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Forty-Five Years of LIS Research Evolution, 1971–2015: An Informetrics Study of the Author-Supplied Keywords

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Abstract
This article sought to investigate the evolution of library and information science by tracking the author-supplied keywords in the research articles published in the domain between 1971 and 2015. Data was extracted from Thomson Reuters' citation mainstream indexes and analysed using the VosViewer computer-aided software to obtain author-supplied keyword frequencies in each decade since 1971. We identified the most salient and common research themes in LIS and how the themes have evolved, by delving into the author-supplied keywords to proxy research themes in the field domain. Results indicate that the field of LIS has evolved in terms of its subject focus from information systems design and management in the 1970s to scientific communication, information storage and retrieval, information access, information and knowledge management, and user education in 2015. The application of ICTs in LIS practice and education, too, has emerged as a prominent topic in the field. These issues have the potential of shaping or have shaped the LIS curriculum in some LIS schools in the continent.

Keywords Library and information science · Research · Social network analysis · Co-occurrence analysis · Informetrics, keywords

Introduction

Ke et al. [19] have observed that there is an increase in interest to understand the dynamics and characteristics of scientific production and the evolution of science. To that end, Chang et al. [5] opine that exploring research trends in a discipline facilitates a deeper understanding of the development of the discipline. On their part, Goldfinch and Yamamoto [13, 8] offer the basis of such an exploration by stating that "disciplines themselves are unstable and change over time". Similar sentiments

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have been proffered by Liu et al. [23] who argue that "detecting intellectual structure of a knowledge domain is valuable to track dynamics of scientific research". The development and/or evolution of a subject or concept, field of knowledge or discipline can be traced through the use of bibliometrics techniques [4, 24, 38]. Numerous studies have been conducted to trace and assess the evolution of concepts or words and their derivations such as *Altmetrics* [22], *citations* [11], and *scientific impact* [26]. Evolution of words, documents, ideas and language has also been a subject of webometrics studies (see [2, 33]). Thelwall [32, 95] opines that although virtual memetics, a concept he defines as "a set of methods to track online the evolution over time of a single meme, that is a single transmitted unit of cultural information" was developed to track international online spread and morphing of a joke, can be used on any text-based information on the Web. In bibliometrics, the number of papers, authors or scientists, institutions, journals, subject terms, and citations (including cited references), among others, constitute the units of analysis that have been applied to track the evolution or development of science or disciplines (see [3, 10, 30], with the key assumption being that the more the number of publications, authors, institutions, subject terms, keywords, or citations, in a given field or discipline, over a period of time, the more progressive the field or discipline is.

Using different indicators, a number of studies have emerged in recent times to assess research evolution in different subject areas, fields or disciplines. De Granda Orive et al. [8] compared the use of words used in the journal *Archivos De Bronchoneumologia* with those used in the Index Medicus database to assess the evolution of descriptions in a dozen sub-fields between 1994 and 2001 and found, among others, that there was no "clear tendency in the evolution of the journal's keyword usage for the knowledge areas analysed during the study period". Evolution or development of science has been assessed in operations management [7], psychotherapy [29], entrepreneurship [10], obstetrics and gynaecology [12], information technology management [20], knowledge management [1], national disciplinary profiles [21], and business research [37], to name but a few disciplines or research areas.

In the library and information science (LIS) field, Chang et al. [5] mapped the subject terms to gauge their evolution using the keyword, bibliographic coupling and co-citation analyses techniques. The authors analysed highly cited papers in LIS research, published between 1995 and 2014, and noted that information seeking, information retrieval and bibliometrics appeared as subject terms in the 5-year time periods investigated. They nevertheless observed that the terms information retrieval and information seeking registered a decreasing trend while that of bibliometrics was on the rise. Prior to Chang et al. [5] study, Jarvelin and Vakkari [18] had observed similar findings whereby library and information service activities, and information storage and retrieval were among the topics of research while there was little attention on methodology, information seeking and scientific communication. The authors had limited their study to articles published in core LIS journals between 1965 and 1985. Basing their study on the Keyword Activity Index (KAI), Chen et al. [6] conducted a co-word analysis whereby they clustered institution-specific keywords to identify the topics that are emphasized by institutions in LIS research in China. The authors noted some overlaps and uniqueness of the eight institutions investigated in terms of their research focus, wherein some terms were

common among several institutions while some institutions had their own unique focus on some research topics. Liu et al. [23] extracted keywords from titles and abstracts of LIS articles published between 2001 and 2013 and noted that among the most frequent keywords in 16 *prominent* LIS journals were information retrieval, h-index, bibliometrics, search engines, impact factor, databases, the World Wide Web, and information behaviour. A few other studies limited to specific geographical contexts have been carried out to, among others, assess the subject content of LIS research, for example [16], who bibliometrically analysed 2490 documents consisting of papers, dissertations and research projects as published in Iran.

It is evident that author-supplied keywords are seldom used to assess the development of LIS despite Chen et al. [6, p. 722] conviction that keywords of publications can be used as reflectors of the development of a discipline, particularly in view of the fact that author-supplied keywords act as proxy of research subjects in a discipline. The void or gap created through the non-use of keywords, and more specifically the author-supplied keywords, to assess the evolution of LIS over time, presents a plausible rationale for the current study.

Purpose and Objectives of the Study

The purpose of the study is to determine the evolution of library and information science through the tracking of author-supplied keywords in the LIS articles published from 1971 to 2015. The specific objectives include:

- To determine the growth of papers with or without author keywords, 1971–2015.
- To assess and map the changing patterns of keyword appearance in LIS research articles, 1971–2015.
- To examine the characteristics of keyword networks, 1971–2015.

Methods and Materials

Data extraction was conducted in December 2016 from the Thomson Reuters' Science Citation Index (SCI), Social Sciences Citation Index (SSCI) and the Arts and Humanities Citation Index (AHCI). The search strategy consisted of (a) searching the databases for research articles published in each year ($PY = Y_{1\ldots n}$) where Y was the year of publication, the scope of which was limited to 1971–2015; (b) analysing the articles using the TR's in-built *Analyse Results* tool wherein the articles were analysed by *Research Areas,* in order to isolate and obtain only the articles that were published in the research area labelled as *Information Science Library Science,* per year. The data was then saved in *Other File Formats* so as to be compatible with the VosViewer software that was used to conduct further analysis. In order to obtain the frequency of occurrence as well as the maps and clusters of author-supplied keywords, the *full counting* of *word occurrence* in VosViewer software's data analysis options were selected. Each set of data was subjected to analysis to obtain author keywords that would reflect the themes of research in each year period, thereby

revealing the evolution of the field over time. Similar approaches, whereby author keywords have been adopted as proxy of themes and research in a discipline, have been employed by Khan and Wood [20], Liu et al. [23], Chen et al. [6] and Neveol et al. [25]; as well as Yang et al. [36]. Data are presented in network maps and tables for complementarity purposes. For instance, while only the ten most frequent author keywords were presented in the tables, the network maps provides a density-based picture of the occurrence and linkage characteristics of author keywords. When read together, the tables and maps provide a robust picture on the evolution of the subject domain of LIS as well as its research between 1971 and 2015. For purposes of this paper, a sample of the data spanning two 10-year and one 5-year periods (i.e. 1971–1980; 1991–2000; and 2011–2015) is presented and discussed due to space limitations.

Limitations of the Study

This study is limited to the author-supplied keywords analysis to gauge the evolution of the discipline of LIS. Firstly, it has been observed that some journals do not provide options for the authors to select keywords from controlled vocabulary [6, p. 722]. Some journals do not even require authors to provide keywords to describe the content of their papers. As results of the current study reveal, this trend is nevertheless slowly changing and most authors are now providing author keywords for their papers. This paper did not explore the journals that might have changed their policies to require authors to provide author keywords. This has been proposed as an agenda for further research. Secondly, given that the author keywords are not controlled vocabulary and are subjective, there is likelihood that two words may be used to refer to the same concept, thereby reducing the frequency of occurrence of the affected words and therefore relegating some of the keywords to the periphery. Thirdly, the early years of LIS research produced a very small percentage of articles that provided author keywords and might have been excluded from the study but given the purpose of the current study to assess the evolution of LIS over time, a decision was made to include those years in the final analysis.

Results and Discussion

Growth of Papers Vis-à-Vis the Number of Author-Supplied Keywords

Table 1 reveals the trend of publication of LIS research articles between 1971 and 2015. A total of 101,886 articles were published within the period under investigation. The majority of the articles, in each year period except 2011–2015, did not provide author keywords. It was, however, noted that the articles without author keywords decreased from 21,082 in 1991–2000 to 15,870 in 2001–2010 and further on to 5348 in 2011–2015. Noteworthy mentioning too is that the number of articles with author keywords has continued to increase, albeit slowly, throughout the period, that is, 1971–2015. It seems that, in 1971–1980, the provision of author

Table 1 Growth of papers vis-à-vis the number of keywords

	Papers with keywords		Papers without keywords		Total
	n	%	*n*	%	*N*
1971–1980	36	0.27	13,456	99.73	13,492
1981–1990	101	0.51	19,638	99.49	19,739
1991–2000	2325	9.93	21,082	90.07	23,407
2001–2010	11,125	41.21	15,870	58.79	26,995
2011–2015	12,905	70.70	5348	29.30	18,253
Total	26,492	26.00	75,394	74.00	101,886

keywords in LIS research articles was not a requirement. In the said period, almost all articles (i.e. 99.7% of 13,492) did not provide author keywords. The scenario has since changed as more and more articles are supplying author keywords, perhaps in their attempt to meet journal requirements. Evidently, in the dawn of this century, most journals may have made it a requirement for authors to provide author keywords in their articles. We have also observed that online journal publishing systems such as ScholarOne and Open Journal System (OJS) require authors to supply keywords that best describe the content of their manuscripts. The trend in Table 1, wherein the number of articles without author keywords is declining, is therefore likely to persist in the future.

The Most Common Author Keywords in the LIS Literature, 1971–2015

In this section, we track the author keywords in the LIS literature from 1971 to 2015 in order to assess the evolution of the LIS knowledge domain. Figure 1 and Table 1, respectively, provide a network map and the most common author keywords that appeared in LIS research articles published between 1971 and 1980. This period exhibited a few appearances of author keywords with *management information systems* leading the pack with five occurrences, followed by *information systems* (f=4) and *MIS planning* (f=4). *Decision support system(s)*, *MIS management,* and *systems analysis*, each appeared in three articles.

Figure 1 provides a network map of the most common keywords. A total of 24 words that met the threshold of two occurrences formed the network. However, during this time period, a total of 16 clusters of keywords were formed. The largest cluster consisted of 23 keywords such as *management information systems, decision support system, application development, user orientation, database systems, information systems design,* and *interactive software.* However, the sparse distribution of the keywords in the network map demonstrates not only the small number but also the non-linkage of some of the keywords in the period. This era was largely dominated with planning, design and management of information and decision-making computerized systems. Swanson [31] locates the origin of *information systems* in the 1950s but, apparently, research on information systems in the LIS field would take place in the 1970s. According to Swanson [31, 2635], it is in this period that the

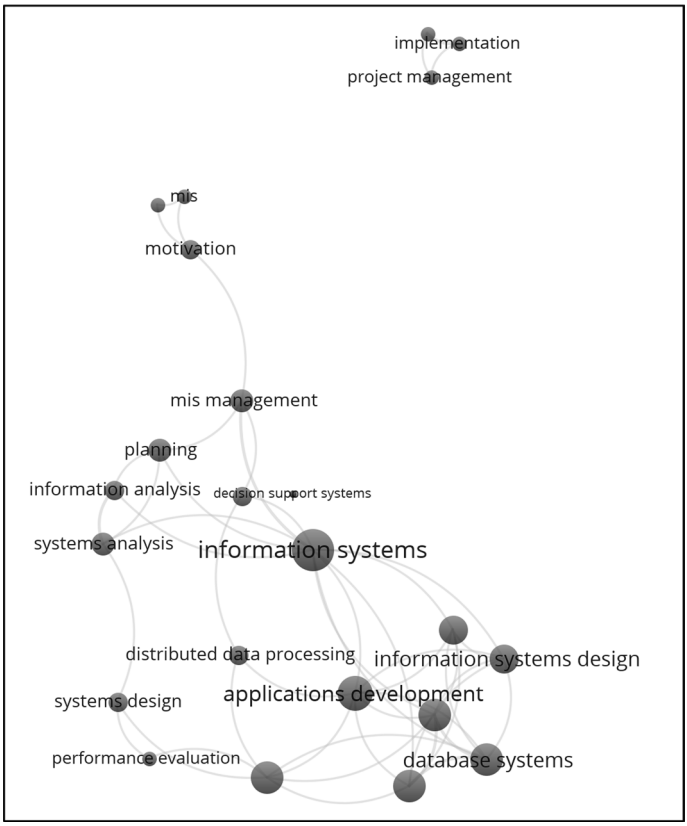

Fig. 1 Network map of author keywords that appeared 2+ times in the LIS literature, 1971–1980

"articulation of the relational data model as a foundation for data bases spurred the development of relational data bases".

Hayes [15] notes that although the journey to bring computers to libraries began in the 1960s, it was not until the 1970s and onwards that computers were accepted in libraries. In the context of information technology, Hayes [15] explains that the 1970s witnessed a paradigm shift from Grosch's Law on "bigger is better" to Moore's Law on the capabilities of microprocessors. In terms of the library technical services, Hayes [15, 3332] therefore says that "during this period, the bits and pieces that were created by individual institutions were replaced by integrated systems (i.e. systems including full range of functions in both technical services and reader services)". This development in the LIS profession seems to have continued until the 1990s as more libraries in different geographical territories accepted and implemented computerized systems in stages.

In the period of 1991–2000, several keywords emerged from nowhere, so to say, to feature prominently among the top twenty most common keywords. These terms include: *Internet*, which appeared in 139 (out of 2325 articles with keywords). In

the second place was *information technology* (118) followed by *information systems* (83), *libraries* (67), and *information retrieval* (55), just to name the keywords that appeared in fifty or more articles. Singh [28] might have vividly captured the rationale for the keen attention and interest on the Internet in the LIS literature published between 1991 and 2000. The author opines thus: "[I]n fact, the library profession is one that has been most intensely affected by the challenges of Internet and the World Wide Web (WWW). The shift from collection management to information management, from ownership to access, and the change in nature, boundaries and structure of information all call for a change in mind set of library professionals" [28, 17]. It is therefore demonstrable that such keywords as *information retrieval*, *document supply, interlending,* and *acquisitions,* which are library-based activities or functions, would feature among the most common keywords, together with *Internet*. The keywords *information systems, decision support systems, systems development,* and *IS (information systems) management,* which were prominently visible in 1971–1980, still persisted in the current period. As reflected in Fig. 2, during the period of 1991–2000, information systems and related keywords were relegated to the periphery as the Internet and library-associated activities and functions took centre stage in LIS research. Their prominence in 1971–1980 was diminished in 1991–2000. An analysis of the networks comprising all the keywords revealed that the 1991–2000 period produced a denser network than the 1971–1980 period, implying more interlinked clusters of keywords in the latter than the former time period. This pattern is partly attributable to the fact that there are more keywords in 1991–2000 than there were in 1971–1980. It is also possible that some author keywords had increasingly become common knowledge among several researchers; there was a tendency towards uniformity of use of some of the keywords. Finally, we can attribute the

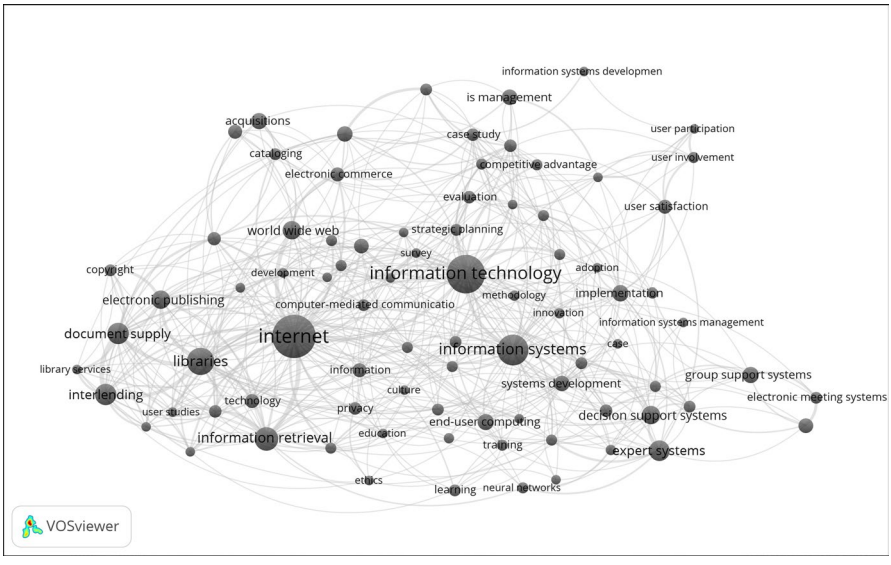

Fig. 2 Network map of author keywords that appeared 12+ times in the LIS literature, 1991–2000

densely mapped keywords and their interlinkages to the likelihood of researchers addressing common research problems or issues in 1991–2000 (Table 2).

Knowledge management is one of the research topics that have received increasing attention from LIS researchers in 2011–2015. The keyword first appeared in 1991–2000 where it was ranked 111th and appeared in only ten journal articles. Various studies have, however, revealed that knowledge management research started much earlier than 1991–2000. For instance, a study conducted by Akhavan et al. [1] locates the first paper on *knowledge management* research in 1987. A bibliometrics study on global knowledge management research, on the other hand, demonstrates that the first articles (4 in number) on knowledge management were published in 1975 (see [14]). *Information retrieval* has maintained a prominent presence among the author keywords since its emergence in 1991–2000 (Table 3).

The period of 2011–2015 has brought to the fore or ushered in "new" author keywords such as *bibliometrics,* which appeared in a total of 364 LIS articles that were published between 2011 and 2015. Tracing the emergence of this keyword backwards in this study places its first mention as author keyword in 1991–2000 where it appeared as *bibliometrics* fourteen times and three times as *bibliometrics analysis*. However, White [35] shows that the term *Bibliometrics* was a major topic in information science literature before the 1990s. White's study on *bibliometrics overview of information science* indicates that bibliometrics was among the most cited topics in 1977 and 1989. *Knowledge management*, too, moved from position 111 in 1991–2000 to be ranked second in 2011–2015. Other author keywords that emerged in the list of the top twenty most common keywords in Table 4 include *social media*, which was ranked 3rd with 307 occurrences, *academic libraries* (4th, f = 255), *citation analysis* (6th, f = 237), *knowledge sharing* (8th, f = 182), *information literacy* (9th, f = 176), *collaboration* (11th, f = 165), *e-government* (12th, f = 161), *innovation* 13th, f = 160), *research* (14th, f = 156), *social networks* (15th, f = 142), *evaluation* (16th, f = 140), *open access* (17th, f = 134), *scientometrics* (19th, f = 129) and *communication* (20th, f = 127). Table 4 illustrates that terms that were dominant in 1971–1980 had

Table 2 Most common author keywords, 1971–1980 ($n_a = 36$; $n_b = 13{,}456$; $N_c = 13{,}492$)

	Label	Cluster	Links	f	$\%_a$	$\%_b$	$\%_c$
1	Management information systems	1	19	5	13.89	0.04	0.04
2	Information systems	2	22	4	11.11	0.03	0.03
3	MIS planning	4	11	4	11.11	0.03	0.03
4	Decision support system	1	21	3	8.33	0.02	0.02
5	Decision support systems	7	8	3	8.33	0.02	0.02
6	MIS management	2	8	3	8.33	0.02	0.02
7	Systems analysis	2	14	3	8.33	0.02	0.02
8	Applications development	1	16	2	5.56	0.01	0.01
9	Database systems	1	16	2	5.56	0.01	0.01
10	Distributed data processing	4	10	2	5.56	0.01	0.01

n_a papers with keywords, n_b papers without keywords, n_c total number of papers

Table 3 Most common author keywords, 1991–2000 ($n_a = 2325$; $n_b = 21{,}082$; $N_c = 23{,}407$)

	Label	Cluster	Links	(f)	$\%_a$	$\%_b$	$\%_c$
1	Internet	53	498	149	6.41	0.71	0.64
2	Information technology	98	378	118	5.08	0.56	0.50
3	Information systems	103	313	83	3.57	0.39	0.35
4	Libraries	54	146	67	2.88	0.32	0.29
5	Information retrieval	86	171	55	2.37	0.26	0.23
6	Document supply	54	72	46	1.98	0.22	0.20
7	Interlending	54	82	46	1.98	0.22	0.20
8	Expert systems	94	157	42	1.81	0.20	0.18
9	Decision support systems	16	139	37	1.59	0.18	0.16
10	Electronic publishing	43	91	37	1.59	0.18	0.16
11	World wide web	62	139	36	1.55	0.17	0.15
12	End-user computing	8	118	30	1.29	0.14	0.13
13	Group support systems	5	97	30	1.29	0.14	0.13
14	Implementation	51	163	30	1.29	0.14	0.13
15	Acquisitions	42	79	29	1.25	0.14	0.12
16	Is management	57	101	28	1.20	0.13	0.12
17	Systems development	71	112	27	1.16	0.13	0.12
18	Electronic data interchange	33	86	26	1.12	0.12	0.11
19	Group decision support systems	5	82	25	1.08	0.12	0.11
20	Telecommunications	89	119	24	1.03	0.11	0.10

n_a papers with keywords, n_b papers without keywords, n_c total number of papers

completely disappeared from the list of the top twenty keywords in 2011–2015. The term *information systems*, although not among the top thirty author keywords in 2011–2015, was nevertheless prominent among researchers as it was ranked 35th in 2011–2015.

It has been observed in similar studies (e.g. [5, 35, 36]) that bibliometrics has emerged as one of the frequent keywords in the LIS literature, implying that it has become one of the most researched topic or applied methods in LIS research. A study conducted by Jarvelin and Vakkari [18], for instance, revealed that bibliometric strategies had become increasingly more popular, with citation analysis recording a growth rate of 2.0% between 1965 and 1975 and 1.3% from 1975 to 1985. Other bibliometric methods were applied in 0.7, 1.1 and 0.9% of LIS research articles in 1965, 1975 and 1985, respectively. Tuomaala et al. [34] observed similar patterns in their content analysis of LIS journal articles published between 1965 and 2005.

Figure 3 provides a network map of the author keywords that occurred 50 or more times in the LIS literature published between 2011 and 2015. The period witnessed a denser network with 29,503 author-supplied keywords that appeared in a total of 18,253 articles. The network map is a further testimony of the evolution of the LIS field as not only new topics have emerged as time has progressed but also the number of keywords used in the LIS field has continued to rise.

Table 4 Most common author keywords, 2011–2015 ($n_a = 12{,}905$; $n_b = 5348$; $n_c = 18{,}253$)

	Label	Cluster	Links	(f)	$\%_a$	$\%_b$	$\%_c$
1	Bibliometrics	1	887	364	2.82	6.81	1.99
2	Knowledge management	3	1104	361	2.80	6.75	1.98
3	Social media	4	1121	307	2.38	5.74	1.68
4	Academic libraries	2	807	255	1.98	4.77	1.40
5	Internet	4	979	252	1.95	4.71	1.38
6	Citation analysis	1	615	237	1.84	4.43	1.30
7	Information retrieval	5	629	200	1.55	3.74	1.10
8	Knowledge sharing	3	618	182	1.41	3.40	1.00
9	Information literacy	2	507	176	1.36	3.29	0.96
10	Libraries	2	656	168	1.30	3.14	0.92
11	Collaboration	1	597	165	1.28	3.09	0.90
12	E-government	7	572	161	1.25	3.01	0.88
13	Innovation	3	606	160	1.24	2.99	0.88
14	Research	9	572	156	1.21	2.92	0.85
15	Social networks	4	586	142	1.10	2.66	0.78
16	Evaluation	1	520	140	1.08	2.62	0.77
17	Open access	1	428	134	1.04	2.51	0.73
18	Trust	6	538	130	1.01	2.43	0.71
19	Scientometrics	1	370	129	1.00	2.41	0.71
20	Communication	9	528	127	0.98	2.37	0.70

n_a papers with keywords, n_b papers without keywords, n_c total number of papers

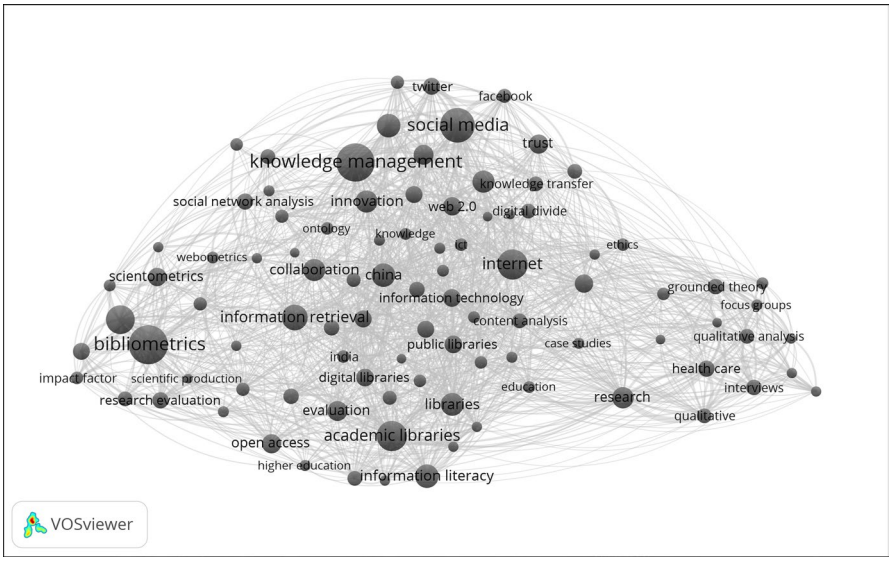

Fig. 3 Network map of author keywords that occurred 50+ times in the LIS literature, 2001–2015

Characteristics of Keyword Networks, 1971–2015

Table 5 illustrates the growth of LIS, both as a research area and field of study. The number of keywords per paper (column 4 in Table 5) as well as the number of clusters of keywords and links has continued to grow over time. The number of keywords grew from just 139 in 1971–1980 to 6396 in 1991–2000, a percentage increase of 4501%. They further grew to 29,503 in 2011–2015, accounting for 361% increase. In terms of the average keywords per article, based on the total number of articles in each year, the growth rate was slower than the absolute number of keywords. The average number of keywords grew by 2600% from 0.01 in 1971–1980 to 0.27 in 1991–2000 and onward to 1.62 in 2011–2015, thereby recording an increase of 500%. In terms of the keyword clusters (CS), 1971–1980 produced the least number (i.e. 16) while 2011–2015 had the highest number of clusters, that is, 455. A similar pattern was replicated in terms of the number of links (LS) and total link strengths (TLS). Table 5 shows that the number of clusters grew by 1700% between 1971 and 2000 and upward by 58% between 2001 and 2015. The links between keywords, too, grew from a mere 405 in 1971–1980 to 321,878 in 2011–2015, while the total link strength stood at 355,266 in 2011–2015, from 411 in 1971–1980.

Conclusions and Recommendations

Research in and development of the LIS field seem to be shaped partly by the developments taking place outside the profession but within the related disciplines such as computer science (e.g. information systems) and data processing (e.g. decision-making systems) in the 1960s and 1970s. This trend would persist in the 1990s when the Internet and the World Wide Web (WWW) became popular among library users/workers and other information workers. The uptake of these tools or technologies by libraries and other information professions might have created the need for investigation by researchers, thereby shaping the direction that not only research followed but also influencing the curriculum in LIS schools, to some extent [27]. Furthermore, LIS (comprising of library science/study and information science/study) is said to be interdisciplinary in their nature [9, 17], hence its adoption of methods, approaches and theories from related disciplines. In their study on interdisciplinary

Table 5 Characteristics of the keyword networks, 1971–2015

	P	Kws	Kws/P_a	Kws/P_b	CS	*LS*	*TLS*
1971–1980	13,492	139	0.01	3.86	16	405	411
1981–1990	19,739	416	0.02	4.12	38	1302	1315
1991–2000	23,407	6396	0.27	2.75	288	25,127	26,444
2001–2010	26,995	22,772	0.84	2.05	496	114,323	126,104
2011–2015	18,253	29,503	1.62	2.29	455	321,878	355,266

P paper(s), *Kws* keywords, *CS* clusters, *LS* links, *TLS* total link strength, P_a total number of papers, P_b papers that provided author keywords

changes between information science and library science, Huang and Chang [17, 789] summarize their findings as follows: "[B]ased on the research generated by five library science journals and five information science journals, library science researchers tend to cite publications from library and information science (LIS), education, business/management, sociology, and psychology, while researchers of information science tend to cite more publications from LIS, general science, computer science, technology, and medicine." The authors conclude as follows: "[D]isciplines with larger contributions to library science are almost entirely different from those contributing to information science." The current study's findings concur with Huang and Chang's [17] findings in that LIS researchers might have not only consulted information sources in other disciplines, but also conducted research that may be termed as multidisciplinary, interdisciplinary and/or transdisciplinary. This is evident through the appearance of such keywords as *health care, mental health and illness, geographic information systems, women's health, information technology, Internet, social media,* and *e-government*, among others.

Estabrook had observed in 2010 that "LIS education and research continues to expand into newly developing areas of information organization and use" such as "discipline-specific applications of informatics… the study of design, application, and use of information technology within specific domains" [9, 3291]. The author further predicted that LIS would expand and develop into the area of data curation—that is, "data creation, management, preservation, and use". Whereas the former featured prominently in the early years of investigation in this study, the latter was not as strongly visible. Nevertheless, *data management* appeared in seven articles in 1991–2000 and twenty times in 2011–2015. *Research data management*, one of the emerging concepts in LIS research, was ranked in position 961 in 2011–2015 while it never appeared among author keywords in 1991–2000. Whereas *data management* seems to be interdisciplinary, the uptake and ownership of *research data management* by librarians is taking shape in the LIS field. LIS has, however, evolved into some newly developing areas such as knowledge management, information literacy and bibliometrics. The context of study is inclined towards academic libraries, although there was some visibility of *public libraries*, a keyword that appeared 117 times and ranked 25th in 2011–2015. Overall, both strands of LIS, namely library science (LS) and information science (IS), have experienced new areas of development. However, IS tends to receive more research attention than LS. The most commonly used author keywords to describe LIS research, throughout the entire period under investigation in this study, emphasizes an understanding of the properties of information and how to manage it (i.e. IS) as opposed to organizing and providing access to collections of materials (i.e. LS) (see [9]). This pattern is consistent with Huang and Chang's [17] observation that the degree of interdisciplinarity in IS has consistently remained above that of LS from 1978 to 2007.

An analysis of this study's findings according to Jarvelin and Vakkari's main classes of their classification scheme (see Tuomaala et al. [34]) for LIS reveals that LIS research is largely concentrated in Class 700 (scientific and professional communication) as well as Class 500 (information storage and retrieval). Class 660 (information management [IRM], knowledge management) and Class 440 (user education, including information literacy), too, have become a major contributing

knowledge sub-field in LIS research. The emphasis on the use of ICTs (including Internet, social media, social networks, etc.) in different facets of LIS profession (e.g. provision of services, conducting LIS-based activities, teaching and learning, management, etc.) has also attracted researchers' interest, thereby shaping the current trends in LIS education, research and practice. It was noted that author keywords associated with one of the major components of the LIS field, namely archives and records management, was conspicuously missing in the list of the top ranked author keywords. Neither were the following recent developments in LIS practice and education visible: introduction of new rules for information resource description (RDA—Resource Description and Access), information ethics, infopreneurship or knowledge entrepreneurship; implying that the areas have not attracted much attention from research in LIS.

Finally, going by the increase in the number of author keywords and the growth in terms of the average number of keywords per article, clusters and links among the keywords, the LIS field can be said to be evolving. We anticipate witnessing the dominance of bibliometrics and related methods (e.g. scientometrics, citation analysis, etc.) in the LIS research and, possibly, education; the latter being more pronounced at post-graduate level. The interest that research support, ranking and assessment have received at universities, governments, libraries, and research organizations is likely to greatly influence the dominance of bibliometrics in the field.

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