

## **Cloud Computing in Context with Library and Information Science (LIS): A Scientometric Analysis and Knowledge Mapping**

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### **Abstract**

Cloud computing (CC) has been a buzzword in recent years. The application of cloud computing has been seen in almost all domains. It has also sparked interest in Libraries and the Information field because it provides new solutions to the emerging problem. The study aims to map LIS's global cloud computing literature between 2010 and 2021. Scientometric methods were employed to gauge the global research performance on cloud computing LIS. The analysis also identifies the leading countries, Institutions, authors, sources, funding agencies, authorship pattern, international collaboration, and most used author keywords on CC literature in LIS. The research data were retrieved from the Scopus database. 808 publications were downloaded and analyzed with the help of bibliometric tools such as Biblioshiny, Bibexcel, VOSviewer, and Microsoft Excel. The study results showed that research on cloud computing in LIS has a mounting trend in publications and citations during the 12-year study period. The highest number of research papers were published in 2020 (n=135), China produced the maximum research in the field with 194 publications, and the top three organizations identified from Taiwan contributed the maximum research. Cloud computing, big data, and Knowledge Management were acknowledged as LIS researchers' most important research area. However, e-learning, library services, systematic reviews, bibliometrics, and blockchain have gained recent research absorption. Two authorship patterns were the most prevalent among the LIS researchers, and the authors from China and the USA preferred to collaborate highest in the field.

**Keywords:** Cloud Computing, Library and Information Science, Scientometric, Literature Review, Knowledge Mapping.

### **Introduction**

Cloud computing (CC) is one of the hottest terms used in the information technology (IT) industry (Antonio Regalado, 2021). It refers to storing and accessing data and programs through the Internet rather than the hard disk; the Internet is symbolized as the cloud. The foundations of cloud computing were laid down years ago when companies started

experimenting with storage and virtualization approaches. The concept of virtual machines was initiated in 1970, while telecommunications firms began offering virtual private network (VPN) services with a comparable level of service in the 1990s, replacing specialized point-to-point data circuits. A virtual private network allowed them to share the same hardware infrastructure for various operators, giving rise to cloud computing development (Dutt, 2015). It has been debated for a long time who coined the phrase "cloud computing" among scientists, but it was said that the term was first used by Compaq's internal document in 1996 (Antonio Regalado, 2021). The National Institute of Standards and Technology (NIST) defined CC as "Cloud computing is a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction." (Mell, Grance & Grance, 2011, P. 2). In other words, it can be said that CC uses shared computing resources instead of local servers or personal devices to handle applications. There are four types of CC service models, i.e., Software as a service (SaaS), Platform as a service (PaaS), Infrastructure as a service (IaaS), and Container as a Service (CaaS) (Alouffi, Hasnain, Alharbi, Alosaimi, Alyami & Ayaz, 2021). The CC infrastructure is deployed in four models: Public Cloud, Private Cloud, Community Cloud, and Hybrid Cloud (Sinha, Bhattacharjee & Bhattacharjee, 2014).

Due to the emergence of information technology (IT), the libraries converted to automated libraries, which coined the concept of virtual libraries. The e-libraries, increase in internet usage, application of web-based tools, and library consortia system leads to more progress and challenges in the LIS field, which is adopting many new technology and trends, cloud computing is one of them (Gosavi, Shinde & Dhakulkar, 2012). CC plays a significant role in the LIS field to achieve low-cost library functioning. It has become a core area of research as LIS professionals identified the need. Therefore, in recent years, CC's popularity and rapid development have resulted in an explosion of research publications in this field. This TMI (too much information) in CC research affects the researchers since the information is scattered all over, causing difficulties in locating important research, identifying the relevant sources, and following the research trends of CC in LIS, making it challenging to understand and access the overall growth and development without any analytical approaches.

### Literature Review

Anandhalli, Hadagali, Shettar and Kiran (2021) examined the global research performance of CC technology published in the Scopus database between 2007 and 2019. A total of 73174 research papers were downloaded and analyzed, and findings show that the highest literature growth was noted in 2018. China has published the most articles (19123) on CC technology. Beijing University of Posts and Telecommunications, with 1143 publications, has emerged as one of the top research institutes, and *Communications in Computer and Information Science* journal identified as a productive journal. Khan, Arjmandi and Yuvaraj (2021) examined the most cited research papers on cloud computing between 2010 and 2020 from the Dimensions database, analyzed in R Studio's Biblioshiny, a bibliometric analytical software. Journals such as *Future Generation Computer Systems*, *IEEE Communication Survey and Tutorials*, *IEEE Transaction on Parallel and Distributed Systems*, *Computer*, and *IEEE Access* are identified as highly impactful sources, and R. Buyya is a prolific author with nine citations. Ezenwoke & Emebo (2020) analyzed research productivity on cloud

computing in African nations between 2009 and 2017 from Scopus. The study's finding shows a strong significant correlation between internet penetration and the total number of scholarly outputs over the study period for all countries, suggesting that the increase in internet penetration is directly proportional to the rise in cloud computing research activities and outputs. The widespread use of Internet technology has considerably impacted research and academic outputs in ICT-related fields. Ezenwoke, Omosebi and Ezenwoke (2019) also performed a bibliometric analysis of educational cloud computing research between 2011 and 2017 from the Scopus database. There are 840 papers published. Saudi Arabia's King Abdulaziz University was noted as the most prolific institution, though China was the country that contributed the most to cloud computing and education research. Cloud computing has significantly impacted engineering and higher education than primary and secondary school education. Yu Yang, Zhu, Xu, Li and Zhang (2018) conducted a bibliometric study to analyze research productivity on cloud computing technology during 2005-2018 from Web of Science to investigate the research hot spots and international collaboration. The findings reveal that the quantity of papers in cloud computing is increasing, and numerous fields, including Computer Science, Engineering, and Telecommunications, are participating in cloud computing research. The Chinese Academy of Sciences is very active in cloud computing research, and its papers are far ahead of other institutions. China is the most prominent in international cooperation and has solid cooperative relations with the major countries. Satheesh and Rao (2016) demonstrated a scientometric analysis of cloud computing to investigate the evolution and state of cloud computing research. The researchers explored the term clusters to see how related subtopics interact. Jan, Wani and Hafiz (2015) have examined the development pattern of CC publications between 2009 and 2013 based on the Web of Science database by focusing on scientometric indicators such as relative growth rate and doubling time of literature growth. The study also used the collaborative index and modified collaborative co-efficient for authorship patterns. Heilig and Vob (2014) performed a scientometric analysis of cloud computing. This study uses scientometric methods to investigate the evolution and state of cloud computing research in terms of publishing trends, research impact, productivity, and especially international collaboration.

The above overview of the literature development shows that the scientometric or bibliometrics approaches are used to analyze the literature growth and subject development in CC research. However, no significant studies were conducted to map the CC literature growth in the LIS field. Therefore, this paper is designed to trace the CC literature in LIS to assess, analyze, and align the volume of research productions with the help of scientometric indicators. This study might help recognize worldwide research productivity trends, growth, and the subject development of CC research in the LIS field. For the scientometric assessment, the following objectives have been set:

- i. to assess the annual research growth and citation structure of CC in LIS
- ii. to identify the most relevant sources, organizations, and countries
- iii. to locate the most prolific authors and identify the pattern of authorship
- iv. to spot the most important author's keywords
- v. to trace the most cited research papers and influential funding agencies
- vi. to explore the research theme by analyzing author keywords
- vii. to detect the international collaboration in the production of literature on CC in LIS

## Materials and Methods

Scientometric analyses are considered to be steady to achieve the objective set above. Scientometric is a sub-discipline of bibliometric studies that examines scientific publications using statistical methods, and the bibliometric methods are extensively used in the LIS field. The research data was collected on 25 November 2021 at King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia. A total of 811 research papers were found, exclusion criteria have been applied, and four research papers from the publication year (2022) were excluded from the analyses; therefore, 808 research papers have been selected to conduct the study. The following search query (Figure 1) was framed in the advanced search box of the Scopus database to retrieve the bibliographic data. ("Library and Information Scienc\*" OR "library science\*") AND ("cloud computing"). Then, the 808 research papers were downloaded in different file formats to be analyzed in various bibliometric software such as VOSviewer (van Eck & Waltman, 2010), Biblioshiny (Aria & Cuccurullo, 2019), Bibexcel (Pradhan, 2016), and Microsoft Excel.

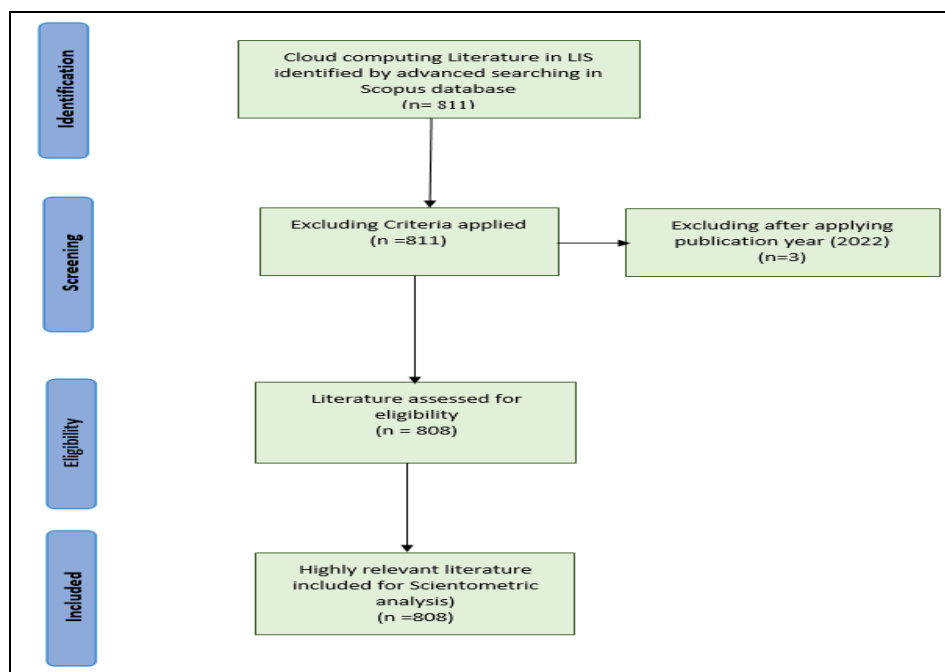


Figure 1: PRISMA Flow Diagram for Data Extraction Process on CC Research in LIS Between 2010 and 2021

## Result

Of the 808 procured documents, 60% were in article form, 24% were in conference papers, 16% were in other forms, and 97% were published in English. The 808 documents from 2010-2021 produced 6345 citations from 552 total cited publications. The average citation per publication was approximately 8. 468 sources, and 61624 references have been used to produce 808 publications between 2010 and 2021. 1864 authors contributed 2282 author keywords, Authors of single-authored documents being 168, while Authors of multi-authored documents were 1696. One hundred eighty-one publications were contributed by single authorship and 627 by multiple authorship. The author per publication was 2.31, and the publication per author was 0.433. In contrast, the collaboration index was 2.7, which implies a good collaboration among the cloud computing researcher in the library and

information.

### Growth and development of publications and citations between 2010 and 2021

Figure (2) demonstrates the growth and development of CC literature LIS from 2010-2021. 2010 was the pioneering year in producing CC literature in the LIS field, with ten publications and 236 citations, and the average citation per publication was 24. 2020 had the highest number of research papers, with 135 and 512 citations, followed by 2021, with 134 publications and 120 citations. 2019, with 103 publications and 501 citations, and 2016 and 2018, with 71 publications and 666 and 477 citations, respectively. Regarding the citation trends, 2015 received the highest citation with 1200 TC, followed by 2013 with 1049 citations, 2012 with 673 citations, and 2016 with 666 citations. The citation impact (CI) was highest for 2012 with 34, followed by 2010 with 24 and 2013 with 21. The analysis indicates that CC literature has increased exponentially in the LIS field. It is important to mention here that cloud computing papers for the year 2021 are included till 25 November. The citation scores for the most recently published papers will always be below; at least two years are required to obtain significant data.

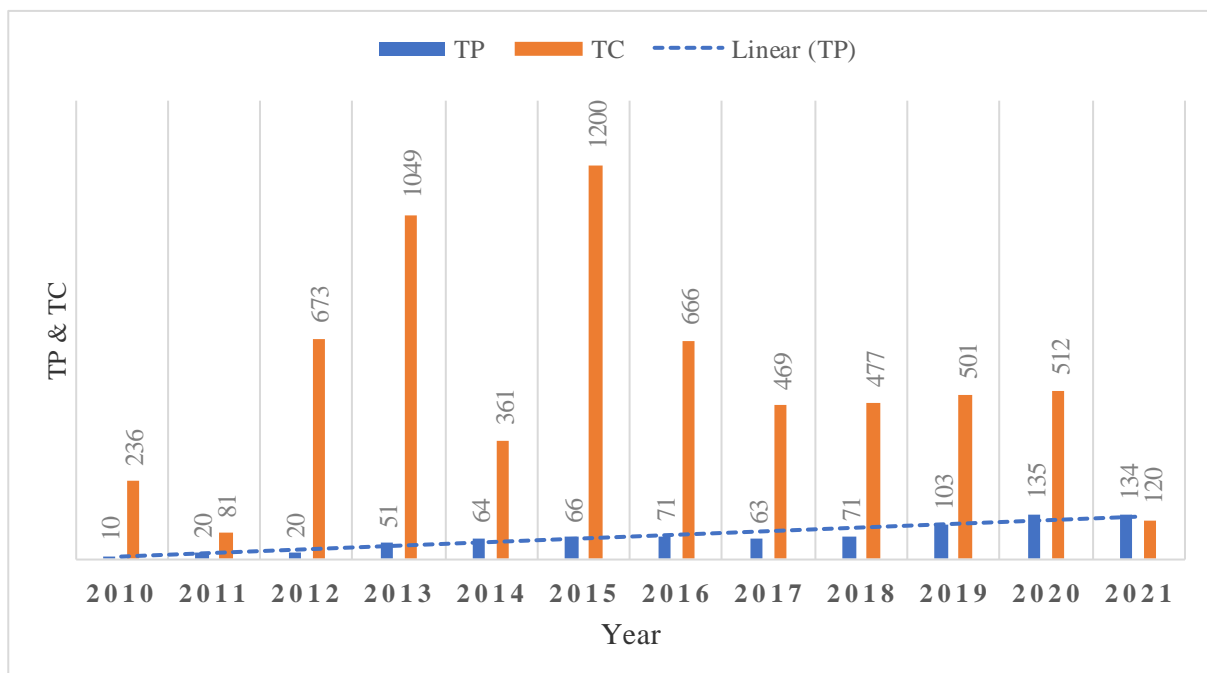


Figure 2: Growth and development of publications and citations

### Most productive countries and Organizations

Table 1 represents most leading countries and organizations highly engaged in CC research in LIS. China was the leading producer with 194 publications and 821 citations, followed by the USA with 111 publications and 2140 citations, India with 103 publications and 517 citations, Taiwan with 61 publications and 634 citations, and Malaysia with 36 publications and 186 citations. Spain was noticed as the least productive country in the top ten lists, with 23 publications and 441 citations. The research publication associated with United States institutions received the highest citations with 2140 TC. The average citation per

publication was highest for the USA and Spain, with approximately 19 TC/TP, followed by the UK, with around 11 TC/TP.

Regarding the top ten most prolific institutions (as shown in Table 1), four institutions affiliated with Taiwan were among the top ten productive institutions, followed by the institution from India and each from Sweden, South Africa, China, and Malaysia. Fu Jen Catholic University (Taiwan) was the most productive organization, with 36 publications and 370 citations, followed by Asia University (Taiwan) with 31 publications and 264 citations, the Tainan University of Technology with 21 publications and 111 citations, Högskolan I Borås (Sweden) with 13 publications and 188 citations and nine publication each from the University of South Africa and Chaoyang University of Technology respectively. Banaras Hindu University (BHU) was the least productive in Table 1, with five publications and 67 citations. Fu Jen Catholic University was the highest receiver of citations, with 370 TC. The highest average citation per publication was recorded for the publications affiliated with Högskolan I Borås (CI=14), followed by Banaras Hindu University (CI=13) and Fu Jen Catholic University (CI=10).

Table 1  
Top Ten Leading Countries and Organizations

Top ten countries					Top ten Institutions					
Rank	Country	TP	TC	CI	Rank	Organization	Country	TP	TC	CI
1	China	194	821	4.23	1	Fu Jen Catholic University	Taiwan	36	370	10.28
2	USA	111	2140	19.28	2	Asia University	Taiwan	31	264	8.52
3	India	103	517	5.02	3	Tainan University of Technology	Taiwan	21	111	5.29
4	Taiwan	61	634	10.39	4	Högskolan i Borås	Sweden	13	188	14.46
5	Malaysia	36	186	5.17	5	University of South Africa	South Africa	9	66	7.33
6	South Africa	34	102	3.00	6	Chaoyang University of Technology	Taiwan	9	52	5.78
7	UK	32	351	10.97	7	Nanjing University	China	8	79	9.88
8	Iran	26	62	2.38	8	Universiti Teknologi MARA	Malaysia	7	51	7.29
9	Nigeria	24	61	2.54	9	Rani Durgavati Vishwavidyalaya	India	6	60	10.00
10	Spain	23	441	19.17	10	Banaras Hindu University	India	5	67	13.40

TP=Total publications, TC=Total Citations, CI=Citations Impact

### Most relevant sources on CC literature in LIS

Table 2 show the top ten most preferred sources of LIS, where researcher publish their CC literature. The sources published by Emerald (n=3) and Springer (n=2) were the most preferred by LIS researchers contributing CC research papers. Among the top ten, Library Philosophy and Practice, published by the University of Idaho Library, was the most productive source in the list with 26 publications and 88 citations, followed by Library Hi-Tech with 16 publications and 104 citations, Electronic Library with 14 publications and 179 citations, scientometrics with nine publications and 195 citations and Lecture Notes in Computer Science with eight publications and 46 citations. Research papers published by Scientometrics engrossed the highest total number of citations (n=195) as well as the highest average citation per publication with 22 CI.50% (n=5) of the listed sources fell in the category of quartile one (Q1), followed by two in the third quartile and one in the second quartile. The

table also reveals that most journals were published in the United Kingdom (n=4), followed by the United States of America (n=2), and one from the Netherlands, Germany, Canada, and India.

*Table 2*  
*Top ten sources on cloud computing literature in LIS*

Rank	Source	TP	TC	CI	Q	Publisher	Country
1	Library Philosophy and Practice	26	88	3.38	Q2	University of Idaho Library	USA
2	Library Hi Tech	16	104	6.50	Q1	Emerald	UK
3	Electronic Library	14	179	12.79	Q1	Emerald	UK
4	Scientometrics	9	195	21.67	Q1	Springer	Netherlands
5	Lecture Notes in Computer Science	8	46	5.75	Q3	Springer	Germany
6	ACM International Conference Proceeding Series	7	15	2.14	NA	ACM	USA
7	Canadian Journal of Information and Library Science	6	23	3.83	Q3	University of Toronto	Canada
8	Journal of Documentation	6	37	6.17	Q1	Emerald	UK
9	Journal of the Association for Information Science and Technology	6	62	10.33	Q1	John Wiley	UK
10	Cloud Computing and Virtualization Technologies in Libraries	5	30	6.00	NA	IGI Global	India

TP=Total publications, TC=Total Citations, CI=Citations Impact, Q=Quartile

### Most Prolific authors

Table 3 presents the top ten most prolific authors of CC literature in LIS. Author Lee CC, affiliated with Asia University, Taiwan, was the most prolific author of CC in LIS with 30 publications and 453 citations, followed by Li CT from the Tainan University of Technology, Taiwan, with 18 publications and 214 citations. The third and fourth positions belonged to Lai YM from National Taiwan University, Taiwan, and Meshram C from Nagpur University, India, with eight publications each and 93 and 70 citations. Wittek P from the National University of Singapore has seven papers. Lee CC received the highest number of citations from Asia University, Taiwan, 453 for his 30 publications, with an average citation impact of 15. Hwang MS from Asia University managed the highest average citation (31) per publication.

*Table 3*  
*Top ten prolific authors on CCLIS*

Rank	Author	TP	TC	CI	Affiliations	Country
1	Lee CC	30	453	15.10	Asia University	Taiwan
2	Li CT	18	214	11.89	Tainan University of Technology	Taiwan
3	Lai YM	8	93	11.63	National Taiwan University	Taiwan
4	Meshram C	8	70	8.75	Nagpur University	India
5	Wittek P	7	71	10.14	National University of Singapore	Singapore
6	Chen Cl	6	50	8.33	Xiamen University of Technology	China
7	Meshram SG	6	55	9.17	Rani Durgavati University	India
8	Aharony N	5	69	13.80	Bar-Ilan University	Israel

Rank	Author	TP	TC	CI	Affiliations	Country
9	Darnyi S	5	30	6.00	University of Borås	Sweden
10	Hwang MS	5	155	31.00	Asia University	Taiwan

### Pattern of authorship

Figure 3 signifies the trend in the authorship pattern of CC literature in LIS. Two authorships have been the most trending authorship pattern of CC literature of LIS with 244 publications and 1384 citations, followed by single author publications with 181 papers with 1053. There were three authorships with 155 publications, 1390 citations, and four with 113 and 1294 citations. The highest number of citations received by the research publication was produced by three-authorship with 1390 citations, followed by two-authorship with 1384 citations and four-authorship with 1294 citations. Regarding the best average citation per publication in the authorship, ten-authorship received the highest citation impact of 637 citations for the single paper, followed by 13th authorship with 16 CI and four authorships with 11 CI for the 113 publications. The analysis indicated that researchers of CC literature in LIS were highly engaged in collaborative research. This collaborative trend also produced many citations in the field, with more average citations per publication in the multiple authorship than the single authorship pattern.

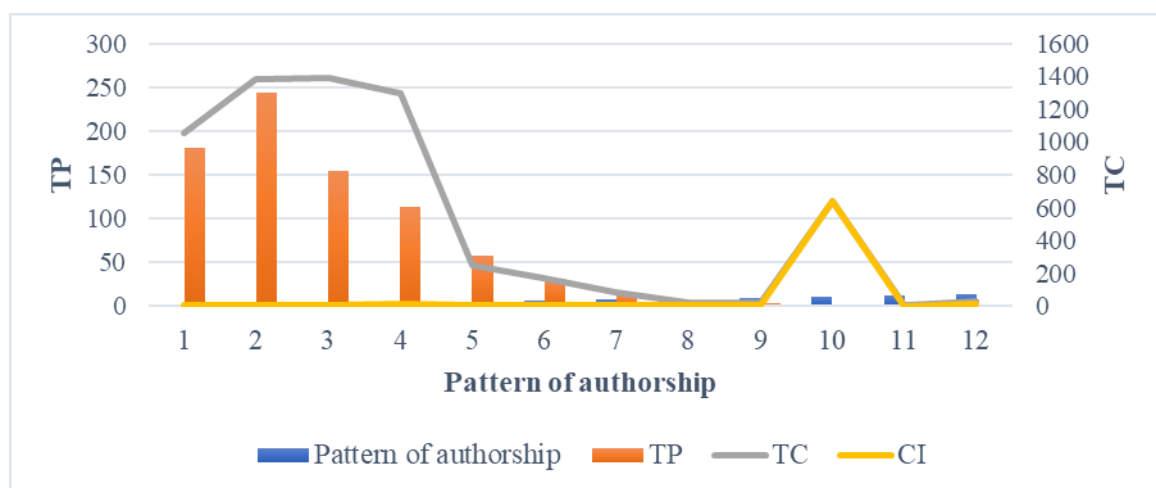


Figure 3: Authorship pattern

### Mapping co-occurrence of author keywords

Figure 4 highlights the most frequently used author's keyword of CC research in LIS. The analysis was done with the help of VOSviewer software, where five minimum occurrences of the author's keywords were considered. Therefore, from 2282 authors' keywords, 73 keywords meet the thresholds. All 73 keywords were grouped in 8 clusters; each color in the map represents different clusters. Each cluster represents a particular research theme that forms the map. The node's size indicates the frequency of the author's keyword occurrence. The keywords such as cloud computing, big data, bibliometric, academic libraries, digital library, internet of things, libraries, library, data mining, scientometric, security, social media, cloud storage, co-word analysis, privacy, citation analysis, knowledge management, information



technology, social network analysis, and e-learning were most frequently occurred author's keywords on CC research in LIS.

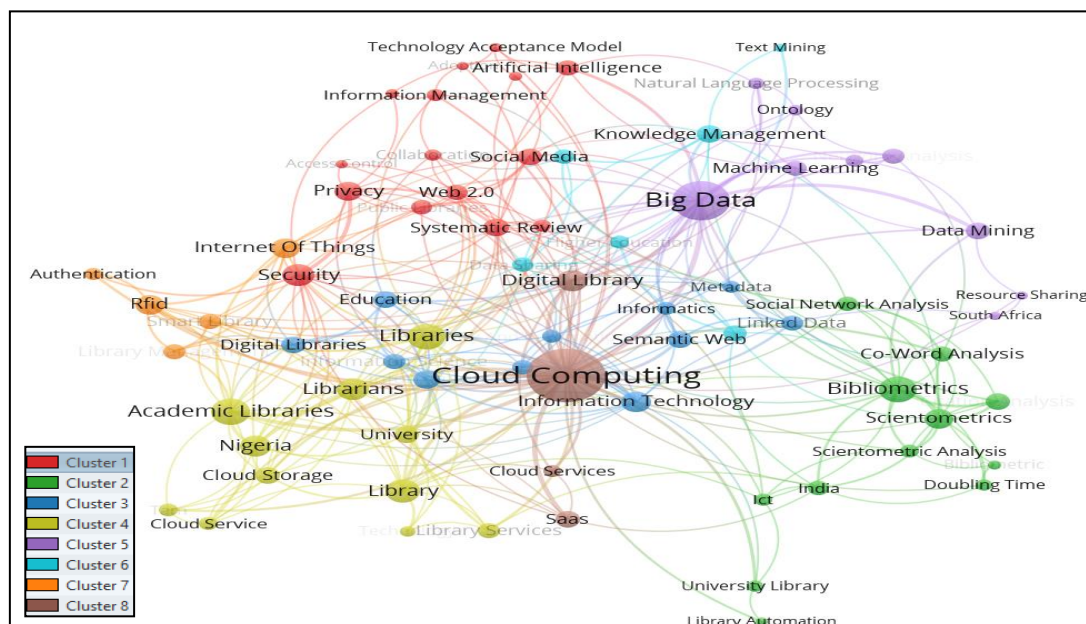


Figure 4: Mapping of Author's keywords Using VOSviewer Software

### Thematic evolution of author keywords

Figure 5 demonstrates the thematic evolution of author keywords used for CC literature in LIS. With the help of the Bilioshiny software, the study was separated into two time slices to observe the usage and emergence of various author keywords at different times. Cloud computing, the Internet of Things, digital libraries, big data, education, information technology, cloud storage, libraries, social media, security, and knowledge management were the most common keywords of CC research in LIS during the first nine years (2010-2018). The recent keywords like e-learning, library services, systematic reviews, bibliometric, and blockchain emerged during the last three years (2019-2021), indicating a change in research themes from the initial nine years to the last three years. Cloud computing, big data, and knowledge management have been the most famous research themes throughout the 12 years research period of the CC in LIS.

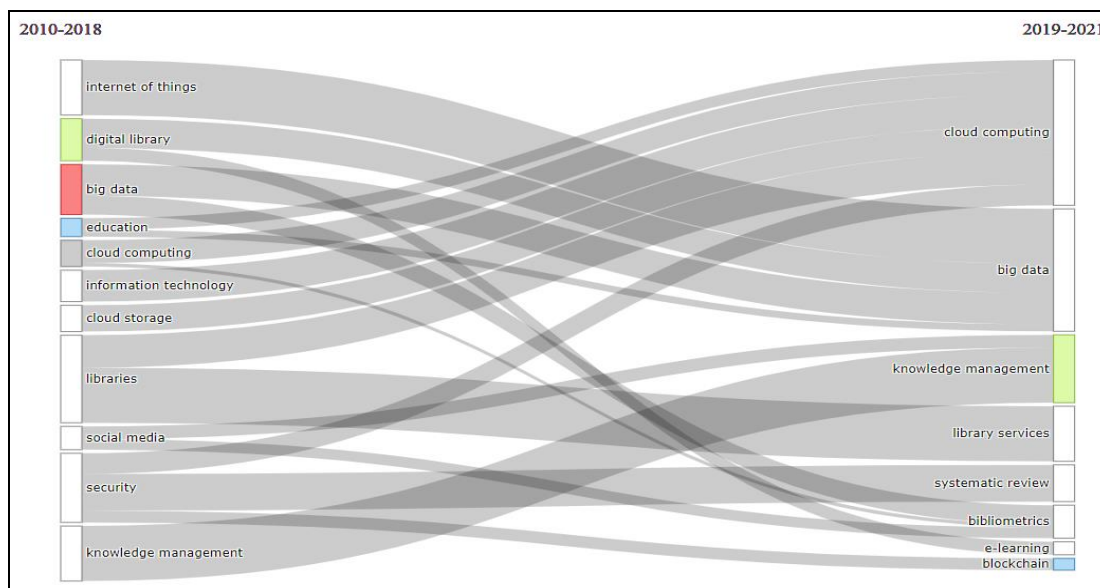


Figure 5: Thematic Evolution of Author Keywords Using Biblioshiny Software

### Most cited research paper on cloud computing in Library and information science

Table 4 represents the top ten most cited research publications of CC in LIS. The total citations among the top ten publications ranged between 65 and 637. The article titled "Big Data: Astronomical or Genomical?" (2015) by Stephens ZD was the most cited publication with 637 citations (Stephens et al., 2015). Among the top most cited research papers, the article entitled "A systematic method to create search strategies for emerging technologies based on the Web of Science: illustrated for 'Big Data'" by Huang, Schuehle, Porter and Youtie (2015) was the least cited in the list with 65 citations. Again, the most cited article entitled as "Big Data: Astronomical or Genomical?" received the highest total citation per year (TC/Y) as well as the highest normalized total citation (n=35.04 NTC) (ibid).

Table 4

Top ten most cited research papers on Cloud computing in LIS

TC	Title	Author	Year	Source	TC/Y	NTC
637	Big Data: Astronomical or Genomical?(Stephens et al., 2015)	Stephens ZD	2015	Plos Biol	91	35.04
486	The impact of polices on government social media usage: Issues, challenges, and recommendations (Bertot, Jaeger & Hansen, 2012)	Bertot JC	2012	Gov Inf Q	48.60	14.44
344	Security and privacy in electronic health records: a systematic literature review(Fernández-Alemán, Señor, Lozoya & Toval)	Fernndez-Alemn JL	2013	J Biomed Informatics	38.22	16.72
120	Increasing process orientation with business process management: Critical practices' (Škrinjar & Trkman, 2013)	Krinjar R	2013	Int J Inf Manage	13.33	5.83
112	A survey on attribute-based encryption schemes of access control in cloud environments(Lee, Chung & Hwang, 2013)	Lee CC	2013	Int J Netw Secur	12.44	5.45
84	Interactions with Search Systems(White, 2016)	White RW	2016	Interact with	14.00	8.96

				Search Syst		
79	Moving towards smart cities: Solutions that lead to the Smart City Transformation Framework(H. Kumar, Singh, Gupta & Madaan 2020)	Kumar H	2020	Technol Forecast Soc Change	39.50	20.83
77	Visualizing the knowledge structure and evolution of big data research in healthcare informatics (Gu, Li, Li & Liang, 2017)	Gu D	2017	Int J Med Informatics	15.40	10.34
68	An Introduction to Search Engines and Web Navigation (Levene, 2010)	Levene M	2010	An Introd To Search Engines and Web Navig	5.67	2.88
65	A systematic method to create search strategies for emerging technologies based on the Web of Science: illustrated for 'Big Data' (Huang et al., 2015)	Huang Y	2015	Scientometrics	9.29	3.58

\*TC/Y=Total citation per year, \*\*NTC=Normalized total citations

### Most influential funding agencies in Cloud computing literature in LIS

Table 5 presents the top ten international funding organizations that actively participated in the production of CC research in LIS. It was noted that numerous agencies had funded CC research of LIS; among them, the National Natural Science Foundation of China was found as the leading funding agency, and a similar result was reported by Rahaman, Ansari, Kumar and Shah (2021). This was followed by the Ministry of Science and Technology (Taiwan) and the National Science Foundation (USA). National Office for Philosophy and Social Sciences (China), funding 13 and 10 publications, respectively. China Postdoctoral Science Foundation, Deutsche Forschungsgemeinschaft (Germany), and National Research Foundation of Korea were among the top ten least sponsoring agencies in the table, with three publications each. It is essential to mention that most of the research was funded by Chinese institutions (n=43), followed by Twain (n=22), USA (n=13), and Belgium (n=8).

Table 5  
Top ten funding agencies in CC literature of LIS

Rank	Funding agency	Country	TP	TC	CI
1	National Natural Science Foundation of China	China	24	176	7.33
2	Ministry of Science and Technology	Taiwan	22	164	7.45
3	National Science Foundation	USA	13	749	57.62
4	National Office for Philosophy and Social Sciences	China	10	32	3.20
5	European Commission	Belgium	8	38	4.75
6	Engineering and Physical Sciences Research Council	UK	6	47	7.83
7	Ministry of Education of the People's Republic of China	China	6	25	4.17
8	China Postdoctoral Science Foundation	China	3	35	11.67
9	Deutsche Forschungsgemeinschaft	German	3	2	0.67
10	National Research Foundation of Korea	Korea	3	89	29.67

### Country collaboration Map

Figure 6 exhibits the map of the collaborating countries developing CC literature in LIS.

It implies that the collaboration between China and the USA researchers has resulted in 15 publications on CC research in LIS, the leading producer of research publications prepared to collaborate between any two countries among the top ten leading funding agencies, followed by China and India with 9 Publications. This was followed by five publications: China and the UK, Malaysia and Saudi Arabia, the USA and the UK. China and Australia collaborated on four publications, three by Malaysia and Iran, Nigeria and South Africa, Pakistan, Saudi Arabia, and The USA and Austria.

Rank	From	To	TP	Rank	From	To	TP
1	CHINA	USA	15	6	CHINA	AUSTRALIA	4
2	CHINA	INDIA	9	7	MALAYSIA	IRAN	3
3	CHINA	UNITED KINGDOM	5	8	NIGERIA	SOUTH AFRICA	3
4	MALAYSIA	SAUDI ARABIA	5	9	PAKISTAN	SAUDI ARABIA	3
5	USA	UNITED KINGDOM	5	10	USA	AUSTRALIA	3

*Figure 6: International Collaboration*

### Discussion

The quantitative scientometric approach was used to analyze the data retrieved from the Scopus database to assess the growth and development of CC literature in LIS for a decade (2010-2021). The results have given a complete and clear insight into the subject development. In 2010, the LIS researchers started considering the study of CC and produced ten research papers. This study area showed remarkable growth, but 62% of research contributed during the last five years. The findings align with Ezenwoke et al. (2019) and Yu et al. (2018). The research citation also showed an increasing trend; maximum citations have been received from 2012 to 2020. The citation impact for the recent years is lower than the older years, as it required at least one to two years to get expressive data. This finding opposes Baldwin, Alhawi, Shaughnessy, Akinbi and Dehghantanha (2018), who have studied cloud forensics and found that in recent years, received the highest number of citations. Chinese are highly driven in the production of CC research in LIS. They contributed the most research papers and financed more research; their country's collaboration was also noticeable in the literature production. Baldassarre, Caivano, Dimauro, Gentile and Visaggio (2018) have systematically mapped cloud computing for education, and China was the most productive country. After China, The USA, India, and Taiwan also placed among the top five most productive countries where authors and institutions contributed with more research, begging citations, and extending hands to contribute to the literature production. However, the USA had the highest average citation per publication (19). The results are also similar to those of Baldwin et al. (2018), Anandhalli et al. (2021), and Baldassarre et al. (2018). Malaysia, South Africa, the United Kingdom, Iran, Nigeria, and Spain are other leading contributors to CC research in LIS. Further analysis regarding the most productive organizations, Fu Jen Catholic University (Taiwan), Asia University (Taiwan), the Tainan University of Technology, Höskolan I Borås (Sweden), and the University of South Africa were the top five most productive organizations in CC literature in LIS. This result contradicts other scientometric analyses by Ezenwoke et al. (2019), Chaurasia, Chavan, and Verma (2016), Yu et al. (2018),

and Khan et al. (2021). While considering the most prominent sources, the analysis showed that Library Philosophy and Practice became a leading producer of the literature on CC in LIS (n=26), indicating its popularity among LIS professionals and researchers. Siddique, Rehman, Khan and Altaf (2021) stated a similar type of analysis. The journal has a speedy review and publication process and is indexed in Scopus, assuring quality. This finding is in agreement with Siddique et al. (2021). The journal *Scientometrics* engrossed the highest total number of citations (n=195) and the highest average citation per publication with 22. The possible reason for begging the highest citation is Springer published this high quartile journal (Q1). The most prolific (Lee CC) author also belongs to Taiwan. The other leading authors in the fields are Meshram C. from India, Wittek P. from Singapore, Chen C.L. from China, Aharony N. from Israel, and Darnyi S. from Sweden. The findings showed that the authorship of two authors (n=244) is more prevalent, similar to reports by Kumar, Joshi, Rahaman and Ansari (2021); Rahaman, Ansari, Kumar, Shah (2021) and Rahaman, Ansari, Tewari and Shah (2021). This finding contradicts Anandhalli et al. (2021), who identified the authorship pattern as the three-authorship contributing the highest number of research papers. It is worth mentioning that 10th authorship received the highest average citation per publication, with 637 citations for a single publication. Regarding the most influential funding agencies, the National Natural Science Foundation of China, the Ministry of Science and Technology (Taiwan), and the National Science Foundation (USA) were the most influential. The finding showed moderate international collaboration in producing CC literature in the field of LIS, with the highest collaboration among China with the USA, India, and the UK. The reflection of the analyses suggested that researchers of CC in LIS are highly engaged in collaborative research since this collaborative work trend led to achieving the highest number of citations and has more average citation per publication in the multiple authorship instead of the single authorship. The thematic evolution of author keywords reveals that the subject development and the sub-area of research study, cloud computing, big data, and knowledge management have been the most prominent research themes throughout the research period. Then the other concerning sub-area arises, such as e-learning, library services, systematic reviews, bibliometric, and block-chain are new research themes. Research topics like the internet of things, digital library, information technology, social media, and security need further contemplation and emphasis.

### Conclusion

Based on the literature review, this study was the first scientometric study conducted for CC research in LIS. The scientometric approach to studying one-decade research production reveals that until 2010, no investigation was conducted in the LIS field to study CC, but after that, there was consistent research growth in publication and citations from 2012 to 2020. The researchers identified the study area and worked on cloud computing, big data, and knowledge management. However, with the thematic evolution analysis, the researcher would like to suggest that the Internet of Things, digital library, information technology, social media, and security require more study focus. The mapping of this scientometric study will aid the new researchers, professionals, and academics in the field in identifying mistreated topics that deserve additional attention. Based on the theme and keywords analysis, it will be easier for the upcoming researchers to focus on finding and filling the gaps in the most forthcoming and challenging areas.

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