-Strategy* and PIM communities. Similarly, Agarwal, R connects the communities on *MIS-Strategy* and *IT management*. By means of Karger, DR, the *IT management* and PIM communities are connected as well. Though, the strongest citation relations in the network are of internal type. That is, the top co-cited authors are those who belong to the same cluster as for instance Chen, CY and Chen, CW (Miscellaneous, cluster 15); Dexter, F and Epstein, RH (ls: 521) (HIM, cluster 14); and Bergman, O and Whittaker, S (ls: 371) (PIM, cluster 12).

3.2 RQ 2. How does the IM field have been evolving over the 1980–2015 period in terms of the research areas of authors?

In this section, a strategic diagram is displayed according to density and centrality data of individual clusters (see Table 1).

Note: Cluster 15 (Miscellaneous) was not considered for the strategic diagram.

For the first sub-period (1980–1991), topics like MIS and *Database systems* are under-developed as they are located in quadrant IV (see Fig. 5). They tend to lose internal connections; though, they have called the attention of external authors. *IM foundations* has an immature character given its position in quadrant III. The centrality and density of this community are low, so their authors tend to lose internal and external connections. *Library automation* stands for the core of the intellectual structure in this period, given its position in quadrant I. Both *IM foundations* and *Library automation* are topics only visualized during this early stage of IM field. On an individual level, we found some foundational authors included in clusters during 1992–2015; however, the *Library automation* community disappears from 1992 onwards.

For the second sub-period (1992–2003), MIS stands still in an under-developed position, while *Database systems* becomes a peripheral topic because of the decrease in its centrality measures (see Fig. 6). Joined to MIS, the *MIS-Organizational* community stands as an under-developed area as well, while the *Technology-based strategy* locates in a converging zone between quadrant III and IV. We note that the *MIS-Organizational* and the *Technology-based strategy* communities have higher density measures than the MIS community. That is, they are less important than MIS, but their coherence as topic is higher because of the strong internal co-citation relations. HIM is a topic that emerges during this second stage. It locates in quadrant I, thus, it is the most important and well-developed topic. This core character of HIM it is beside visualized during the last period analyzed (see Fig. 7).

In 2004–2015, MIS keep standing as an under-developed topic but it tends to lose internal connections with respect to the previous periods. PIM appears as a new topic with the highest centrality measures located in quadrant IV. This under-developed community becomes the second most important in this time-frame. The low centrality and density measures of MIM and *IT management* make them appear in a peripheral zone. Even though *IT management* is the second

Table 1 Centrality and density measures by clusters over time

Research area	1980–1991 Centrality	Density	1992–2003 Centrality	Density	2004–2015 Centrality	Density
MIS	397	26	331	13	404	8
Library automation	685	110	–	–	–	–
IM foundations	177	30	–	–	–	–
Database systems	467	15	170	19	–	–
MIS- Organizational	–	–	265	17	–	–
Technology-based strategy	–	–	249	18	–	–
HIM	–	–	442	74	447	159
IT management	–	–	–	–	149	6
PIM	–	–	–	–	751	36
MIM	–	–	–	–	17	57

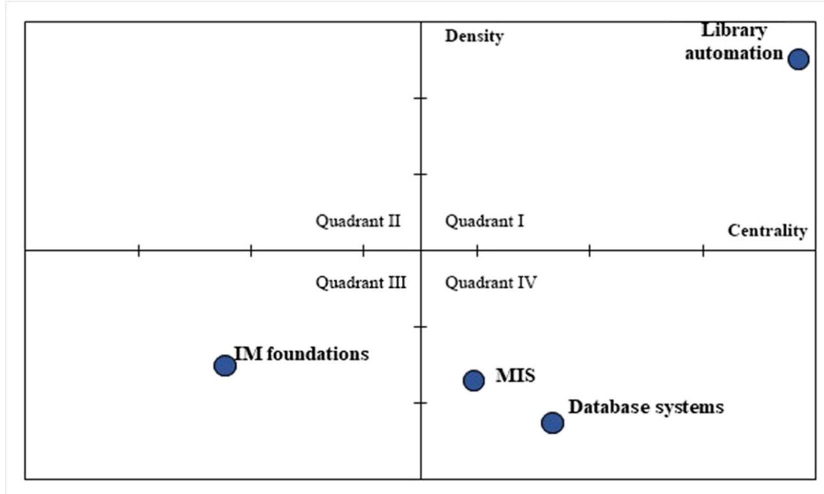


Fig. 5 Strategic diagram of IM research areas, 1980–1991

largest community (see Fig. 4), it is the less coherent and important topic for the period.

In general, it is possible to track the evolution of three individual clusters as they appear from the first to the third sub-periods indistinctly (See Appendix Table 4). For example, MIS is standing as an under-developed area located in quadrant IV from 1980 to 2015. *Database systems* decreases in terms of centrality over the transition from the first to the second sub-period and, as a single community, tend to disappear in the last sub-period. Lastly, HIM emerges in the second stage as a core research area that still keeps its mainstream character until 2015.

4 Discussion

In this study ACA was used to detect how IM has been evolving since its early stages (1980) to more current times (2015). As we stated in the literature review, few studies have focused on analyzing the evolution of IM by means of citation-based data. Thus, this paper contributes in providing an evolutionary overview of the field derived from Web of Science database.

Two major patterns are visualized during 1980–1991. The first pattern deals with the high influence of library automation thinkers (cluster 2). This was an emergent topic in the 80s derived from the so-called «office automation» [6] and the introduction of personal computers [26]. This community of authors made important contributions regarding the automation in the library environment. As seen in the strategic diagram of Fig. 5, it was the core topic although their authors were only visible during this timeframe. The second pattern has to do with the close relations of IM founders with MIS researchers in the intellectual structure. Their connections represent the consideration of information as a resource framed into systemic processes for the strategic planning in organizations.

Over 1992 to 2003 we have observed the dominance of MIS. This community keeps its importance in the co-citation network but their coherence as a research area is low since the density values do not increase from one sub-period to another.

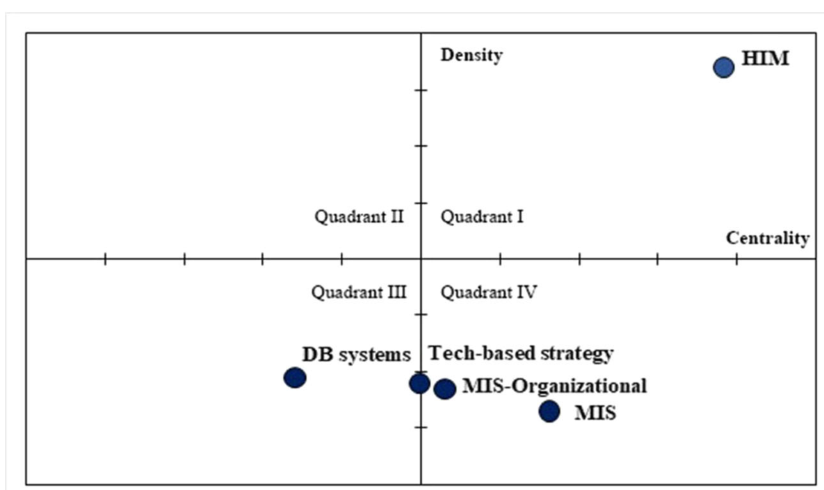
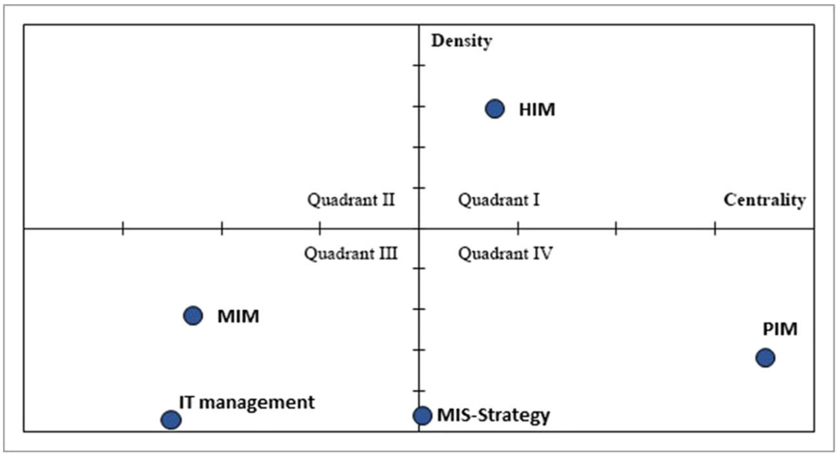


Fig. 6 Strategic diagram of IM research areas, 1992–2003

Fig. 7 Strategic diagram of IM research areas, 2004–2015



As seen in Fig. 6, it still stands as an under-developed area. The second largest community in 1992–2003 was formed from the MIS cluster in 1980–1991, *MIS-Organizational* (cluster 6). This is a representation of the organizational theorists who have emphasized the organizational change and structure in relation to information systems. This finding is quite similar to that obtained by Culnan [12], who visualized a cluster related to the organizational approach in MIS research as well. Thus, from sub-period 1 to 2 the MIS influencers disaggregate into two communities representing the individual and organizational approach in the design and implementation of information systems.

During the second sub-period a community of classical strategists was formed (cluster 7), in combination with information technologists. They have promoted the strategic management of technology in order to achieve competitive advantage, enable innovation and transform organizations [13, 29, 60]. This community finds its antecedents in cluster 3, just where the foundational authors were grouped from 1980 to 1991. In general, MIS, *MIS-Organizational* and *Technology-based strategy* are the most connected and important topics in the intellectual structure for this timeframe.

In sub-period 1992–2003 it is visualized the coming out of a research area referred to IM in the health domain (cluster 8). Its high centrality and density measures suggest that from sub-period 2–3 HIM acquires a core position in the strategic diagram. Nevertheless, this health-related area is an intellectual community separated from the rest. Co-citation maps evidence clusters formation where managerial and medical communities are poorly connected from 1992 to 2015 (see Figs. 3 and 4). Hence, HIM rises as a contributing area in IM, but restricted only to the medical domain. This topic has a different historical, academic and epistemological trajectory [16, 27, 28, 33, 49, 71]. HIM finds its roots in the production of medical records in paper format, coupled with the introduction of computers for the automation of medical procedures [70]. First data processing and storage tools were paper-based, and then computer-based. By the 1990s, given that information systems were no longer focused on hospital administration but on patients, research lines opened up towards strategic information management for strategic planning and business processes based on patients [28]. Derived from our network results, the most significant shift produced around HIM community refers that in sub-period 2 major co-citation relations are established with computer scientists (e.g. Gorry, GA; Sonebraker, M; Simon, HA), while in sub-period 3 there are with experts in innovation and personal information management (e.g. Rogers, EM; Gupta, AK; and Cutrell, E). This finding, although not entirely representative, could mean a slight change of focus in research on IM in the health and medical context.

Important shifts are produced in the socio-intellectual structure of IM in 2004–2015. MIS stands as the largest community with a stronger focus on strategy (cluster 10). Despite management information systems play an important role in the strategic planning of organizations, the strategy-oriented authors are more visible in this community during the last timeframe. This cluster labeled *MIS-Strategy* in 2004–2015 is the result of the merger of MIS and *Technology-based strategy* clusters during 1992–2003. This community is the same as evidenced by Schlögl [67] when he mapped the intellectual structure of IM as well. Over 1980–2015 we have seen that around MIS topic some changes in focus have been produced. Perhaps, this is the reason why the cluster decreases in terms of density (see Table 1), becoming a research area lacking in coherence due to low internal citation relations.

From 1980 to 2003, the socio-intellectual structure has been composed by notorious information technologists and computer scientists. As previously stated, they have studied the role and adoption of IT in the organizational performance. However, a single community has not been only formed until 2004–2015. This community of *IT management* (cluster 11) is completely different in composition and approach from the previous clusters on MIS or *Technology-based strategy*. Although it stands as a peripheral topic (see Fig. 7), it is a clear representation of the technological dimension of IM, where, the most important is the providing of hardware and software for IM projects. We visualize that the small group of authors oriented to database research (clusters 4 and 9) during the first and second sub-periods are included in this technological group of authors. The reason is that within this community there is also a subtopic related to data management in online environments.

The strategic diagram of Fig. 7 displays that PIM is the second most important topic for the 2004–2015 sub-period. Thus, for the first time in the socio-intellectual structure it is denoted the personal approach towards IM. The PIM area refers to both the practice and study of activities a person performs in order to acquire, create, store, organize, maintain, retrieve, use and distribute information to complete certain tasks from very personal collections [34]. This concept was coined by Mark W. Landsale in 1988, although Vannevar Bush envisioned, to some way, the use of IT for PIM [15, 34, 73]. In our results, PIM cluster includes the HIB as a subtopic, given the presence of authors like Thomas Wilson, Brenda Dervin, Reijo Savolainen, and Donald O. Case.

In the mid-1980s, Dervin and Nilan [14] announced a paradigmatic shift within the HIB realm, as all attention would be referred to people instead of technological systems. That is why Jennifer Rowley [65] highlights the behavioral dimension of IM. HIB research boomed in the 1990s [56], playing a significant role within the library and information science domain [24], regardless the interest of many other disciplines [47, 81]. Conceptually, HIB is no more than “the study of how people need, seek, give and use information in different contexts, including the workplace and daily life” [57].

Parallel to our results, Greifeneder’s [25] bibliometric findings revealed the linkage between PIM and HIB research; pointing out that such thematic relation had to be explored in the future. Perhaps, their relations are based on the notion that human information behavior does not ignore the individual perspective towards IM [54]. At the same time, behavioral emphasis also presents the MIM research, specifically with respect to the information-seeking process [1]. Nevertheless, MIM resulted to be a peripheral area that claims external connections with the remaining topics.

5 Conclusions

This paper has provided an extensive analysis and visualization of the IM field over time. The mapping of IM is not an easy task given the changing environment of informational issues both in IM research and practice. The most representative fragmentation visualized in the socio-intellectual structure has taken place between the managerial and medical areas. Despite HIM has been a core theme since 1992, its authors conform an academic community relatively disconnected from the rest of the IM research community. This is clearly demonstrated by the low co-citation relations between HIM and the rest of IM reflected in networks of sub-periods 1992–2003 and 2004–2015.

Taking into account the three perspectives of IM emphasized by Detlor [15] (which conform the main theoretical background used in this paper), we prove that the organizational perspective prevails in the IM research throughout the whole period. However, a change in the last sub-period is identified, caused by the influence of PIM authors. Discarding the cluster on HIM, PIM is the most representative research area from 2004 to 2015 in terms of centrality and density, displacing the authors that represent the organizational perspective. This change supports the idea that there is a socio-intellectual transition from the organizational level to the individual level in the study and application of IM. With respect to the library perspective, we have visualized its short-lived perdurability since it was only visible during the first stage.

According to the IM dimensions reflected by Jennifer Rowley [65], it was visualized that the systemic dimension is leading throughout the 36 years examined. Inside this systemic dimension, represented by the community on MIS, certain evolutionary patterns are manifested. This research area has exhibited a change of focus from a micro level (individual) in the 1980s to a macro level (organizational) in the 1990s and finally to a combination of both from 2000 onwards, accentuating the strategic character of the field. As Schlögl [67] proved, in the socio-intellectual structure of IM a technology-oriented approach coexists, represented by computer science authors, and an information-oriented approach, represented by information science authors. However, our findings point to an evolution from a technological orientation to the informational since in the last sub-period are mostly visualized the information scientists as from the presence of authors on information behavior and information retrieval.

Regarding the behavioral dimension announced by Rowley [65] as well, this was only visible during the last sub-period, specifically as a branch of the PIM area. In that sense, we can say that IM has been gradually accentuated towards the study of human information behavior. Brian Detlor considers that the challenge of IM “is less about solving technical problems and more about addressing the human-side of information management” [15] (p. 107).

These results will contribute to understand the trajectory of IM. They may evoke actions in order to establish, improve or redirect scientific research, academic programs or professional practices. Likewise, potential routes for future research may be considered. For example, it would be interesting to study the correlation between the intellectual base and the research front in IM. Additionally, the combination of ACA with other bibliometric techniques will serve to deepen on the evolution of IM.

Acknowledgements The corresponding author is deeply thankful for the financial support received by Coimbra Group and Leiden University. Both institutions made possible a research stay at the Centre for Science and Technology Studies (CWTS) in order to conduct this study. We also acknowledge the suggestions provided by Gloria Ponjuán for the corrected version of the paper.

Appendix 1

Table 2 Names and disciplines of the top ten authors in IM by sub-periods

Sub-period	Author	Discipline	Cites
1980–1991	Horton, Forest W.	Management	54
	Ives, Blake	IS	49
	Lucas, Henry C.	IS	49
	Simon, Herbert A.	Economics	43
	Rockart, John F.	Management	42
	Keen, Peter G.W.	Management	41
	King, William R.	IS	38
	McFarlan, Franklin W.	Business Administration; IS	36
	Davis, Gordon B.	Business Administration, IS	34
	Nolan, Richard L.	Operations Research	34
1992–2003	Porter, Michael E.	Economic	104
	Davenport, Thomas H.	Management; Business	102
	Ives, Blake	IS	94
	Keen, Peter G.W.	Management	90
	Earl, Michael J.	Management	73
	Stonebraker, Mike	Computer Science	68
	Mintzberg, Henry	Management	67
	Culnan, Mary J.	IS	66
	Rockart, John F.	Management	66
	Simon, Herbert A.	Economics	63
2004–2015	Foster, Ian T.	Computer Science	261
	Davenport, Thomas H.	Management; Business	238
	Dexter, Franklin	Biomedicine	220
	Jones, William	Cognitive Psychology	188
	Agarwal, Ritu	MIS	151
	Berners-Lee, Tim	Computer Science	135
	Abiteboul, Serge	Computer Science	133
	Yin, Robert K.	Cognitive Science	131
	Whittaker, Steve	Cognitive Science	127
	Nonaka, Ikujiro	Business Administration	123

Note: Information of these authors was obtained by manual procedures, mostly analyzing academic public profiles from university web sites.

Appendix 2

Table 3 Thematic clusters derived from author co-citation networks by sub-periods

Sub-period	Cluster (color)	Size	Topic(s)	Top author in cluster	Average citation in cluster
1980–1991	1 (red)	16	MIS	Ives, B.	31
	2 (green)	7	Library automation	Krasnoff, B.	16
	3 (blue)	7	IM foundations	Horton, FW.	29
	4 (yellow)	2	Database systems	Nolan, RL.	32
1992–2003	5 (red)	26	MIS	Ives, B.	43
	6 (green)	17	MIS-Organizational	Keen, PGW.	48
	7 (blue)	15	Technology-based strategy	Porter, ME.	55
	8 (yellow)	7	HIM	McDonald, CJ.	36
	9 (purple)	2	Database systems	Stonebraker, M.	62
2004–2015	10 (red)	54	MIS-Strategy	Davenport, TH.	59
	11 (green)	28	IT management	Foster, I.	82
	12 (blue)	22	PIM	Jones, WP.	61
	13 (yellow)	4	MIM	Afifi, WA.	79
	14 (purple)	4	HIM	Dexter, F.	103
	15 (cyan)	3	Miscellaneous	Chen, CW.	44

Appendix 3

Table 4 Evolution of research areas derived from strategic diagram

Research area	1980–1991	1992–2003	2004–2015
MIS	Under-developed	Under-developed	Under-developed
Library automation	Mainstream	–	–
IM foundations	Peripheral	–	–
DB systems	Under-developed	Peripheral	–
MIS-Organizational	–	Under-developed	–
Technology-based strategy	–	Under-developed	–
HIM	–	Mainstream	Mainstream
IT management	–	–	Peripheral
PIM	–	–	Under-developed
MIM	–	–	Peripheral

References

1. Afifi WA, Weiner JL (2004) Toward a theory of motivated information management. Commun Theor 14(2):167–190
2. Anderton RH (1986) Postgraduate education for information management in the UK-new developments at Lancaster. Int J Inf Manag 6(4):247–249
3. Bellis N (2009) Bibliometrics and citation analysis: from the science citation index to cybermetrics. Scarecrow Press, Inc, Maryland
4. Boaden R, Lockett G (1991) Information technology, information systems and information management: definition and development. Eur J Inf Syst 1(1):23–32
5. Braam RR, Moed HF, Raan AFJ (1991) Mapping of science by combined co-citation and word analysis. I. Structural aspects. J Am Soc Inf Sci 42(4):233–251
6. Bryant A, Black A, Land F, Porra J (2013) Information systems history: what IS history? What IS IS history? What IS history? . . . And why even bother with history? J Inf Technol 28(1):1–17
7. Cambrosio A, Limoges C, Courtial JP, Laville F (1993) Historical scientometrics-mapping over 70 years of biological safety research with co-word analysis. Scientometrics 27(2):119–143

8. Choo CW (2002) Information management for the intelligent organization: the art of environmental scanning. Learned Information, Medford
9. Courtial JP (1994) A coword analysis of scientometrics. Scientometrics 31(3):251–260
10. Courtial JP, Callon M, Sigogneau A (1993) The use of patent titles for identifying the topics of invention and forecasting trends. Scientometrics 26(2):231–242
11. Culnan MJ (1986) The intellectual development of management information systems, 1972-1982: a co-citation analysis. Manag Sci 32(2):156–172
12. Culnan MJ (1987) Mapping the intellectual structure of MIS, 1980-1985: a co-citation analysis. MIS Q 11(3):341–353
13. Davenport TH (1993) Process innovation: reengineering work through information technology. Harvard Business Press, Boston
14. Dervin B, Nilan M (1986) Information needs and uses. Annu Rev Inf Sci Technol 21:3–33
15. Detlor B (2010) Information management. Int J Inf Manag 30(2): 103–108
16. Dinh M, Chu M (2006) Evolution of health information management and information technology in emergency medicine. Emergency Medicine Australasia 18(3):289–294
17. Dwivedi YK, Mustafee N (2010) Profiling research published in the journal of Enterprise information management (JEIM). J Enterp Inf Manag 23(1):8–26
18. Dyrby SS (2011) What is information management? An investigation of meaning creation through discourse and construction (Master thesis). Business Administration and Information Systems: information management, Copenhagen Business School. Copenhagen
19. Eck NJV, Waltman L (2014) Visualizing bibliometric networks. In: Ding Y (ed) Measuring scholarly impact. Springer International Publishing, Switzerland, pp 285–320
20. Eck NJV, Waltman L, Dekker RR, Berg JV (2010) A comparison of two techniques for bibliometric mapping: multidimensional scaling and VOS. J Am Soc Inf Sci Technol 61(12):2405–2416
21. Freeman LC (1979) Centrality in social networks. Conceptual clarification. Soc Networks 1(3):215–239
22. Galliers RD (1995) A manifesto for information management research. Br J Manag 6:45–52
23. Ghahnaviyeh H, Movahedi F, Yarmohamadian M, Ajami S (2011) Content and citation analysis of articles published in the journal of "health information management". Health Information Management 8(1):86–89 URL http://him.mui.ac.ir/index.php/him/article/download/380/417. Accessed 17 May 2017
24. Given M, Julien H, Case D (2012) The evolution of information behavior research: looking back to see the future. Proc Am Soc Inf Sci Technol 49(1):1–2
25. Greifeneder E (2014) Trends in information behaviour research. Inf Res 19(4). URL http://curis.ku.dk/ws/files/137513587/Trends_in_information_behaviour_research.htm. Accessed 17 May 2017
26. Haigh T (2011) The history of information technology. Annu Rev Inf Sci Technol 45(1):431–487
27. Halbeis CBE, Epstein RH, Macario A, Pearl RG, Grunwald Z (2008) Adoption of anesthesia information management systems by academic departments in the United States. Anesth Analg 107(4):1323–1329
28. Haux R (2006) Health information systems-past, present, future. Int J Med Inform 75(3):268–281
29. Henderson JC, Venkatraman H (1999) Strategic alignment: leveraging information technology for transforming organizations. IBM Syst J 38(2):472–484
30. Herring JE (1991) Information management-the convergence of professions. Int J Inf Manag 11(2):144–155
31. Horton FW (1979) Information resources management: concept and cases. Association for Systems Management, Cleveland
32. Horton FW, Marchand DA (1982) Information management in public administration. Information Resources Press, Arlington
33. Jaspers MWM, Ammenwerth E, Burg WJPPT, Kaiser F, Haux R (2004) An international course on strategic information management for medical informatics students: international perspectives and evaluation. Int J Med Inform 73(11):807–815
34. Jones W (2007) Personal information management. Annu Rev Inf Sci Technol 41:453–504
35. Khasseh AA, Soheili F, Moghaddam HS, Chelak AM (2017) Intellectual structure of knowledge in iMetrics: a co-word analysis. Inform Process Manag 53(3): 705-720
36. Khasseh AA, Soheili F, Chelak AM (2018) An author co-citation analysis of 37 years of iMetrics. Electron Libr 36(2):319–337
37. Kleinubing LS (2010) Análise bibliométrica da produção científica em gestão da informação na base de dados LISA. RDBCI: Revista Digital de Biblioteconomia e Ciência da Informação 8(1):1–11
38. Köseoglu MA, Okumus F, Dogan IC, Law R (2018) Intellectual structure of strategic management research in the hospitality management field: a co-citation analysis. Int J Hosp Manag
39. Law J, Bauin S, Courtial JP, Whittaker J (1988) Policy and the mapping of scientific change - a co-word analysis of research into environmental acidification. Scientometrics 14(3–4):251–264
40. Lewis DA, Martin WJ (1989) Information management: state of the art in the United Kingdom. ASLIB Proc 41(7/8):225–250
41. Leydesdorff L (1987) Various methods for the mapping of science. Scientometrics 11(5–6):295–324
42. Liu P, Wu Q, Mu X, Yu K, Guo Y (2015) Detecting the intellectual structure of library and information science based on formal concept analysis. Scientometrics 104(3):737–762
43. Macevièiûtë E, Wilson TD (2002) The development of the information management research area. Inf Res 7(3):7–3
44. Mamdapur GMN, Rajgoli IU, Chavan SM, Khamitkar KS (2014) Bibliometric portrait of SRELS Journal of Information Management for the period 2004–2013. Library Philosophy and Practice, paper 1166. Library Philosophy and Practice p paper 1166. URL http://digitalcommons.unl.edu/libphilprac/1166. Accessed 17 May 2017
45. Marshakova IV (1973) System of document connection based on references. Nauchno-Teknichescaya Informatisya, Seriya 2(6):3–8
46. McCain KW (1991) Mapping economics through the journal literature: an experiment in journal co-citation analysis. J Am Soc Inf Sci 42(4):290–296
47. McKechnie EF, Goodall GR, Lajoie-Paquette D, Julien H (2005) How human information behaviour researchers use each other’s work: a basic citation analysis study. Inf Res 10(2):10–12
48. Moya-Anegón F, Vargas-Quesada B, Herrero-Solana V, Chinchilla-Rodríguez Z, Corera-Álvarez E, Muñoz-Fernández FJ (2004) A new technique for building maps of large scientific domains based on the co-citation of classes and categories. Scientometrics 61(1): 129–145
49. Muravchick S, Caldwell JE, Epstein RH, Galati M, Levy WJ, O’Reilly M, Plagenhoef JS, Rehman M, Reich DL, Vigoda MM (2008) Anesthesia information management system implementation: a practical guide. Anesth Analg 107(5):1598–1608
50. Nerur SP, Rasheed AA, Natarajan V (2008) The intellectual structure of the strategic management field: an author co-citation analysis. Strateg Manag J 29(3):319–336
51. Nimale VP, Khaparde V, Alhamdi FA (2015) Acknowledgement patterns: a bibliometrics study on international journal of information management. International Journal of Advanced Library and Information Science 3(1):111–120
52. Palvia P, Chau PYK, Kakhki MD, Torupallab Ghoshal T, Uppala V, Wang W (2016) A decade plus long introspection of research published information & management. Inf Manag 54(2):218–227
53. Pandita R (2014) Trends in Information Management (TRIM) Journal: a bibliometric analysis. Trends in Information

Management (TRIM) 9(2). URL https://www.researchgate.net/profile/Ramesh_Pandita/publication/262932696_Trends_in_Information_Management_. Accessed 17 May 2017
54. Paula IAN, Caballero IZ (2016) Análisis de modelos sobre Comportamiento Informacional, desde un enfoque socio-psicológico. Bibliotecas Anales de Investigación 12(1):63–89
55. Persson O (1994) The intellectual base and research fronts of JASIS 1986-1990. J Am Soc Inf Sci 45(1):31–38
56. Pettigrew KE, McKenchie L (2001) The use of theory in information science research. J Am Soc Inf Sci Technol 52(1):62–73
57. Pettigrew KE, Fidel R, Bruce H (2001) Conceptual frameworks in information behavior. Annu Rev Inf Sci Technol 35:43–78
58. Ponjuán GD (2011) La gestión de información y sus modelos representativos. Valoraciones. Ciencias de la Información 42(2): 11-17
59. Ponzi LJ (2002) The intellectual structure and interdisciplinary breadth of knowledge management: a bibliometric study of its early stage of development. Scientometrics 55(2):259–272
60. Porter M (1985) How information gives you competitive advantage. Harv Bus Rev 63(4):149–160
61. Rao IKR, Raghavan KS (2015) COLLNET journal of Scientometrics and information management (2007-2013): an analysis. COLLNET Journal of Scientometrics and Information Management 9(1):15–23
62. Reis GA, Macadar MA, Filho EG, Rossoni L (2010) Redes sociais e intelectuais em administração da informação: uma análise cientométrica do período 1997-2006. Informação e Sociedade: Estudos 20(1):95–110
63. Rodionov II, Tsvetkova VA (2015) Information management in information science. Sci Tech Inf Process 42(2):73–77
64. Rodríguez YC, Martínez AR (2009) Comportamiento de la producción científica sobre gestión de información en revistas del Web of Science. Acimed 20(6). URL http://scielo.sld.cu/pdf/aci/v20n6/aci021209.pdf. Accessed 17 May 2017
65. Rowley J (1998) Towards a framework for information management. Int J Inf Manag 18(5):359–369
66. Santana GAD, Lopes HMS, Sobral NV, Ferreira MHW (2013) A produção cientifica sobre gestão da informação indexada na BRAPCI entre 2006 e 2013: uma análise cientométrica. URL http://enancib.sites.ufsc.br/index.php/enancib2013/XIVenancib/paper/viewFile/485/301 . Accessed 17 May 2017
67. Schlögl C (2003) Wissenschaftslandkarte Informationsmanagement. Wirtschaftsinformatik 45(1):7–16
68. Small H (1973) Cocitation in scientific literature-new measure of relationship between 2 documents. J Am Soc Inf Sci 24(4):265–269
69. Small H (2003) Paradigms, citations, and maps of science: a personal history. J Am Soc Inf Sci Technol 54(5):394–399
70. Stead WW, Sittig DF (1995) Building a data foundation for tomorrow's healthcare information management systems. International Journal of BioMedical Computing 39(1):127–131
71. Street T (2012) Creating change in the health information management profession. Health Information Management Journal 41(1): 20–20
72. Tarapanoff K (2006) Inteligência, informação e conhecimento em corporações. IBICT, Brasília
73. Teevan J, Jones W, Bederson BB (2006) Personal information management. Commun ACM 49(1):40–43
74. Trauth EM (1989) The evolution of information resource management. Inf Manag 16:257–268
75. Vaughan L, You J (2006) Comparing business competition positions based on web co-link data: the global market vs. the Chinese market. Scientometrics 68(3):611–628
76. Vickers P (1984a) Information management: a practical view. ASLIB Proc 36(6):245–252
77. Vickers P (1984b) Promoting the concept of information management within organisations. J Inf Sci 9(3):123–127
78. White HD, Griffith BC (1981) Author co-citation: a literature measure of intellectual structure. J Am Soc Inf Sci 32(3):163–171
79. White HD, McCain KW (1998) Visualizing a discipline: an author co-citation analysis of information science, 1972-1995. J Am Soc Inf Sci 49(4):327–356
80. Wilson TD (1989) Towards an information management curriculum. J Inf Sci 15(4–5):203–209
81. Wilson TD (1997) Information behaviour: an interdisciplinary perspective. Inf Process Manag 33(4):551–572
82. Yang S, Han R, Wolfram D, Zhao Y (2016) Visualizing the intellectual structure of information science (2006-2015): introducing author keyword coupling analysis. Journal of Informetrics 10(1): 132–150
83. Zhao D (2006) Towards all-author co-citation analysis. Inf Process Manag 42(6):1578–1591
84. Zhao D, Strotmann A (2008) Evolution of research activities and intellectual influences in information science 1996–2005: introducing author bibliographic-coupling analysis. J Am Soc Inf Sci Technol 59(13):2070–2086
85. Zins C (2007) Conceptual approaches for defining data, information, and knowledge. J Am Soc Inf Sci Technol 58(4):479–493