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The Evolution of Wireless Technology in Library Systems (2000-2024) : A Bibliometric Analysis

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ABSTRACT

This study presents a bibliometric analysis of research on wireless technologies in libraries from 2000 to 2024. The investigation highlights significant growth in publications, particularly between 2015 and 2024, reflecting an increasing focus on wireless technology's role in modern library systems. Early studies exhibited high citation rates, while recent publications show lower averages due to limited time for citation accumulation. The findings reveal that journal articles dominate the field, with SENSORS and IEEE ACCESS leading in impact metrics. The University of California System emerges as the



most prolific contributor, and China accounts for the highest number of publications, underscoring its leadership in this domain. The practical implications of this research are far-reaching, including the adoption of emerging technologies like AI and blockchain to enhance library systems, improving user experiences, and fostering cross-institutional collaborations to broaden research scope. This analysis provides a roadmap for future investigations and the continued evolution of wireless technologies in libraries.

Keywords :

Wireless Technology, Library Systems, Bibliometrics, Digital Libraries, Wireless Networks, Bibliometrics Analysis.

1. INTRODUCTION :

Advancements have significantly influenced the evolution of physical library spaces into fully digitized environments in wireless technology. Early implementations of wireless networks primarily focused on transforming libraries into internet access hubs, enhancing the user experience by enabling patrons to connect to digital resources through their own devices (Smith, 2001; Alsharif et al., 2005). Over time, libraries have faced various challenges but have progressively adopted sophisticated wireless technologies, such as RFID systems, to improve inventory management and automate library services (Donthu et al., 2021; Luo, 2013).

The rise of mobile technologies has further expanded the scope of library services, enabling offerings such as real-time borrowing notifications and e-book downloads, effectively transcending the boundaries of traditional library operations (Ameen & Gorman, 2016). The critical role of wireless technology in libraries became particularly



evident during the COVID-19 pandemic when many libraries prioritized digital services, relying heavily on Wi-Fi networks to facilitate access to online resources (Lance & Ackerman, 2021).

Wireless technology dissemination within library systems continues to advance at a rapid pace. Bibliometric analyses reveal an increasing trend toward technological innovation in libraries, focusing on the development and evaluation of new systems (Margono et al., 2024).

Emerging trends point toward the rise of smart libraries, driven by technologies such as Artificial Intelligence, the Internet of Things, and Blockchain, which promise to deliver enhanced information retrieval services with personalized recommendations (Asad Ullah Khan et al., 2023). Additionally, the adoption of green information systems emphasizes minimizing environmental impact throughout the lifecycle of these systems (Radu & Popescu, 2024).

Current research also highlights the growth of library automation software, with the United States leading in the development of innovative solutions. Prominent areas of exploration include library management systems, open-source software, and integrated library systems.These advancements underscore the ongoing transformation and modernization of libraries in response to evolving technological landscapes.

This study presents a bibliometric analysis of wireless technology-related literature within library systems from 2000 to 2024. Key metrics such as publication growth rates and citation patterns across institutions are examined to shed light on the expansion of wireless technology in libraries and its profound impact on modern library operations.

2. LITERATURE REVIEW :

This bibliometric review explores the changes in wireless technologies and multi-criteria decision procedures in different domains. The wireless technologies such as mobile, satellite and IoT deployed in the hospitality and tourism sector have undergone rapid advancements since the year 2000 facilitating sensor-based convergence innovations (Navío-Marco et al., 2019). Similarly, smart libraries have employed new technologies like AI, IoT and blockchain which help in information retrieval and user experience improvements (Khan et al., 2023).

In addition to this for a long time from the year 2000 to 2020 electronic word-of-mouth (eWOM) has played an essential role across multiple platforms and industries influencing consumer behavior to a great extent (Bhaiswar et al., 2021). The use of multi-criteria decision aid techniques has been on an increase since 1977 where AHP and TOPSIS became the most popular approaches (Basílio et al., 2022).

Collectively these investigations reveal how fast digital technologies are advancing rapidly and being adopted by different sectors affecting current information systems as well as modern-day decision-making processes (Gaviria-Marin et al., 2018).

3. OBJECTIVES :

1. To assess the annual growth of research articles on wireless technology in libraries from 2000 to 2024.
2. To analyze citation patterns and evaluate the impact of these studies.
3. To identify key contributors (institutions and countries) to the literature on wireless technologies in libraries.



4. To evaluate the leading journals in the field and their influence on wireless library technology research.

4. METHODOLOGY :

This study in bibliometrics utilised the essential scientific database Web of Science for data gathering. The right articles were picked out by selecting only those which have been published from the year 2000 to the year 2024 although they had to specifically talk about wireless technology in libraries. The analysis of data involved checking on publication counts, citation metrics and author contributions. To measure the effect of an article or journal, h-index, g-index and m-index were employed. Moreover, Bradford's law was used to look at the distribution of papers in journals while Lotka's law tested productivity levels among authors.

5. SCOPE AND LIMITATIONS :

The scope of this study encompasses global research contributions on wireless technology in libraries, focusing on peer-reviewed journal articles, conference papers, and reviews. However, the analysis is limited to data available in select academic databases, potentially excluding research not indexed in these platforms. Additionally, technological developments beyond 2024 are outside the scope of this analysis

6. DATA ANALYSES AND INTERPRETATION :

Table No. 1 reflects the steady growth of research on wireless technology in libraries from 1995 to 2024. Initially, the number of articles was minimal, with only 5 publications (1.10%) between 1995 and 1999. The next two periods, 2000-2004 and 2005-2009, saw slight increases in publications, contributing 7.74% and 7.52%, respectively.



A significant surge occurred from 2010 onwards, with 15.71% of the articles published in 2010-2014, followed by a sharp increase in 2015-2019 (27.43%). The most notable growth occurred in 2020-2024, accounting for 40.49% of the total output. This trend highlights the increasing focus and importance of wireless technology in modern library systems.

Table No. 1 : Annual Growth of Wireless Technology Research Literature on Libraries

Period	Articles	%	Cumulative freq.
1995-1999	5	1.10%	5
2000-2004	35	7.74%	40
2005-2009	34	7.52%	74
2010-2014	71	15.71%	145
2015-2019	124	27.43%	269
2020-2024	183	40.49%	452
Total	**452**	**100%**	

Figure No. 1 : Annual Growth of Wireless Technology Research Literature on Libraries

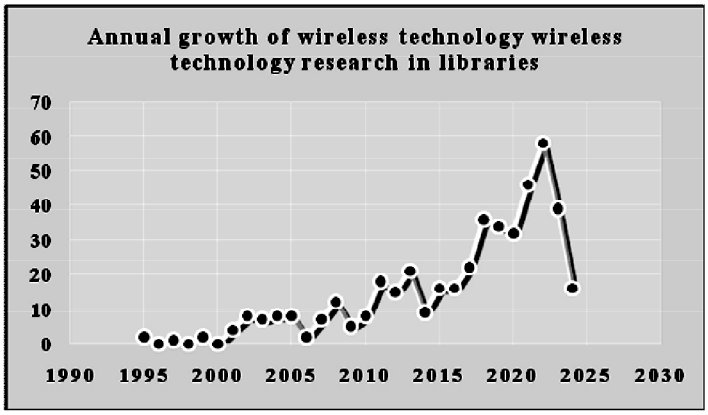




Table No. 2 highlights the changing impact of research on wireless technology in libraries from 1995 to 2024. While early articles (1995-1999) had high Mean Total Citations per Article (55.83), later periods saw more publications but lower individual citation rates, particularly in 2000-2004 and 2020-2024. Despite a significant increase in article output in recent years, newer works have had less time to accumulate citations, leading to a lower MeanTCperArt for 2020-2024.

Table No. 2 : Citation per Article

Period	MeanTCperArt	N	MeanTCperYear	CitableYears
1995-1999	55.83	5	2.44	30
2000-2004	12.63	35	0.58	21-24
2005-2009	26.22	34	1.47	16-20
2010-2014	32.77	71	2.49	Nov-15
2015-2019	37.63	124	4.73	06-Oct
2020-2024	11.42	191	3.39	01-May

Mean Total Citations per Article (MeanTCperArt), Number of Articles (N), Mean Total Citations per Year (MeanTCperYear), and Citable Years.

Figure No. 2 : Citation per Article

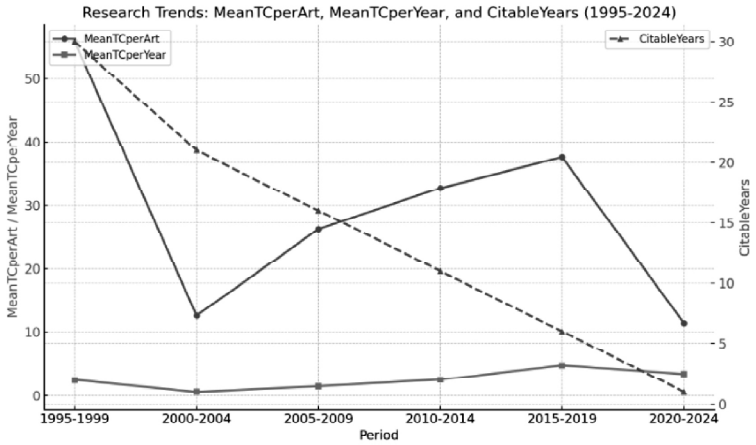


Table No. 3 and Figure No. 3 present document types distribution in research on wireless technology in libraries. The majority of publications (84.07%) are journal articles, with reviews accounting for 8.41%. Other document types include proceedings papers (3.98%), retracted publications (1.55%), and smaller contributions like book reviews (0.22%) and editorial materials (0.44%). Early access articles make up 1.11% of the total, while retracted reviews are extremely rare (0.22%). Overall, 452 publications were analyzed, with journal articles being the dominant format.

Table No. 3 : Document Types

Type	Publications	%
Journal Article	380	84.07%
Article; early access	5	1.11%
Article; proceedings paper	18	3.98%
Article; retracted publication	7	1.55%
Book review	1	0.22%
Editorial material	2	0.44%
Review	38	8.41%
Review; retracted publication	1	0.22%
Total	**452**	**100.00%**

Figure No. 3 : Document Types

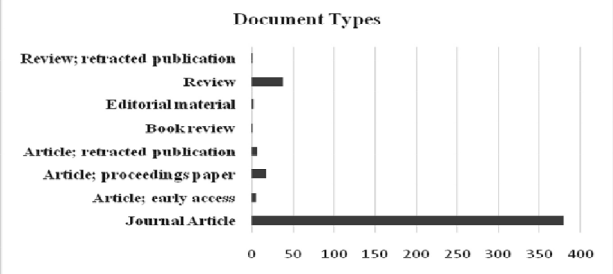


Table No. 4 highlights the top 5 journals with the highest impact in research on wireless technology in libraries. SENSORS lead with an h-index of 14, a g-index of 25, and a m-index of 1.167, with 673 total citations across 25 publications since 2013. IEEE ACCESS follows, boasting the highest total citations (1,356) and 27 publications since 2018, with an impressive m-index of 1.714. ELECTRONIC LIBRARY, which began publishing in 2002, has a moderate h-index of 8 and a total of 361 citations from 12 articles. Both IEEE SENSORS JOURNAL and LIBRARY HI-TECH have similar h- and g-index values, but IEEE SENSORS JOURNAL has garnered more total citations (523) than LIBRARY HI-TECH (87), indicating a broader reach in its field.

Table No. 4 : Top 5 Source Impact (Journals)

Source	H_index	G_index	M_index	Tc	Np	Py_start
Sensors	14	25	1.167	673	25	2013
IEEE access	12		1.714	1356	27	2018
Electronic library	8	12	0.348	361	12	2002
IEEE sensors journal	6	7	0.4	523	7	2010
Library hi-tech	6	8	0.333	87	8	2007
Wireless communications & mobile computing	6	10	0.857	115	32	2018
Wireless personal communications	6	10	0.5	120	20	2013
Information technology and libraries	5	7	0.227	52	7	2003

Table No. 5 lists the top 5 highly cited papers related to wireless technology in libraries. The most cited paper, SHAKHATREH H, 2019, IEEE ACCESS, has received 1,047 total citations, averaging 174.50 citations per year, with a normalized total citation score of 21.04.



SEZER N, 2021, NANO ENERGY follows with 621 citations and an impressive 155.25 citations per year. BURNS A, 2010, IEEE SENS J has 406 citations, while MCDONALD CJ, 1999, INT J MED INFORM has accumulated 287 citations over a longer period, averaging 11.04 citations per year.

Lastly, HE DB, 2015, MULTIMEDIA SYST has 258 citations with a yearly average of 25.80. These papers reflect influential works in the field, with strong citation impact.

Table No. 5 : Top 5 Highly Cited Papers

Paper	DOI	Total Citations	TC per Year	Normalized TC
Shakhatreh H, 2019, IEEE Access	10.1109/ACCESS.2019.2909530	1047	174.50	21.04
SezerN, 2021, Nano Energy	10.1016/j.nanoen.2020.105567	621	155.25	20.43
Burns A, 2010, IEEE Sens J	10.1109/JSEN.2010.2045498	406	27.07	6.64
McdonaldCj, 1999, Int J Med Inform	10.1016/S1386-5056(99)00009-X	287	11.04	1.88
He Db, 2015, Multimedia Syst	10.1007/s00530-013-0346-9	258	25.80	4.72

Table No. 6 showcases the top 10 institutions contributing to research on wireless technology in libraries.

The University of California System leads with 37 published articles, followed by Fu Jen Catholic University with 29 articles, and Asia University Taiwan with 28 articles. TechnischeUniversitat Wien, University of California San Diego, and the University of Toronto each contributed 15 articles.



Guizhou University follows with 13 publications, while the University of London contributed 12 articles. Both Harvard University and Qatar University round out the list, each with 10 articles. These institutions represent key players in advancing research in this domain.

Table No. 6 : Top 10 Institutions (Contribution)

Affiliation	Articles
University of California System	37
Fu Jen Catholic University	29
Asia University Taiwan	28
TechnischeUniversitat Wien	15
University of California San Diego	15
University of Toronto	15
Guizhou University	13
University of London	12
Harvard University	10
Qatar University	10

Figure No. 4 : Top 10 Institutions (Contribution)

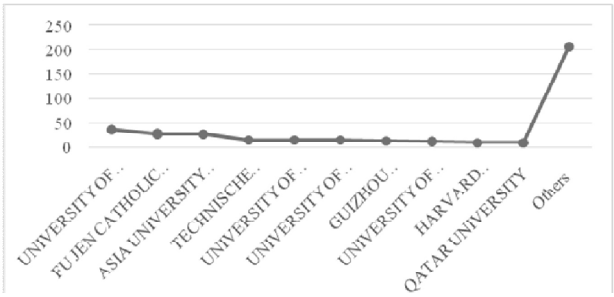


Table No. 7 details the contribution of countries to research on wireless technology in libraries. China leads with 389 publications, accounting for 31.02% of the total, followed by the USA with 219 articles



(17.46%). South Korea is third with 67 publications (5.34%), while India contributes 52 articles (4.15%). Germany and the UK have 45 (3.59%) and 44 articles (3.51%) respectively. Canada follows with 41 publications (3.27%), Austria with 39 (3.11%), and both Japan and Spain contribute 27 articles each (2.15%). This distribution highlights China's significant role in the research field compared to other countries.

Table No. 7

Top 10 Countries Contribution

Country	Freq	%
China	389	31.02%
USA	219	17.46%
South Korea	67	5.34%
India	52	4.15%
Germany	45	3.59%
UK	44	3.51%
Canada	41	3.27%
Austria	39	3.11%
Japan	27	2.15%
Spain	27	2.15%

Figure No. 5

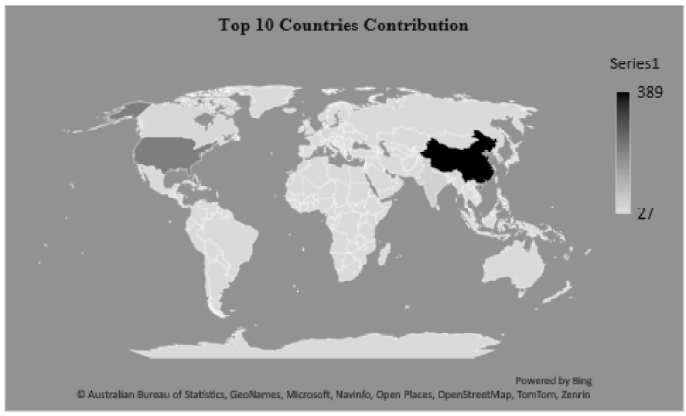




Table No. 8 lists the top 10 journals for research on wireless technology in libraries. Wireless Communications & Mobile Computing is the leading journal with 32 articles (7.08% of the total). IEEE Access follows with 27 articles (5.97%), and Sensors is third with 25 articles (5.53%). Wireless Personal Communications ranks fourth with 20 articles (4.42%).

Other notable journals include Electronic Library with 12 articles (2.65%), Library Hi Tech with 8 articles (1.77%), Eurasip Journal on Wireless Communications and Networking, IEEE Sensors Journal, and Information Technology and Libraries each with 7 articles (1.55%). Electronics and Communications in Japan complete the list with 6 articles (1.33%).

Table No. 8 : Top Used Channels for Scientific Communication

Used Channels for Scientific Communication			
SO	Rank	Freq	%
Wireless Communications & Mobile Computing	1	32	7.08%
IEEE Access	2	27	5.97%
Sensors	3	25	5.53%
Wireless Personal Communications	4	20	4.42%
Electronic Library	5	12	2.65%
Library Hi Tech	6	8	1.77%
Eurasip Journal on Wireless Communications and Networking	7	7	1.55%
IEEE Sensors Journal	8	7	1.55%
Information Technology and Libraries	9	7	1.55%
Electronics and Communications in Japan	10	6	1.33%



Bradford's Law of Scattering is illustrated which shows the distribution of articles across different journal zones. Zone 1 features 10 journals with 151 articles, Zone 2 includes 69 journals with 135 articles, and Zone 3 comprises 149 journals with 149 articles. This distribution indicates a high concentration of articles in a few core journals, with a more dispersed spread across additional journals in subsequent zones.

Table No. 9 : Bradford's Law of Scattering

Distribution of Publications and Journals According to Zones

Zones	Journals	Articles	Bradford Multiplier
1	10	151	4.3
2	69	135	
3	149	149	
Total	228	435	

Figure No. 6 : Bradford's Law of Scattering

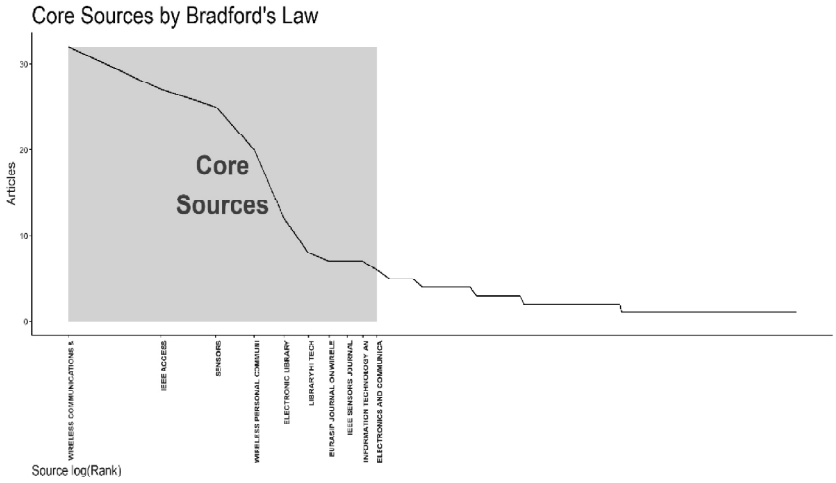
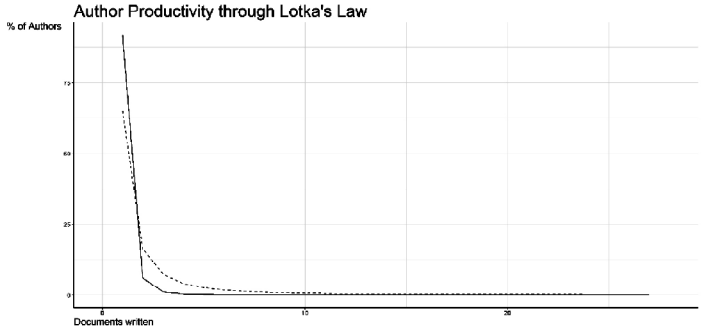


Table No. 9 Figure No. 7 presents the results of a Lotka's Law test, which examines the distribution of authors based on their number of published documents. The majority of publications are authored by single authors (1 document, 91.8% of authors), with a significant drop as the number of publications increases. Authors with multiple publications are less common : 103 authors have 2 documents (6%), 19 authors have 3 documents (1.1%), and fewer authors have even more publications, highlighting a typical inverse relationship between the number of authors and the number of their publications.

Table No. 9 : Lotka's Law Test

Documents written	N. of Authors	Proportion of Authors
1	1570	0.918
2	103	0.06
3	19	0.011
4	8	0.005
5	4	0.002
6	2	0.001
7	2	0.001
8	1	0.001
12	1	0.001
27	1	0.001

Figure No. 7 : Lotka's Law Test



7. FINDINGS

- Research on wireless technology in libraries has surged, especially from 2015 to 2024, showing an increasing focus on this area.
- Early studies had high citation rates, while recent articles have lower average citations due to their more recent publication dates.
- The majority of research is published as journal articles, with reviews and conference papers being less common.
- Leading journals include SENSORS and IEEE ACCESS, with SENSORS having the highest impact metrics.
- The University of California System is the top contributor, followed by Fu Jen Catholic University and Asia University Taiwan.
- China leads in publications with 31.02% of the total, highlighting its significant role in this research field.

8. SUGGESTIONS :

- Investigate the impact of emerging technologies like AI and blockchain on library systems.
- Implement longitudinal analyses to track the long-term effects of wireless technology on library operations.
- Encourage cross-institutional and international collaborations to enhance the depth and breadth of research.
- Assess how advancements in wireless technology are impacting user experiences and satisfaction in library settings.



9. CONCLUSION :

Wireless technology has become a cornerstone of modern library operations, revolutionizing the way information is accessed, managed, and delivered. This bibliometric study delves into the extensive advancements in wireless library systems research, providing a comprehensive overview of publication trends, citation patterns, and key contributors over the years. It highlights the pivotal roles played by leading countries, institutions, and journals in driving innovation in this field.The evolution of wireless technologies, such as Wi-Fi, RFID, and mobile-based services, has enabled libraries to transition into dynamic hubs of digital connectivity, offering users seamless access to resources beyond physical boundaries. These technologies have not only improved inventory management and automation but have also enhanced user engagement through personalized services like real-time notifications and digital downloads. As libraries continue to adapt to the changing demands of the digital age, the development and integration of advanced wireless systems will remain critical. These advancements will ensure libraries remain accessible, efficient, and user-centric, fostering an enriched learning and research environment.

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