The Changing Landscape of Digital Library Services Research: A Comparative Study of Two Periods (1994–2023)

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Abstract

This research employed a bibliometric analysis to investigate the trends and development of digital library service publications in the Scopus database over two distinct periods time: 1994–2008 and 2009–2023. A total of 415 related articles were analyzed (199 documents in the early period and 216 in the later period). The study was conducted using the Bibliometrix-R package in RStudio to analyze and visualize the data. The research aimed to compare the publication output, citation frequency, research themes, and patterns across the two periods. The results revealed a slight increase in the number of publications in the later period, while the citation frequency significantly declined. The United States remained the most prolific country in this research domain throughout both periods. The International Journal on Digital Libraries and The Electronic Library were the leading publication sources in the respective timeframes. In addition, the study identified patterns of co-occurrence and thematic evolution of key research topics, including digital libraries, information services, metadata, user experience, and service quality. The findings offer practical insights and serve as a guideline for future research and development in digital library services.

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Keywords: Bibliometric analysis, Library service, Digital library service, Digital libraries, Biblioshiny

Introduction

Due to rapid changes and advancements in technology, digital library services are one of the important services provided by libraries. This has led to the availability of digital library services that allow library users to access information conveniently and quickly, as they seek to learn and research various types of information. Digital library services involve the integration of digital tools with computer systems, information storage, and communication capabilities using necessary software to create services that are similar to traditional libraries. This includes gathering and organizing various types of information and media for storage, retrieval, and dissemination (Shrivastava, 2022). Therefore, digital library services provide an alternative option for library users who wish to search for and access information extensively without the need to travel to the physical library (Sun & Yuan, 2012). These services provide wide-range access to digital information sources, enabling users to explore and retrieve information conveniently though the Internet. The services offered include search tools for e-books, academic databases, online journals, electronic theses and dissertations, as well as email communication (Kenchakkanavar, 2014; Ekere et al., 2016). The digital library service remains highly significant in promoting learning and educational development for individuals in society. In addition, it can also foster collaboration, knowledge sharing, and interaction between the library and its users, contributing to the development of contemporary skills and knowledge.

Currently, digital library services have gained immense popularity and hold significant importance. This is primarily due to the fact that digital libraries serve as important and valuable sources of information for a wide range of users, including students, researchers, and individuals seeking access to diverse information on various topics. For example, digital libraries at the university level have gained increasingly popularity and importance in the wake of global Covid-19 pandemic in 2019. The pandemic highlighted the significance of digital library services, with scholars Mehta and Wang (2020) emphasizing their growing importance, particularly in ensuring uninterrupted access to academic resources and supporting remote learning during times of crisis. Digital libraries offer numerous advantages, including enhanced convenience in accessing information and swift updates to the library's collection without the need for users to

physically visit the library. Technology has undoubtedly played a crucial role in revolutionizing library services across all aspects. Digital libraries provide distinct services compared to traditional libraries, as they store information in digital formats that are highly accessible through networks (Arms, 2000).

This research aims to study literature on digital library services through the utilization of content analysis, a well-established method widely employed in diverse research fields worldwide. Furthermore, the use of bibliometric analysis has shown a consistent upward trend, with an increasing number of research studies adopting this technique. Therefore, several researchers have explored and published works using bibliometric analysis techniques; for example, the study of Ali et al. (2022) investigated the bibliometric research in information literacy and research support services in academic libraries; and global research on library service quality in the Web of Science database (Ashiq et al., 2022). Therefore, digital library service with bibliometric techniques in the Scopus database has found a lack of research on this dimension. In order to promote research on library services and improve service delivery to meet the satisfaction and needs of library users, researchers and institutions must adopt user-centered and evidence-based approaches. This research aims to study and review relevant literature using bibliometric techniques, because this technique requires advanced statistical data with software to help store and analyze the data, such as, CiteSpace, SciMAT, Bibexcel, VOSviewer, etc. (Innovation Foresight Institute, 2019). These tools can bring information from various bibliographies and scientific databases to create charts and citation networks that provide a clear overview of bibliometric research data. Researchers are therefore able to analyze data and produce research reports of higher quality.

Research Objectives

The objective of this research is to analyze publications, network countries, authors, affiliations, and journals and topics relating to digital library services using literature analysis. By comparing studies between 1994-2008 and 2009-2023 in the Scopus database, this research also aims to demonstrate the topics and trends of publications related to this subject. The results could be valuable for policymakers, librarians, academics, researchers, and those interested in studying this subject. It could serve as important foundational data for advancing research, promoting research, creating more publications on digital library services, and identifying gaps for current issues in future research on this topic.

Research Methodology

This research examines publications on digital library services, using Scopus as the selected database for data collection. As part of the Domain Discovery, the study identified key terminology and conceptual boundaries within the field of digital library services based on previous literature. Scopus was chosen due to its status as the largest scientific literature database, offering a comprehensive collection of abstracts and references. It is widely recognized as one of the most comprehensive electronic databases covering a wide range of academic disciplines. (Chander et al., 2022; Donthu et al., 2021; Falagas et al., 2008; Mongeon & Paul-Hus, 2016). The researchers conducted the search using the search string TITLE-ABS-KEY ("digital librar* service" OR "virtual librar* service" OR "electronic librar* service" OR "library without walls service"), where the asterisk symbol (*) serves as a wildcard to include variations of a word root. Based on the literature review, the terms “digital library”, “virtual library”, “electronic library”, and “library without walls” are commonly used to define the meaning of digital library (Cleveland, 1998; Nazim & Saraf, 2005; Magoi & Gani, 2014; Mishra, 2016). Therefore, these terms are used as keywords in this research methodology.

This step corresponds to the Data Collection and Extraction phase, where the search terms were developed based on the literature review of Cleveland (1998), Nazim and Saraf (2005), Magoi and Gani (2014), and Mishra (2016), all of whom are notable researchers in the field of digital libraries. The selection of these four search terms contributes to comprehensive data collection and provides a representative overview of the evolution of library services in the digital era. Data were extracted from the comparative study covering two time periods, 1994-2008 and 2009-2023. Only articles written in English were selected for analysis. Subsequently, the researchers opted to employ the program Bibliometrix-R (Aria & Cuccurullo, 2017) and MS Excel for data analysis for cleaning. Duplicate records were identified and removed using the “Data » Remove Duplicates » Select All” function. The data analysis, along with the creation of visual representations, was conducted on 2 April 2023.

During the Data Processing Stage, the extracted bibliographic data were cleaned, organized, and structured to ensure consistency and reliability. This included the removal of duplicates, standardization of author and affiliation names, and preparation of the dataset for bibliometric analysis. For Visualization and Mapping software, the study employed the Bibliometrix-R package (version 4.2.2), which enabled the generation of network diagrams and

thematic maps. These visual tools revealed the co-occurrence of keywords, research clusters, and thematic evolution across the study period, providing a clearer picture of trends and relationships in the field (Aria & Cuccurullo, 2017). In the final phase, Analyzing, Interpreting and the Results, the visual and statistical outputs were interpreted using a modified analytical framework based on Jabeen et al. (2015). This interpretive approach allowed for a deeper understanding of the development, key contributors, and research gaps in digital library services over the studied timeframe.

Modified from: Jabeen et al. (2015)

Figure 1 The Procedure of Bibliometric Analysis

Research Findings

1. Publication Output and Citations

Figure 2 (A) displays the results depicting the number of publications in the two different periods. In the early period from 1994-2008, a total of 199 articles were identified. The highest number of articles was observed in 2006, with 28 articles, followed by 2002 with 25 articles and 2005 with 19 articles. During the later period from 2009 to 2023, a total of 216 relevant articles were discovered. Among these, the year 2021 stood out with 21 articles, while both 2009 and 2011 shared the same number of articles, totaling 18 each. The higher number of papers published during the first 15 years compared to the last 15 years suggests a potential increase in research area or interest in this area of study. However, it is important to note that the number of publications alone does not necessarily indicate the quality of the research. Nevertheless, it can serve as an indication of the growing interest and increasing publication activity in the field during that period.

In Figure 2 (B), the total number of publications referring to library services during the early period from 1994-2008 was 2,099. While in the subsequent period from 2009-2023 the total number dropped to 1,141. This shows that in the early year, there were more references to published works on library services than in the latter (2009-2023). It was noticed that the

number of citations began to decrease significantly compared to the number of published works of digital library services. Therefore, it can be concluded that the number of citations and the number of published works of digital library services differed significantly for each period from the comparison of the production of published works as shown in Figure 2 (A-B).

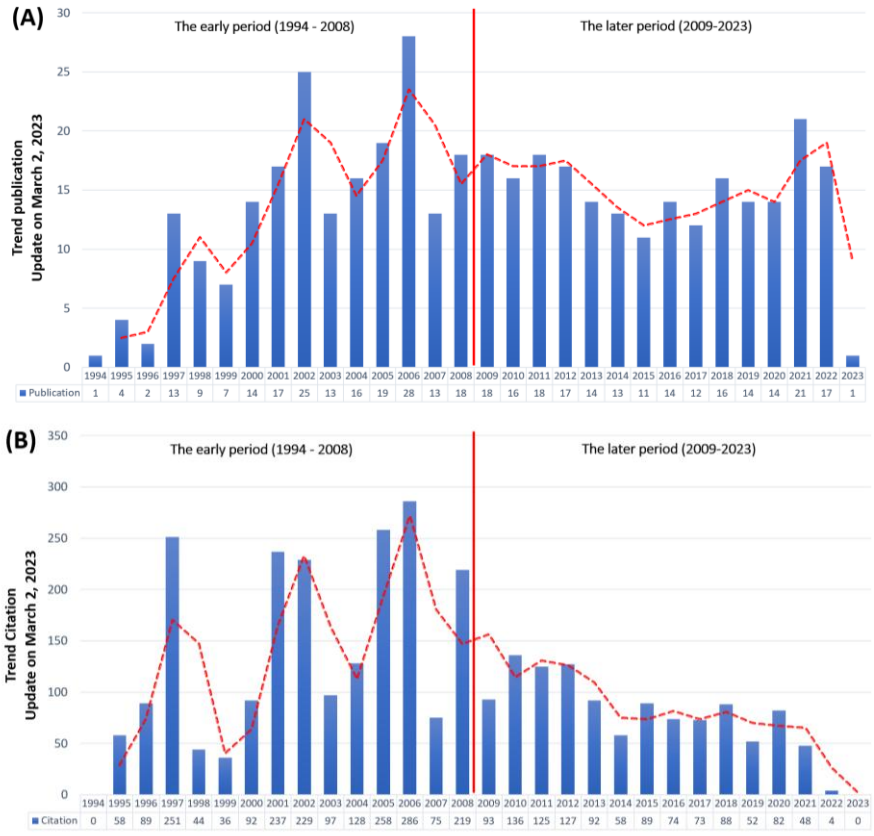

Figure 2 Number of publications trend (A) and total number of publications citations for both periods (B) (1994-2008 and 2009-2023).

2. Publication type

Figure 3 reveals that during the early years (1994-2008), the highest number of documents were research articles (88 articles), followed by conference papers (72 articles) and review papers (28 documents). In the latter years (2009-2023), the most prevalent types of publications were research articles (106 articles), followed by conference papers (74 documents), book chapters (24 documents), conference review and review papers (6 documents).

When considering both periods, it is evident that research articles had the highest number of publications, closely followed by conference papers. It is worth noting that digital library services had a limited presence in the category of books and note. This indicates a

clear tendency among authors and researchers to publish research articles and conference papers over other publication types.

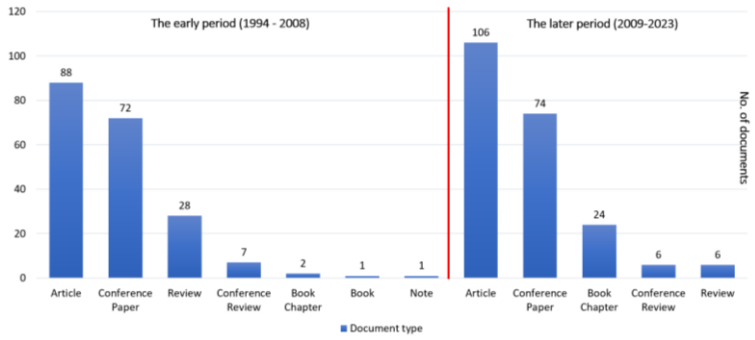

Figure 3 Types of published works

3. Sources

Table 1 shows the analysis results of 415 publications, highlighting the journal with the highest H-index and the number of citations. The findings indicated that during the early years (1994-2008), the International Journal on Digital Libraries achieved the highest H-index of 7, with a total of 298 journal citations. This was followed by Lecture Notes in Computer Science with an H-index of 6 and Library Review with an H-index of 5, respectively. Furthermore, the analysis results revealed that apart from sources published in journals, there were also publications from research articles in academic conferences. Notably, the Proceedings of the ACM International Conference on Digital Libraries and Proceedings of the ACM/IEEE Joint Conference on Digital Libraries were among the top 10 publications with the highest H-index and citation count. This demonstrates the significant impact of research conducted at the academic conference level in generating other publications.

In addition, Table 1 also illustrates the efficiency of research at the academic conference level in contributing to scholarly output. At the same time, during the years after 2009-2023, the research found that The Electronic Library Journal was the publication with the highest H-index of 7 with a total of 149 citations in the journal, followed by the Journal of Librarianship and Information Science with an H-index of 4 and the ACM International Conference. Proceeding Series, publications from academic conferences, have an H-index of 3, respectively. Upon comparing the two periods, it was observed that the top 10 journals remained consistent. In addition to works published at the journal level, there were also publications from academic conferences. This indicates that researchers during that period

were interested in submitting their papers for publication at both the journal and conference levels.

Notably, the Electronic Library Journal sustained its popularity throughout both periods. Despite the passage of time, researchers continued to submit their works for publication in this journal. Remarkably, the Electronic Library journal, which was among the top 10 in the early years, rose to become the top-ranked journal in the latter years. This indicates the sustained interest of authors and researchers in submitting their publications to this journal (Table 1).

Table 1 Top 10 most prolific publications

Rank	Sources	H-index[1]	TC[2]	NP[3]	PY_Start[4]
	Period 1994-2008				
1	International Journal on Digital Libraries	7	298	9	1997
2	Lecture Notes in Computer Science	6	157	25	1995
3	Library Review	5	83	11	2000
4	D-lib Magazine	4	99	6	1997
5	Library Trends	4	123	5	2000
6	Proceedings of the ACM International Conference on Digital Libraries	4	121	8	1999
7	Proceedings of the ACM/IEEE Joint Conference on Digital Libraries	4	112	6	2003
8	Reference Services Review	3	91	4	2000
9	Australian Academic and Research Libraries	2	16	2	2002
10	Electronic Library	2	37	3	2000
	Period 2009-2023				
1	Electronic Library	7	149	8	2009
2	Journal of Librarianship and Information Science	4	39	4	2011
3	ACM International Conference Proceeding Series	3	32	7	2015
4	Digital Library Perspectives	3	89	7	2020
5	Lecture Notes in Computer Science	3	33	6	2009
6	Library Philosophy and Practice	3	36	5	2013
7	OCLC Systems and Services	3	30	3	2009
8	CEUR Workshop Proceedings	2	4	2	2009
9	IFLA Journal	2	11	2	2009
10	International Journal on Digital Libraries	2	21	3	2010

Notes: [1]Highly-cited index or Hirsch index; [2]Total number of citations; [3]Net production; [4]Starting year of the journal

4. The top authors/researchers, countries, and affiliations

4.1 The top authors/researchers

Based on the research findings, it was determined that Gonçalves, M.A. was the author/researcher with the highest H-index and number of citations in digital library services during the early years (1994-2008). Gonçalves, M.A. achieved an H-index of 5 and a total of 80 citations. Following closely behind were Esposito, F., Fanizzi, N., Ferilli, S., Fox, E.A., and Semeraro, G. with an H-index of 4. Other authors/researchers ranked 6-10 in Table 2 had an H-index of 3. Meanwhile, for the later year (2009-2023), it was found that new authors/researchers with publications in the digital library service are Divayana, D.G.H., with an H-index of 4 and the highest number of citations was 67. Regarding other authors/researchers ranked 2-10 in the later years, their H-index was also 3, indicating similar levels of impact compared to the early years. The H-index values between the first and subsequent years did not exhibit significant differences. The citations of these authors/researchers were relatively consistent, with H-index values ranging from 2 to 5. Table 2 provides further details on the H-index values for these authors/researchers.

Table 2 Authors/Researchers with the highest contribution on digital library services

Period 1994-2008						Period 2009-2023					
Rank	Author	H-index[1]	TC[2]	NP[3]	PY_Start[4]	Rank	Author	H-index[1]	TC[2]	NP[3]	PY_Start[4]
1	Gonçalves, M.A.	5	80	5	2002	1	Divayana, D.G.H.	4	67	8	2017
2	Esposito, F.	4	57	7	1997	2	Fox, R.	3	30	3	2009
3	Fanizzi, N.	4	70	7	1997	3	Minyaev, I.	3	19	3	2018
4	Ferilli, S.	4	56	6	1997	4	Ojala, T.	3	24	4	2018
5	Fox, E.A.	4	73	4	2002	5	Pouke, M.	3	19	3	2018
6	Semeraro, G.	4	74	8	1997	6	Ylipulli, J.	3	19	3	2018
7	Castelli, D.	3	52	4	2002	7	Abadi, I.B.G.S.	2	25	4	2018
8	Choudhury, S.	3	84	3	2002	8	Adiarta, A.	2	33	2	2017
9	Joint, N.	3	29	7	2000	9	Candela, L.	2	5	2	2009
10	Malerba, D.	3	43	4	1997	10	Crivellari, F.	2	19	2	2009

Notes: [1]Highly-cited index or Hirsch index; [2]Total number of citations; [3]Net production; [4]Starting year of the journal; Total number of authors: 1994–2008 = 118; 2009–2023 = 520

4.2 The top countries

During the initial period (1994-2008), the United States emerged as the leading country in terms of research articles on digital library services, with 67 articles. The United Kingdom followed with 21 articles, Italy with 8 articles, China with 7 articles, and Japan with 5 articles.

In the later period (2009-2023), the trend continued with the United States maintaining its position as the primary contributor to research in digital library services, publishing a total of 30 articles. China closely followed with 25 articles. Additionally, Nigeria, Indonesia, and Pakistan each published a similar number of articles, ranging from 6 to 7.

Notably, countries in the Asian region began to play a more prominent role in producing publications related to digital library services after 2009. This shift highlights the increasing utilization of information technology in enhancing the capabilities of digital library services (Figure 4).

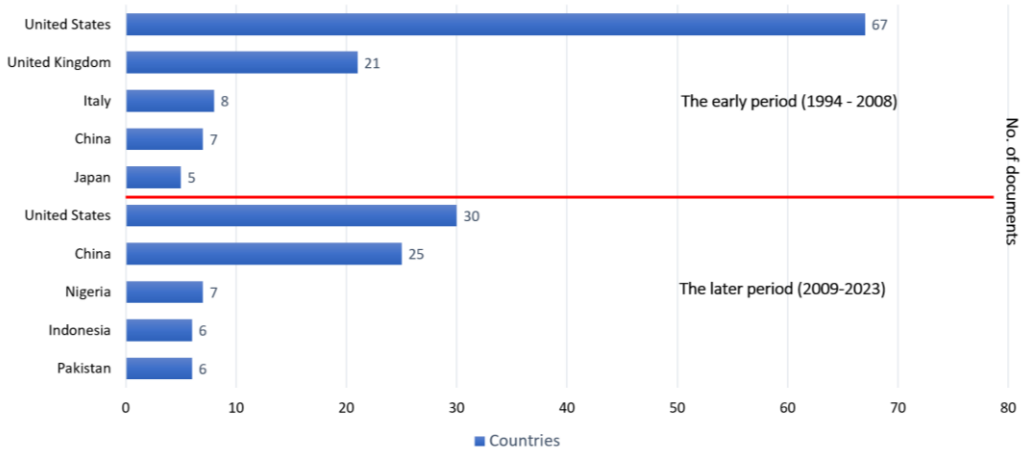

Figure 4 The top countries

4.3 The top affiliations

The analysis of the top 5 institutions during the early period (1994-2008) revealed that the University of California had the highest number of articles with a total of 15, followed by Stanford University with 12 articles, University of Strathclyde with 10 articles, Università Di Bari with 9 articles, and Universidade Federal de Minas Gerais with 8 articles. Meanwhile, in the period of 2009-2023, it was found that Universitas Pendidikan Ganesha had the highest number

of articles, with 17 articles, followed by University Politehnica of Bucharest with 7 articles, and University of Incheon, University Malaysia Sabah, and University of Nevada with the same number of 6 articles. It was also found that the number of publications between the two periods did not differ significantly at the institutional level. Additionally, the majority of publications in the field of digital library services originated from universities and other educational institutions. This indicates a widespread interest and engagement in creating publications related to digital library services. Therefore, it can be concluded that a significant portion of research and publications in this domain are conducted by educational institutions, primarily at the university level, across different countries (Figure 5).

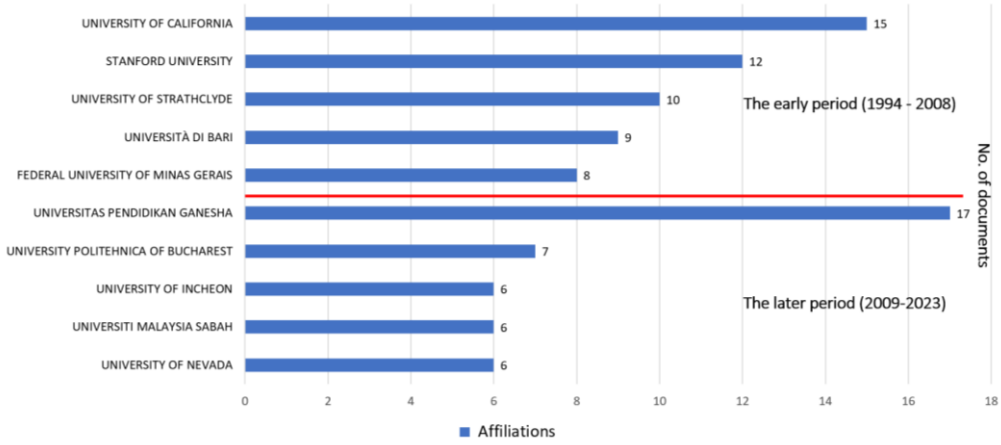

Figure 5 The top affiliations

5. The top cited documents

Table 4 shows the list of articles with the highest citation counts in digital library services research, based on the number of citations from the Scopus database. This demonstrates the significant impact of these articles on digital library services research. The analysis found the top 5 most cited articles and their Field-Weighted Citation Impact (FWCI) in the Scopus database. The comparison is conducted between two distinct time periods: 1994-2008 and 2009-2023. The analysis found that the research article titled 'The Stanford Digital Library metadata architecture' by Baldonado et al. (1997) delves into the structure of metadata in the digital library of Stanford University. This study focuses on the storage and management of digital data to facilitate digital library services. Additionally, Cullen (2001) research on 'Perspectives on user satisfaction surveys' garners 100 citations and an FWCI score of 9.4. This study investigated the relationship between service quality and user

satisfaction in an electronic library and information services. Another notable research work by Xie (2006), which studied and analyzed methods for evaluating the quality of digital libraries from the perspective of users. At rank 4 (Table 3), Pinfield's (2001) study examined the role of librarians in changing work practices to promote both traditional and electronic library services. In addition, Fan et al. (2005) studied data structures and comparisons based on principles to examine the efficiency of consumer data retrieval needs in subscribing to news and digital library services.

The most highly cited publication during the period of 2009-2023 was Mehta and Wang's study (2020), with 62 citations and an FWCI value of 9.58. This study focused on digital library services provided by university libraries during the COVID-19 pandemic. The research found that the libraries were able to efficiently adapt their service models to digital platforms using various technologies and online tools to enhance their services. Next, Niemelä et al. (2012) developed an assessment tool for evaluating knowledge and understanding of health information used in daily life. This tool assists users in assessing their knowledge and understanding of health information, which can be utilized to develop skills related to health knowledge and understanding among the general population in the community. The tool presented four screening questions for further study and testing, focusing on problem-solving in the areas of medicine, digital library services, information technology applications, and health education. Following this, Veloso et al. (2012) presented an innovative solution to a pressing issue that impacts the quality of digital library services. Their approach involves utilizing Natural Language Processing (NLP) and Machine Learning (ML) technologies to differentiate author names in academic databases that are similar or duplicated. By extracting author name characteristics and other relevant data for system learning, this method aims to enhance the accuracy and effectiveness of author name disambiguation in digital library services. Deep Learning models are used to analyze the characteristics and relationships of author names. In addition, Awwad and Al-Majali (2015) conducted research studies focusing on the acceptance and usage of electronic library services. Their studies involved analyzing and testing various concepts from theory, with the aim of applying them in the design and development of efficient and user-responsive electronic library services. Additionally, Khan and Ahmed (2013) conducted a research study that focused on surveying researchers' satisfaction with the utilization of digital library resources and services provided by university libraries in Pakistan.

From the analysis of publications in both time periods, it was evident that digital library service publications extend beyond the field of library science. They have connections and relevance to other disciplines, particularly in the areas of computer science and information technology.

Table 3 Top 5 authors/researchers' citation for relevant publications

Rank	Author	Title	Year	Journal	FWCI[1]	Total Citations
	Period 1994-2008					
1	Baldonado, M. et al.	The Stanford Digital Library metadata architecture	1997	International Journal on Digital Libraries 1(2), 108-121	10.76	186
2	Cullen, R.	Perspectives on user satisfaction surveys	2001	Library Trends 49(4), 662-686	9.4	100
3	Xie, H.	Evaluation of digital libraries: Criteria and problems from users' perspectives	2006	Library and Information Science Research 28(3), 433-452	2.98	259
4	Pinfield, S.	The changing role of subject librarians in academic libraries	2001	Journal of Librarianship and Information Science 33(1), 32-38	3.56	74
5	Fan, W. et al.	Effective profiling of consumer information retrieval needs: A unified framework and empirical comparison	2005	Decision Support Systems 40(2), 213-233	1.91	61
	Period 2009-2023					
1	Mehta, D., & Wang, X.	COVID-19 and digital library services – a case study of a university library	2020	Digital Library Perspectives 36(4), 351-363	9.58	62
2	Niemelä, R. et al.	A screening tool for assessing everyday health information literacy	2012	Libri 62(2), 125-134	1.39	46
3	Veloso, A. et al.	Cost-effective on-demand associative author name disambiguation	2012	Information Processing and Management 48(4), 680-697	3.08	41
4	Awwad, M.S., & Al-Majali, S.M.	Electronic library services acceptance and use an empirical validation of unified theory of acceptance and use of technology	2015	Electronic Library 33(6), 1100-1120	1.01	36
5	Khan, A., & Ahmed, S.	The impact of digital library resources on scholarly communication: Challenges and opportunities for university libraries in Pakistan	2013	Library Hi Tech News 30(8), 12-29	1.35	33

[1] Field-Weighted Citation Impact (in Scopus database): shows how well cited this document is when compared to similar documents. A value greater than 1.00 means the document is more cited than expected according to the average.

6. Co-occurrences and Word Cloud analysis

The results of the co-occurrence analysis are obtained by using Bibliometrix-R Impressions program, and are configured to evaluate frequently coexisting keywords within a maximum range of 50 words. Table 4 presents the results of the comparison of co-occurrences between the years 1994-2008 and 2009-2023. The analysis identified the top 10 keywords during each period.

For the early years, the following terms were prominent: ‘digital libraries’, ‘information services’, ‘library services’, ‘metadata’, ‘data acquisition’, ‘information retrieval’, ‘learning systems’, ‘libraries’, ‘user interfaces’, and ‘world wide web’. These keywords indicate the focus areas and topics that were prevalent during that time.

In the later period, the following terms emerged as significant: ‘data mining’, ‘design/methodology/approach’, ‘digital library services’, ‘digital library systems’, ‘information management’, and ‘university libraries’. These keywords reflect the evolving trends and emerging areas of research in the field of digital library services.

When comparing the common terms that appeared in both time periods, it was observed that ‘digital libraries’, ‘information services’, ‘library services’, and ‘metadata’ were keywords of importance. These terms indicate their continued relevance and consistent presence across the years. Additionally, the analysis revealed a connection to research on metadata (Table 4).

Table 4 Top 10 of co-occurrence during the year 1994-2008 and 2009-2023

Rank	1994-2008		2009-2023	
	Keywords	Occurrences	Keywords	Occurrences
1	digital libraries	96	digital libraries	103
2	information services	33	library services	56
3	library services	21	information services	19
4	user interfaces	19	digital library services	13
5	metadata	15	digital library systems	12
6	world wide web	14	metadata	12
7	information retrieval	13	data mining	11
8	libraries	13	information management	11
9	learning systems	12	university libraries	11
10	data acquisition	10	design/methodology/approach	10

Table 5 and Figures 6A1-A2 show the results of comparing the co-occurrence clusters from both time periods. The analysis revealed that during the early period (1994-2008), there were a total of 7 clusters identified. In contrast, during the second period (2009-2023), a total of 6 clusters were identified. It showed that the publications display the word clusters in each time period that indicate their relationships within each cluster. The size of the circles and the connecting lines indicate the density of co-occurrences of keywords, which reflects the relationships among them. The clusters were separated based on the degree of relatedness among the keywords, and the keywords that co-occur more frequently with each other were grouped into different clusters. The prominent co-occurring keywords in the early period include the red cluster with keywords such as, 'digital libraries' and 'information services' (Figure 6A1). In the later period, prominent and important keywords include the purple cluster with keywords, for instance, 'digital libraries' and 'libraries services' (Figure 6A2). It showed the continuity of digital library service-related publications over the past 30 years. In addition, there are other important keywords that have emerged and are noteworthy, such as 'e-learning', 'developing countries', 'service quality', 'metadata', 'data mining', and 'artificial intelligence'. Additionally, in the section of Figures 6B1-B2, it was found that the top 20 frequent occurring keywords in the word cloud setting, with a limit of 20 keywords, displayed a similar and correlated terms to the common keywords identified in Table 4 for both time periods.

Table 5 The top 50 frequently co-occurring keywords between 1994-2008 and 2009-2023

Cluster	1994-2008	Cluster	2009-2023
	Keywords		Keywords
Red	digital libraries, information services, mathematical models, metadata, user interfaces, web services, multimedia systems, data acquisition, libraries, information retrieval, internet, information technology, education, digital library services, electronic publishing, electronic document exchange, information science, online systems, computer software, computer architecture, world wide web,	Purple	digital libraries, library services, user experience, digital services, digital contents, design/methodology/approach, university libraries, semantics, benchmarking, academic libraries, digital library systems, big data, data handling, digital storage, digital library technology, computer crime, digital resources, data processing, algorithms, information retrieval

Cluster	1994-2008	Cluster	2009-2023
	Keywords		Keywords
	e-learning, learning systems, semantics, decision making		
Purple	database systems, distributed database systems, network protocols, information retrieval systems, indexing (of Information), interoperability, large scale systems, interfaces (computer)	Red	information services, surveys, electronic library, learning systems, libraries, digital library service, information management, classification (of information), e-learning, developing countries
Blue	software libraries, information systems, library services, xml, design/methodology/approach	Brown	cloud services, information technology, cloud computing, distributed database systems
Green	digital storage, project management, information management	Blue	digital library service quality, quality of service, quality control, service quality
Orange	teaching, curricula, societies and institutions	Orange	web services, websites, interoperability
Brown	search engines, response time (computer systems), query languages	Green	metadata, data mining
Pink	artificial intelligence, computer science, computers	-	-

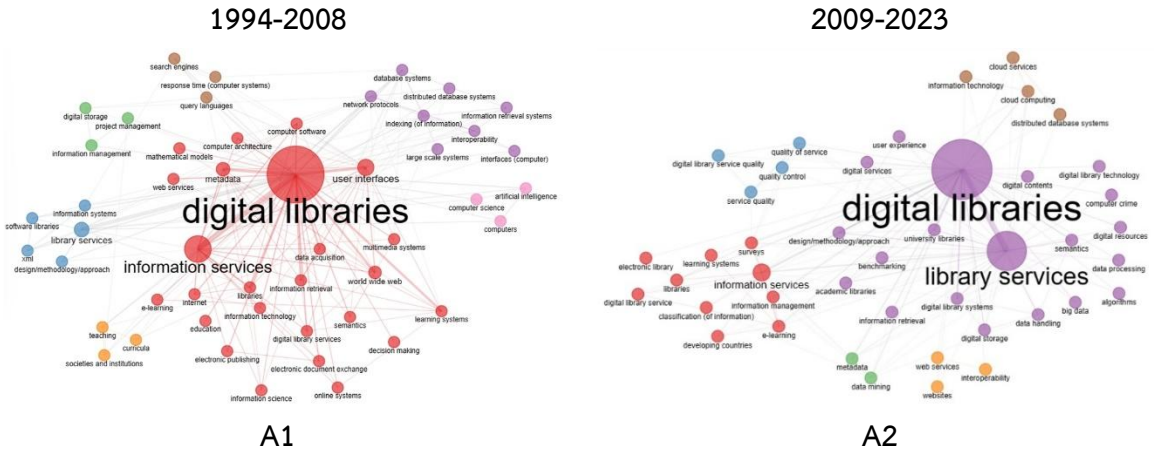

Figure 6 Co-occurrence networks (A1-2) and Word cloud (B1-2)

B1 B2

Figure 6 (cont.) Co-occurrence networks (A1-2) and Word cloud (B1-2)

7. Thematic evolution of publication

The results of the thematic evolution analysis conducted using the Bibliometrix-R program provide valuable insights into the trends and changes in research interests in published works over time. The graph illustrates the relationship between keywords in related publications, showcasing the links between keywords or topics that appear in different articles during the specified time periods. The color and size of the graph nodes indicate the number of references and the relationship between the keywords. In addition, the graph displays lines connecting related keywords, representing the changes and trends in the field of study and the evolution of the publications during the two time periods of 1994-2008 (Figure 7A). It demonstrates the evolution of topics in scholarly publications concerning digital library services, revealing a keen interest in technology and development related to data acquisition, online search engines, computer architecture, information technology, and various other areas.

During the period between 2009 and 2023 (Figure 7B), the focus shifted towards topics related to knowledge and learning through technology, website development, digital library service quality, user experience, metadata, and more. At the same time, it was found that in the early years there was a much greater variety in the development of digital library services than in the later years, indicating a change in the direction of research in digital library services with a reduction in diversity of research topics in the later years. This shift may suggest a narrowing of research focus into fewer, more specific themes, influenced by technological shifts or changing user needs. However, researchers or scholars who wish to develop publications in this area can analyze these trends and use them as a guide to plan their future publications that are suitable for current and future trends.

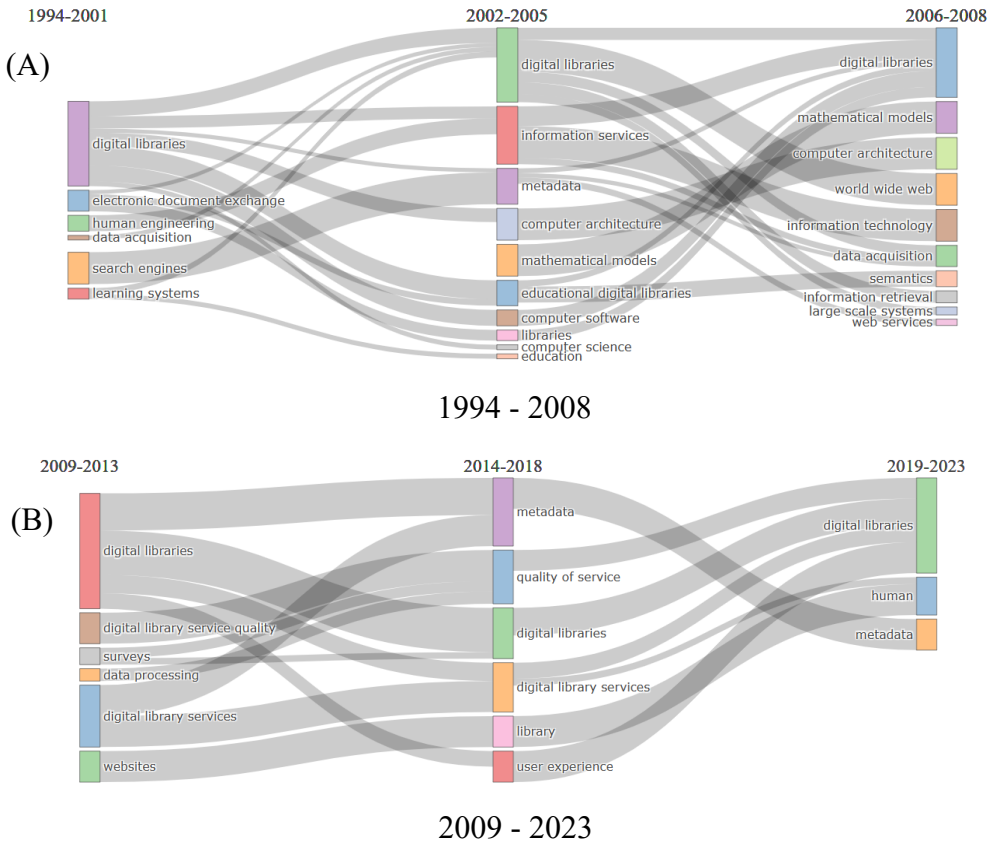

Figure 7 The thematic evolution of digital library services between 1994-2008 (A) and 2009-2023 (B)

Discussion

The analysis using bibliometric methods enables us to foresee the changes in the publications of digital library services and trends in this field. This is found to be of great importance in the present time and should be continuously prioritized. That is especially true in the current era, where technology plays an increasingly important role in the daily lives of people worldwide. The changes in digital library services should focus on utilizing technology to provide services, such as accessing online resources or using search systems to find details about books, which allows users to access information quickly and conveniently. From the total number of publications in both periods, it was found that there are 199 articles published in the early year (1994-2008) and 216 articles published in the latter year (2009-2023). Throughout 30 years (1994-2023), there are a total of 415 articles. There was a difference in the number of works published in both periods of 7 articles, equivalent to 4.09%, and it was found that the number of works published in the

later year began to decrease significantly. It highlights a research gap in this area, emphasizing the need to accelerate the development of more works in the digital age of libraries.

Research in the earlier period focused on system structure and the roles of librarians, whereas the later period emphasized user needs, technology adoption, and contextual responses, marking a shift toward user-centered digital library services. In terms of citation numbers, works published in the early year received more citations compared to the works published in the later year. This can be attributed to the higher number of publications in the early years. Consequently, the increased availability of publications during that period led to a larger pool of readers who had access to these publications, resulting in higher citation numbers. However, the importance and quality of the published works will significantly impact the number of citations received over time, regardless of whether it is in the early years or later. When analyzing research trends or planning future publications, researchers, scholars and individuals interested in this topic can utilize these insights to develop research that aligns with the needs and future direction of digital library services. It can be seen that technology still plays an important role in the development of digital library services. As shown in Table 3, the top 5 most cited publications encompass a range of fields including computer science fields and engineering etc. It is crucial for libraries to prioritize the enhancement and advancement of their digital library service system to establish a robust and high-quality library service. This includes the development of a search system that can accurately accommodate the needs of users. For instance, research by Tang and Hu (2021) examined the design of a digital library search engine using cloud computing technology in the era of big data. They explore the use of distributed processing to increase efficient search and storage.

In addition, libraries should focus on developing and improving the digital library service system. To strengthen and enhance the quality of library services, extensive studies in the field of digital library service have been conducted. For example, there is a growing body of research on the role of librarians in libraries during the Covid-19 epidemic, highlighting the need for libraries to adapt their information storage and provision strategies to support users (Hamad et al., 2022). Additionally, the research conducted by Okuonghae and Achugbue (2022) focuses on the practices of librarians in the digital age and the utilization of open access technology for sustainable development in Nigeria, aiming to promote effective library services. In addition, implementing effective public relations strategies can play a crucial role in raising awareness among users about the value and benefits of using library services. Aligning with research conducted by Wu and Yang

(2022), it has been found that employing social media marketing strategies can generate more interest and attract more pre-teen children's access to library services. This, in turn, has led to an increase in the number of library users and enhanced the efficiency of library services in facilitating this specific target group, etc. It is evident that considering research from various sources helps in making libraries more effective in promoting library services, regardless of whether they are traditional libraries or digital libraries.

At the same time, a literature review pertaining to bibliometric research on library services revealed that there is still a relatively small amount of research dedicated to library services. The majority of studies primarily focus on digital library investigations rather than direct library service provision. For example, a study on research bibliometric in information literacy and research support services in academic libraries (Ali et al., 2022), and a study on library service quality through bibliometric analysis (Ashiq et al., 2022). Borgohain et al. (2022) conducted a study on digital library research from 2016 to 2022 using the VOSviewer program. The study found that the United States had the highest number of published papers, and the University of Illinois had the highest number of publications and H-index values. The study by Borgohain et al. (2022) supports the notion that the United States is a leader in digital library research. These previous studies align with the present findings in terms of focus on digital infrastructure and institutional output, but this study further highlights the thematic shift and narrowing of research scope in recent years. However, when comparing specific institutions, this study found the University of California as a leading institution in digital library service research. Shaikh and Jana (2021) conducted a bibliometric study on digital library research using the keywords ‘digital library’ or ‘digital libraries’ in the Web of Science database for the period of 2011-2020. However, the research on digital library service using bibliometric techniques in the Scopus database found that there is still a lack of clear research studies in this dimension. The study found that the use of bibliometric techniques in digital library service research has not been thoroughly explored in the Scopus database. However, it was found that the utilization of bibliometric techniques can provide researchers with several benefits. These techniques allow researchers to analyze their own research citations in detail and gain insights into the popularity and impact of their work. Additionally, bibliometric analysis helps researchers understand the extent to which their research is cited by others, providing valuable information about the influence and visibility of their work in the academic community (Hunsapun, 2024).

Furthermore, Bibliometrix-R software is an important tool that helps researchers analyze trends in research on a particular topic, as well as the ranking of academic journals that are popular

in the studied area (Aria & Cuccurullo, 2017; Merigó & Yang, 2017). This study is part of the exploration of bibliometric data using quantitative methods to analyze big data and visualize results using graphs and tables. These data are useful in promoting research on library services and improving service delivery. Therefore, it is crucial for researchers, academics, librarians, and individuals interested in library research to maintain a constant awareness of and emphasize the significance of developing library services. This emphasis is necessary to ensure sustainable growth in alignment with the evolving trends and technologies of information. It is essential for these stakeholders to remain prepared and adaptable to changes in information technology, as it plays a pivotal role in shaping the future of library services.

The study examined the publication output of digital library services in Scopus database, specifically compared the data between the years 1994-2008 and 2009-2023. The findings highlighted the potential and productivity of authors and researchers working in this field. In general, the number of publications increased and decreased significantly each year. In the early period, there were indeed more publications compared to the later period. However, it is important to note that the productivity of publications continued to increase gradually over time. Regarding the authors/researchers, Gonçalves, M.A. stood out in the early period with the highest number of publications and the highest H-index value. In the later period, Divayana, D.G.H. emerged as the most productive author with the highest number of publications and H-index value. The United States holds a significant and leading role in generating publications related to digital library services. In terms of journals, the International Journal on Digital Libraries had the most related publications in the early period, while the Electronic Library had the most related publications in the later period. Library services play a significant role in utilizing information technology to facilitate access to published works across various fields, such as computer science and engineering. The trend in digital library services publication continues to focus on digital libraries in both periods, followed by publications on blended topics, including information services, mathematical modeling, mathematical models, quality of service, metadata, semantics, website, data acquisition and user experience, etc.

One limitation of this research is the absence of information regarding the co-citation, bibliographic coupling, or journal quartile ranking of the publications. Therefore, it is recommended that future research endeavors incorporate co-citation and bibliographic coupling data, or consider grouping the journals based on quartile ranking. Including such information would contribute to a more comprehensive understanding and provide additional insights in the field. Furthermore, it

should be noted that this study collected data for analysis on April 2nd, 2023, and the number of selected publications from the last year (2023) is relatively small. To gain a more accurate and comprehensive view of research trends in 2023, future studies should extend the study period throughout the entire year. This would ensure a more representative analysis of the research landscape in that year. It is also important to acknowledge the limitations, which focuses solely on the Scopus database and using Bibliometrix-R software for data analysis.

Recommendations

For future research, it would be beneficial to consider other databases, such as Web of Science, or Dimensions. Furthermore, employing alternative software tools like VOSviewer, CiteSpace could provide different analysis results and facilitate the exploration of various research topics.

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