Journal of Library and Information Science Volume: 3, Nomor 1, 2026, Hal: 1-29

Smart Library Research: A Bibliometric Analysis of Publication Trends, Citation Impact, and Knowledge Structure

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DOI: https://doi.org/10.47134/jip.v3i1.5965
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Received: 24-04-2026
Accepted: 24-05-2026
Published: 24-06-2026

Abstract: The rapid integration of emerging technologies into library ecosystems has given rise to the smart library concept, a transformative paradigm leveraging artificial intelligence (AI), the Internet of Things (IoT), big data, and intelligent systems to enhance information services and operational efficiency. Despite growing scholarly interest, a comprehensive bibliometric mapping of this domain remains limited. This study addresses the gap through a systematic bibliometric analysis of peer-reviewed articles and reviews indexed in Web of Science and Scopus, examining twelve dimensions including publication trends, citation impact, journal quartile distribution, source productivity, highly cited papers, authorship patterns, institutional and national contributions, and keyword co-occurrence structures. Data were retrieved using a structured keyword search, filtered to English-language articles and reviews, and deduplicated prior to analysis using BiblioSpy® as the primary analytical platform. Findings reveal a sustained upward publication trajectory from 2017 to 2026, with peak citation activity between 2019 and 2022 and Relative Citation Impact (RCI) values substantially above the global benchmark during this period. Library Hi Tech, Library Hi Tech News, and The Electronic Library dominated publication output, while China, India, and Pakistan led national productivity. Allama Iqbal Open University and Shahzad, Khurram were the most productive institution and author, respectively. Rafique et al. (2020) was the most highly cited work with 412 citations, with AI emerging as the field's dominant thematic strand. Keyword analysis revealed a coherent thematic core anchored by AI, IoT, machine learning, and library 4.0, with emerging terms pointing toward generative AI and large language model applications.

Keywords: Smart Library, Intelligent Library, Library 4.0, Internet Of Things, Bibliometric Analysis, Scientometric

Introduction

The global library sector is undergoing a profound transformation driven by the convergence of digital technologies, data-intensive systems, and user-centred design philosophies. At the forefront of this transformation is the concept of the smart library, an evolved form of the modern library that integrates intelligent technologies such as artificial intelligence (AI), the Internet of Things (IoT), big data analytics, cloud computing, and radio-frequency identification (RFID) to deliver adaptive, responsive, and efficient

information services (Cao et al., 2018; Gul & Bano, 2019). Unlike traditional libraries, which are defined primarily by their physical collections and static service models, smart libraries are characterised by their capacity to sense environmental and user contexts, process large volumes of data in real time, and dynamically adjust their services to meet the evolving needs of their communities (Noh, 2015). This shift is not merely technological but also epistemic, representing a fundamental reimagining of the library's role in the knowledge economy.

The emergence of the smart library concept has attracted considerable scholarly attention over the past decade, yielding a growing body of literature that spans multiple disciplines including library and information science, computer science, educational technology, and information systems. Researchers have explored a wide range of topics, from the theoretical conceptualisation of what constitutes a smart library (Cao et al., 2018) to empirical investigations of AI adoption in academic libraries (Harisanty et al., 2024), the role of intelligent systems in recommender platforms (Simovic, 2018), and the implications of technology acceptance among library users (Rafique et al., 2020). The interdisciplinary nature of the field reflects both its richness and complexity, yet also poses challenges for researchers attempting to synthesise its intellectual boundaries and thematic contours.

Despite this growing body of work, the smart library research domain has not yet been subjected to a comprehensive bibliometric mapping study that systematically documents its growth trajectory, identifies its most influential contributors, and maps its evolving thematic clusters. Previous reviews have tended to be narrative or systematic in nature, focusing on specific sub-themes such as AI in libraries or IoT-based library services, without providing a holistic quantitative picture of the field's intellectual landscape. Bibliometric analysis offers a powerful and objective approach to address this gap. By applying quantitative methods to large bodies of scholarly literature, bibliometric studies can reveal hidden patterns of knowledge production, trace the diffusion of ideas across disciplinary boundaries, and identify emerging research frontiers that merit further investigation.

Beyond this empirical and methodological gap lies a deeper conceptual one. Although the term "smart library" is now widely used, its conceptual boundaries remain unsettled: the literature variously treats it as a technology-driven infrastructure upgrade (centred on IoT, RFID, and automation), a data-driven service model (centred on analytics and personalisation), or a broader socio-technical reconceptualisation of the library's role (Cao et al., 2018; Noh, 2015). These differing conceptualisations are rarely reconciled within a single study, and no prior work has examined, at scale, how the field's own keyword and thematic structure reflects — or fails to reflect — a coherent underlying construct. Without such clarity, researchers risk talking past one another, comparing studies that nominally share a label but rest on incompatible definitions, while practitioners are left without a stable conceptual reference point for benchmarking their own smart library initiatives. A bibliometric mapping of co-occurring keywords and thematic clusters is therefore not only an empirical exercise but also a conceptual one, offering a data-driven lens through which the field's definitional coherence — or fragmentation — can be assessed.

Against this backdrop, this study presents a comprehensive bibliometric analysis of smart library research, drawing on data retrieved from two major academic databases, namely Web of Science (WoS) and Scopus. Understanding the intellectual landscape of this field is increasingly important as libraries worldwide accelerate their adoption of AI, IoT, and data-driven technologies, yet no systematic quantitative mapping of the accumulated scholarship exists to guide researchers, practitioners, and institutional decision-makers in navigating this rapidly evolving domain. Addressing this gap is timely, given that the absence of a consolidated evidence base risks duplication of research efforts, fragmentation of theoretical frameworks, and missed opportunities for strategic cross-disciplinary collaboration. By doing so, this study aims to provide a rigorous and evidence-based intellectual map of the smart library field, highlight its most prolific and impactful contributors, and chart directions for future research.

Accordingly, this study addresses the following research questions:

RQ1: What are the annual publication output and citation trends in smart library research?
RQ2: What are the yearly bibliometric indicators for smart library research?
RQ3: What is the Relative Citation Impact (RCI) of smart library publications across the study period?
RQ4: What is the distribution of smart library publications across journal quartile rankings?
RQ5: What are the top publication sources for smart library research ranked by total publications?
RQ6: What are the most highly cited papers in smart library research ranked by total citations (TC)?
RQ7: What are the citation trajectories of individual smart library publications plotted against their year of publication?
RQ8: Who are the most prolific authors in smart library research ranked by total publications?
RQ9: What is the distribution of smart library publications by number of authors per document?
RQ10: What are the most productive institutions in smart library research by total publications?
RQ11: What is the national distribution of smart library publications across countries?
RQ12: What does the word cloud of the most frequently occurring keywords in smart library research reveal?

The study is structured as follows: Section 2 reviews the relevant literature on bibliometric methodologies and the smart library domain; Section 3 describes the materials and methods; Section 4 presents the results and findings; Section 5 discusses the implications; and Section 6 concludes with key takeaways and future directions.

Literature Review

Bibliometric Analysis: An Overview

Bibliometrics is a quantitative discipline concerned with the statistical analysis of published works, primarily books, articles, and other academic outputs. The term was first

coined by Pritchard (1969), who defined it as the application of mathematical and statistical methods to books and other media of communication. Since its inception, bibliometrics has evolved considerably, drawing on advances in database technology, network science, and computational linguistics to offer increasingly sophisticated tools for mapping the structure and dynamics of scientific knowledge. Today, bibliometric analysis occupies a central role in research evaluation, science policy, and knowledge management, serving as a foundation for understanding how disciplines grow, how ideas diffuse, and how researchers and institutions contribute to the collective scientific enterprise.

At its core, bibliometric analysis draws on two foundational laws that describe regularities in the distribution of scientific output. Bradford's Law (1934) describes the diminishing returns in literature output across journals in a given subject area, while Lotka's Law (1926) captures the inverse-square relationship between the number of authors and their productivity. Zipf's Law, originally formulated in the context of linguistics, has also been applied to describe word frequency distributions in scientific texts. Together, these laws provide theoretical anchors for interpreting the patterns revealed by bibliometric analyses, and they continue to inform contemporary studies that examine the concentration of scholarly output across journals, authors, and institutions.

Benefits of Bibliometric Analysis

Bibliometric analysis offers several distinct advantages over traditional narrative or systematic literature reviews. First, it enables the objective and systematic handling of large volumes of literature that would be impractical to review manually. Second, it provides quantifiable metrics that allow researchers to assess the relative impact and productivity of scholars, institutions, and journals within a given field. Third, bibliometric methods are particularly well-suited for identifying intellectual communities, research clusters, and thematic frontiers through network-based analyses such as co-authorship mapping and keyword co-occurrence analysis. These capabilities make bibliometrics especially valuable in emerging interdisciplinary fields, where the boundaries between disciplines are fluid and the sources of knowledge are diverse (Donthu et al., 2021). Fourth, bibliometric analyses produce replicable results, since they are anchored in structured datasets and well-defined analytical protocols, thereby enhancing the transparency and reproducibility of scholarly review processes.

From a practical standpoint, bibliometric studies help research communities take stock of what has been accomplished, identify gaps and contradictions in the existing literature, and prioritise areas for future investigation. For relatively young fields such as smart library research, this function is particularly important, as it provides a structured starting point for new scholars entering the field and offers established researchers a broad perspective on how their work fits into the larger intellectual landscape.

Tools for Bibliometric Analysis

A diverse ecosystem of software tools has emerged to support bibliometric research, each with its own strengths and analytical focus. VOSviewer (Van Eck & Waltman, 2010) is among the most widely used tools, offering interactive visualisation capabilities for co-authorship networks, keyword co-occurrence maps, and bibliographic coupling analyses.

Its intuitive interface and free availability have made it a standard fixture in bibliometric studies across disciplines. Bibliometrix, an open-source R package developed by Aria and Cuccurullo (2017), provides a more comprehensive analytical suite that includes performance analysis, science mapping, and various statistical measures, all accessible through either R syntax or the biblioshiny web interface. CiteSpace (Chen, 2006) is another widely used tool, particularly valued for its ability to detect citation bursts and visualise the evolution of research topics over time through timeline and timezone views. For studies requiring large-scale network analysis, Gephi offers powerful graph visualisation and community detection capabilities that complement the outputs produced by other tools.

More recently, BiblioSpy® (Ahmi, 2026) has emerged as a comprehensive and user-friendly platform designed specifically for academic bibliometric studies. BiblioSpy® integrates a wide range of performance indicators and science mapping features into a single interface, supporting analyses of annual publication output, citation trajectories, relative citation impact, source productivity, author and institutional rankings, country-level collaboration, and keyword structures. Its ability to process data from multiple databases simultaneously and generate standardised outputs has made it particularly suitable for comprehensive bibliometric mapping studies such as the present investigation.

Smart Library Research: A Review of the Literature

The concept of the smart library first gained traction in the academic literature around the mid-2010s, coinciding with broader discourse on smart cities, Industry 4.0, and the digitisation of public services. Noh (2015) was among the first to articulate a systematic model of Library 4.0, proposing a framework that aligns library services with the affordances of the Fourth Industrial Revolution, including cognitive computing, personalisation, and seamless connectivity. Building on this foundation, Cao et al. (2018) offered a more granular conceptualisation of the smart library, identifying seven core attributes: automation, intelligence, sensing, connectivity, personalisation, user-centricity, and sustainability. Their work, published in The Electronic Library, remains one of the most highly cited contributions in the field and has served as a theoretical reference point for numerous subsequent studies. Subsequent conceptual work has continued to refine this foundation: Schöpfel (2018) examined smart libraries as a distinct category of intelligent infrastructure shaped by sensor networks and data-driven facility management, while Asemi et al. (2020) offered a systematic review situating smart libraries within the broader landscape of expert systems, artificial intelligence, and robotics, arguing that the field's intellectual identity is best understood as an evolving convergence of these adjacent technological domains rather than a single unified paradigm.

Research on smart libraries has since diversified into multiple streams. One prominent stream concerns the integration of AI into library services. Cox et al. (2019) surveyed thought leaders in the academic library community to gauge their perceptions of AI's likely impact on library roles, resources, and professional identities. Their findings, published in Library Hi Tech, revealed cautious optimism tempered by concerns about job displacement, ethical implications, and the readiness of library professionals to adapt to AI-driven environments. Okunlaya et al. (2022) extended this line of inquiry by proposing a conceptual framework for AI-based library services in the context of university digital

transformation, emphasising the role of intelligent recommendation systems, natural language processing, and predictive analytics in enhancing academic library value. More recently, Harisanty et al. (2024) conducted a pilot study examining the awareness of AI among library leaders, practitioners, and researchers, revealing significant gaps in understanding that have important implications for professional development and organisational readiness. This concern with practitioner readiness has since been echoed across multiple national contexts. Jha (2023a) reviewed the prospects and challenges of AI adoption in libraries and information centres, cautioning that infrastructural and skills gaps remain a persistent barrier in many developing economies. Ali et al. (2024) conducted a SWOT analysis of AI application in Pakistani university libraries, finding that while librarians recognised clear strengths and opportunities in AI-enabled services, weaknesses in technical training and threats from inadequate institutional policy continued to constrain adoption. Similar patterns of cautious optimism have been documented among library professionals in India by Subaveerapandiyan and Gozali (2024) and in South African public academic libraries by Molaudzi and Ngulube (2025), suggesting that the gap between AI awareness and AI implementation identified by Harisanty et al. (2024) is a generalisable feature of the field rather than a context-specific anomaly.

A second stream of research has focused on the role of IoT and big data in enabling smart library functionalities. Gul and Bano (2019) provided a comprehensive overview of IoT applications in library settings, covering smart shelves, RFID-based inventory management, environmental sensing systems, and personalised user interfaces. Simovic (2018) demonstrated the potential of big data analytics in developing intelligent library recommender systems for educational institutions, arguing that data-driven personalisation represents a critical value proposition for academic libraries in the digital age. This IoT-centred literature has grown considerably in scope and technical depth. Massis (2016) was among the earliest to frame the Internet of Things as a structural force reshaping library facilities and resource management, a framing complemented by Hoy's (2016) contemporaneous account of smart buildings as the physical infrastructure layer underpinning the library of the future. This early infrastructural framing was later substantiated empirically by Liang and Chen (2020), who mapped the practical applications and adoption barriers of IoT across academic library settings. Xie et al. (2019) extended this work by designing and testing an IoT-based risk warning system for smart libraries, demonstrating how sensor networks can be operationalised for security and environmental monitoring rather than discussed only in conceptual terms. Bi et al. (2022) subsequently produced a comprehensive technical survey of AI-aided IoT technologies in smart libraries, synthesising architectural approaches across sensing, networking, and intelligent service layers and identifying interoperability and data privacy as the field's most pressing unresolved technical challenges. A range of applied smart library systems has further illustrated these architectural principles in practice, including RFID-based management systems (Younis, 2012), computer-vision-enabled book sorting applications (Shi et al., 2021), and integrated information service platforms developed for university contexts (Baryshev et al., 2018). A third stream has examined user behaviour and technology acceptance in the context of smart library services. Rafique et al. (2020), in one of the most highly cited papers in this domain, extended the Technology Acceptance Model (TAM) to investigate the factors

influencing user acceptance of mobile library applications, identifying ease of use, perceived usefulness, and social influence as key determinants of adoption intention. Their work underscores the importance of human-centred design principles in the development and deployment of smart library technologies. Yu and Huang (2020) corroborated and extended these findings in a separate TAM-based study of consumer intent to use smart libraries, confirming that perceived usefulness and ease of use remain robust predictors of adoption across different national and institutional settings, while Jadhav and Shenoy (2020) approached the question from a measurement perspective, proposing a composite index for quantifying the degree of "smartness" that a given library has achieved relative to its peers.

Collectively, the existing literature reveals a vibrant and rapidly evolving field, yet one that has remained largely fragmented in its theoretical foundations and methodological approaches. The absence of a unifying bibliometric mapping study has made it difficult to assess the cumulative progress of the field, identify its core intellectual foundations, or pinpoint the directions in which it is heading. The present study addresses this gap directly, contributing a systematic and quantitatively grounded overview of smart library scholarship that can serve as a baseline for future research endeavours.

Methodology

This study employed a bibliometric research design to systematically examine the body of scholarly literature on artificial intelligence in library and information science. Bibliometric analysis was selected as the most appropriate methodology given the volume and breadth of the literature under investigation, as it enables objective, quantitative mapping of publication trends, citation patterns, authorship networks, and conceptual themes across large datasets that would be impractical to assess through traditional narrative review (Donthu et al., 2021). Data were retrieved from two major academic databases — Scopus and the Web of Science Core Collection — both of which are widely recognised in the bibliometric research community as the most comprehensive and reliable sources of indexed scholarly literature (Mongeon & Paul-Hus, 2016). Using both databases simultaneously ensured broader coverage and reduced the risk of source-specific indexing bias. The search was confined to journal articles and early access papers published in English between 2000 and 2026, with subject area filters applied to retain only publications classified under Library and Information Science and related Computer Science categories. The search was conducted on June 3, 2026, and all records retrieved on that date constitute the final dataset for this study.

The search string was constructed to capture the full spectrum of AI-related terminology as it appears in LIS scholarship. The query combined AI technology terms — including "artificial intelligence", "machine learning", "deep learning", "natural language processing", "chatbot", "large language model", and "generative AI" — with LIS context terms — including "library", "libraries", "librarianship", "library services", "information science", and "library and information science" — using Boolean operators applied to document titles. Searching within titles rather than abstracts and keywords was a deliberate methodological choice to ensure that retrieved records were substantively focused on AI in LIS rather than merely referencing these terms peripherally. The combined search across

both databases yielded a total of 660 records after applying all filters. Following a deduplication process conducted during database merging, two duplicate records were identified and removed, resulting in a final dataset of 380 unique publications retained for bibliometric analysis. This process is documented in the bibliometric flow diagram presented in Figure 1, which provides a transparent and reproducible account of the data collection and screening procedures in accordance with best practices for bibliometric reporting (Zupic & Čater, 2015).

The retained dataset of 380 publications was analysed using BiblioSpy® (Ahmi, 2026), a dedicated bibliometric analysis platform designed specifically for LIS and social science research contexts. BiblioSpy® was used to conduct a comprehensive suite of analyses covering annual publication output and citation trends, yearly bibliometric statistics including h-index, g-index, m-quotient, and e-index values, relative citation impact (RCI), publication distribution by journal quartile, source productivity and source metrics, highly cited paper identification, author productivity and production over time, institutional productivity, and keyword frequency analysis. The platform's integrated visualisation capabilities enabled the generation of all figures and tables presented in the Results section. This multi-dimensional analytical approach is consistent with the dual-method framework advocated by Donthu et al. (2021), which combines performance analysis — evaluating the contributions of individual actors such as authors, journals, and institutions — with science mapping, which reveals the structural and conceptual organisation of the field.

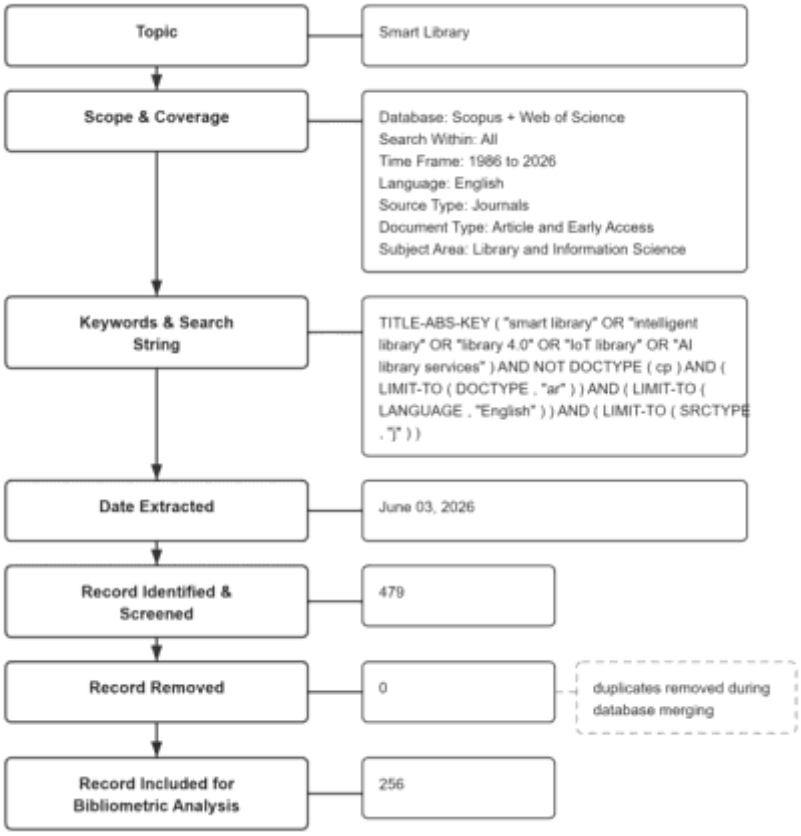

Figure 1. Bibliometric Study Flow Diagram

Source: Generated by the author(s) using BiblioSpy® (Ahmi, 2026).

Result and Discussion

Figure 2 illustrates the annual publication output and citation trends in smart library research from 1986 to 2026. The data reveal a prolonged dormant phase spanning nearly three decades, during which scholarly output remained negligible, with fewer than five publications recorded annually prior to 2010. A gradual but discernible upturn began around 2015, coinciding with the broader discourse on Library 4.0 and the Fourth Industrial Revolution, before accelerating sharply from 2019 onwards. Publication output reached its peak in 2025 with 57 articles, followed closely by 2024 with 45 articles, reflecting the field's rapid maturation and expanding scholarly community. The citation trajectory mirrors this growth pattern, peaking prominently in 2020 and 2021 with 691 and 473 total citations respectively, suggesting that papers published during this formative period have exerted a particularly strong influence on subsequent research. The convergence of rising publications and sustained citation activity from 2019 to 2024 signals that smart library research has entered a phase of robust intellectual consolidation, characterised by growing interdisciplinary engagement and increasing recognition of the field's contributions across the broader library and information science literature.

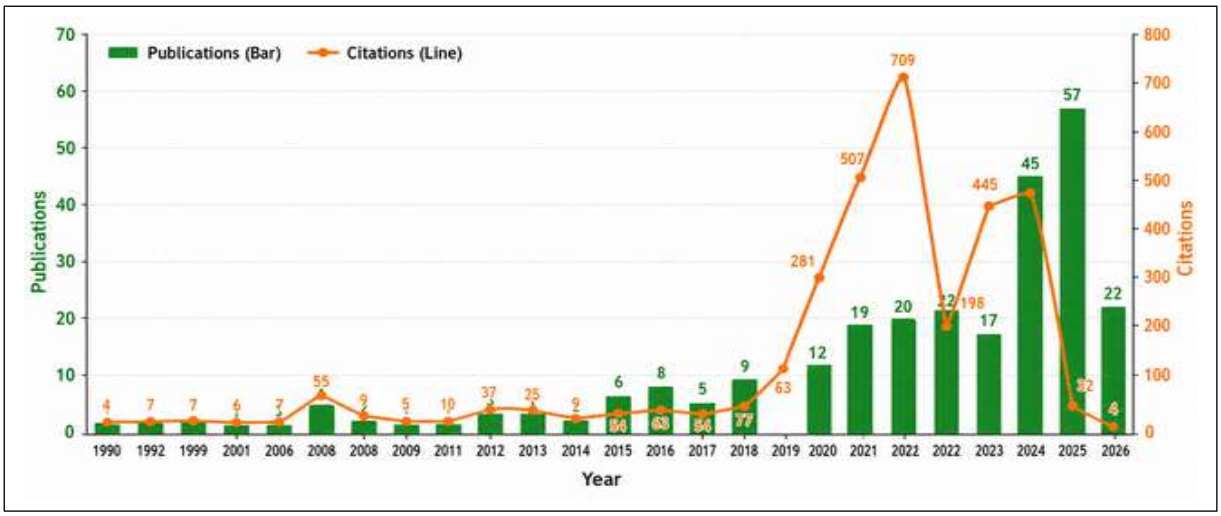

Figure 2. Annual Publications & Citations
Source: Generated by the author(s) using BiblioSpy® (Ahmi, 2026).

Table 1 presents a comprehensive set of yearly bibliometric indicators for smart library research from 2017 to 2026. Several patterns merit attention. First, the citations per publication (C/P) metric reveals that papers published between 2019 and 2020 attracted the highest average citation rates, at 48.17 and 36.37 respectively, indicating that works from this period represent the most influential contributions to the field. This finding is further corroborated by the citations per cited publication (C/CP) values for the same years, which confirm that a high proportion of papers from 2019 and 2020 actively accumulated citations over time. Second, the h-index, which balances productivity and impact, peaks at 11 in 2024, reflecting the field's growing capacity to sustain both high output and meaningful citation accumulation simultaneously. Third, the g-index, which rewards papers with disproportionately high citation counts, reaches its highest value of 21 in both 2024 and 2022,

suggesting the presence of highly cited landmark papers within these cohorts. The m-quotient, which adjusts the h-index for career length or in this context publication age, remains highest for the 2020 and 2021 cohorts at 0.286 and 0.250 respectively, confirming their sustained citation momentum. Collectively, these indicators paint a picture of a field that, while relatively young, has demonstrated consistent growth in both scholarly productivity and academic impact across the study period.

Table 1. Yearly Bibliometric Statistics

Year	TP	NCA	NCP	TC	C/P	C/CP	h	g	m	e
2026	22	59	5	32	1.45	6.4	3	5	0.073	4.58
2025	57	156	34	114	2	3.35	6	8	0.15	4.9
2024	45	97	40	473	10.51	11.82	11	21	0.282	16.19
2023	17	41	15	304	17.88	20.27	8	17	0.211	14.59
2022	22	54	20	448	20.36	22.4	9	21	0.243	17.89
2021	20	63	19	207	10.35	10.89	9	14	0.25	10.05
2020	19	53	18	691	36.37	38.39	10	19	0.286	23.26
2019	12	28	12	578	48.17	48.17	8	12	0.235	22.34
2018	9	18	9	384	42.67	42.67	7	9	0.212	18.11
2017	5	10	5	32	6.4	6.4	4	5	0.125	3.46

Note: *TP = Total Publications; NCA = Number of Contributing Authors; NCP = Number of Cited Publications; TC = Total Citations; C/P = Citations per Publication; C/CP = Citations per Cited Publication; h = h-index; g = g-index; m = m-Quotient; e = e-index*

Source: Generated by the author(s) using BiblioSpy® (Ahmi, 2026).

Figure 3 presents the Relative Citation Impact (RCI) of smart library publications across the study period, with the global average RCI benchmark set at 1.0 (represented by the red dashed line). The RCI metric normalises citation counts relative to the global average for each publication year, thereby providing a more equitable measure of scholarly influence that accounts for differences in citation accumulation patterns across time. The findings reveal a clear bifurcation in citation performance, with publications from certain years substantially exceeding the global benchmark while others fall below it. Most notably, papers published in 2019 and 2020 recorded the highest RCI values of 2.21 and 3.49 respectively, indicating that these cohorts attracted citations at more than twice and three times the global average rate. This finding reinforces the earlier observation that the 2019–2020 period represents the intellectual peak of smart library scholarship, producing works of particularly high and enduring influence. Publications from 2021 and 2022 also surpassed the global average with RCI values of 1.45 and 1.38 respectively, suggesting sustained above-average impact during this period. In contrast, more recent publications from 2024, 2025, and 2026 record RCI values well below 1.0, at 0.14, 0.19, and 0.10 respectively. This is consistent with the natural citation lag phenomenon, whereby recently published papers have not yet had sufficient time to accumulate citations relative to the global average. Collectively, the RCI analysis confirms that smart library research has produced a disproportionately impactful body of work relative to its overall volume, particularly during its formative growth phase between 2018 and 2022.

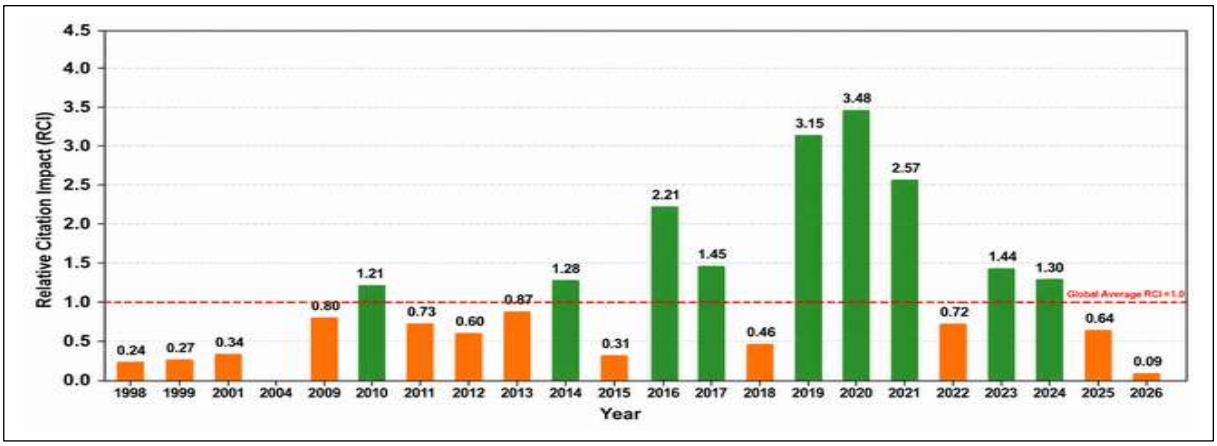

Figure 3. Relative Citation Impact (RCI)
Source: Generated by the author(s) using BiblioSpy® (Ahmi, 2026).

The quartile data offer important insights into the quality trajectory of smart library scholarship over time (Table 2). Across all years, Q2 journals consistently account for the largest share of publications, reflecting the field's strong anchoring in established library and information science journals that, while not always positioned in the top quartile, carry considerable disciplinary prestige and audience reach. The dominance of Q2 outlets is most pronounced in 2025 and 2024, with 23 and 21 publications respectively, underscoring the field's sustained preference for mid-to-high impact LIS-focused venues. Q1 publications, representing the most selective and highest-impact journals, have grown steadily from just one paper in 2017 to 15 papers in 2025, pointing to a marked improvement in the overall quality and ambition of smart library scholarship over the decade. This upward trend in Q1 output is particularly significant as it suggests that researchers in this field are increasingly targeting top-tier interdisciplinary journals, potentially broadening the field's visibility beyond traditional library science circles. The proportion of papers published in unranked outlets (No Q) has remained relatively modest across most years, with a notable spike in 2022 (9 papers) and 2021 (8 papers), likely reflecting the emergence of newer or more specialised publication venues during the field's rapid expansion phase.

Table 2. Quartile Summary by Year

Year	Q1	Q2	Q3	Q4	No Q	Total
2026	3	13	3	1	2	22
2025	15	23	11	5	3	57
2024	8	21	2	7	7	45
2023	5	8	3	1	0	17
2022	4	6	2	1	9	22
2021	2	4	3	3	8	20
2020	6	6	2	3	2	19
2019	2	8	1	0	1	12
2018	2	4	0	1	2	9
2017	1	1	3	0	0	5

Source: Generated by the author(s) using BiblioSpy® (Ahmi, 2026).

Figure 4 presents the top publication sources for smart library research ranked by total publications. The distribution reflects a clear concentration pattern consistent with

Bradford's Law of Scattering, whereby a small number of specialised outlets account for a disproportionately large share of the field's output. Library Hi Tech and Library Hi Tech News jointly lead with 12 publications each, followed by The Electronic Library with 10, collectively establishing these three journals as the primary intellectual homes of smart library scholarship. Their strong editorial alignment with technology-oriented library research explains their dominance in this field. Beyond the top tier, the Indian Journal of Information and Library Science (8 publications) and the Journal of Librarianship and Information Science (7 publications) reflect a notable South Asian scholarly presence in the literature. A mid-tier cluster comprising Applied Mathematics and Nonlinear Sciences, Journal of Academic Librarianship, and Library Philosophy and Practice — each with 6 publications — signals the field's interdisciplinary reach, bridging both technical and humanistic library science traditions. Collectively, these findings confirm that while smart library research remains anchored in core LIS journals, it is progressively diffusing into adjacent disciplinary territories, a trend likely to intensify as AI and IoT technologies become further embedded in library practice.

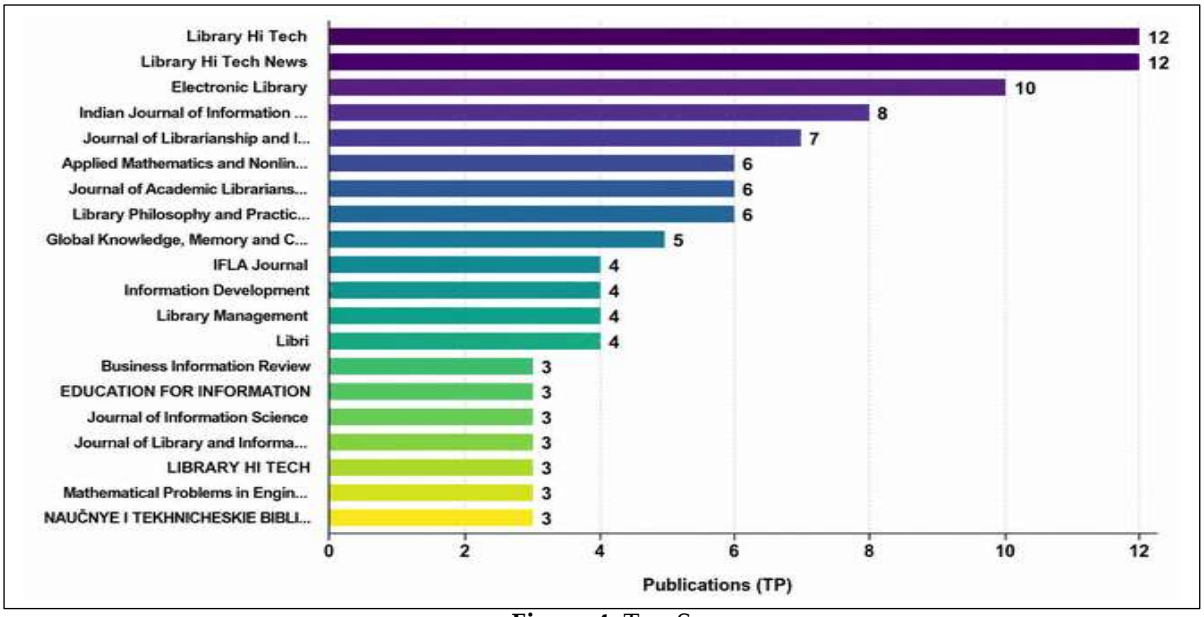

Figure 4. Top Sources

Source: Generated by the author(s) using BiblioSpy® (Ahmi, 2026).

Table 3 identifies the ten most highly cited papers in smart library research, ranked by total citations (TC). Rafique et al. (2020) leads the ranking with 412 total citations and the highest annual citation rate of 58.86, reflecting the widespread scholarly uptake of their extended Technology Acceptance Model framework in the context of mobile library applications. This is followed by Cox et al. (2019) with 269 citations and Okunlaya et al. (2022) with 265 citations, both published in Library Hi Tech, reinforcing that journal's position as the field's most influential outlet. The dominance of AI-themed papers in the upper half of the table — spanning intelligent library systems, AI service frameworks, and awareness studies — signals that artificial intelligence represents the single most cited

thematic strand within smart library scholarship. The normalised total citations (NTC) metric, which adjusts for differences in publication age, reveals a slightly different hierarchy. Okunlaya et al. (2022) records the highest NTC value of 13.01, surpassing even the top-ranked Rafique et al. (2020) at 11.33, indicating that its citation impact is exceptionally strong relative to its publication year. Similarly, Harisanty et al. (2024) achieves an NTC of 10.18 despite being a recent publication, suggesting it is accumulating citations at a remarkably rapid pace. In contrast, earlier works such as Gul and Bano (2019) and Simović (2018), while historically significant, record comparatively lower NTC values, reflecting the natural dilution of relative impact as citation windows widen. Collectively, these findings suggest that the field's intellectual core is increasingly defined by empirically grounded, AI-focused contributions published in high-ranking LIS journals.

Table 3. Highly-Cited Papers

#	Authors	Title	Source	TC	C/Y	NTC
1	Rafique et al. (2020)	Investigating the Acceptance of Mobile Library Applications with an Extended Technology Acceptance Model (TAM)	Computers and Education	412	58.86	11.33
2	Cox et al. (2019)	The intelligent library: Thought leaders' views on the likely impact of artificial intelligence on academic libraries	Library Hi Tech	269	33.62	5.58
3	Okunlaya et al. (2022)	Artificial intelligence (AI) library services innovative conceptual framework for the digital transformation of university education	Library Hi Tech	265	53	13.01
4	Gul & Bano (2019)	Smart libraries: an emerging and innovative technological habitat of 21st century	Electronic Library	163	20.38	3.38
5	Cao et al. (2018)	How to make the library smart? The conceptualization of the smart library	Electronic Library	123	13.67	2.88
6	Harisanty et al. (2024)	Leaders, practitioners and scientists' awareness of artificial intelligence in libraries: a pilot study	Library Hi Tech	107	35.67	10.18
7	Noh (2015)	Imagining Library 4.0: Creating a Model for Future Libraries	Journal of Academic Librarianship	91	7.58	2.9
8	Harisanty et al. (2024)	Leaders, practitioners and scientists' awareness of artificial intelligence in libraries: a pilot study	LIBRARY HI TECH	76	25.33	7.23
9	Simović (2018)	A Big Data smart library recommender system for an educational institution	Library Hi Tech	70	7.78	1.64
10	Asim et al. (2023)	Investigating applications of Artificial Intelligence in university libraries of Pakistan: An empirical study	Journal of Academic Librarianship	69	17.25	3.86

Note: *TC = Total Citations; C/Y = Citations per Year; NTC = Normalised Total Citations*
Source: Generated by the author(s) using BiblioSpy® (Ahmi, 2026).

Figure 5 illustrates the citation trajectories of individual smart library publications plotted against their year of publication, with bubble size representing total citation count and colour indicating open access status. The visualisation clearly identifies Rafique et al. (2020) as the single most influential paper in the field, represented by the largest bubble positioned at approximately 412 citations, substantially distanced from all other works. A

secondary cluster of highly cited papers is visible around the 2019–2022 period, featuring Cox et al. (2019), Okunlaya et al. (2022), and Gul and Bano (2019), all accumulating between 163 and 269 citations, confirming this window as the field's most intellectually productive era. The chart also reveals that the vast majority of publications prior to 2015 attracted negligible citations, appearing as small dots near the zero baseline, reflecting the field's limited scholarly traction during its early years. Notably, recent publications from 2024 onwards, including multiple entries by Harisanty et al. and Asim et al., are already showing early citation momentum despite their recency, suggesting an accelerating rate of knowledge uptake in the field's most current research front.

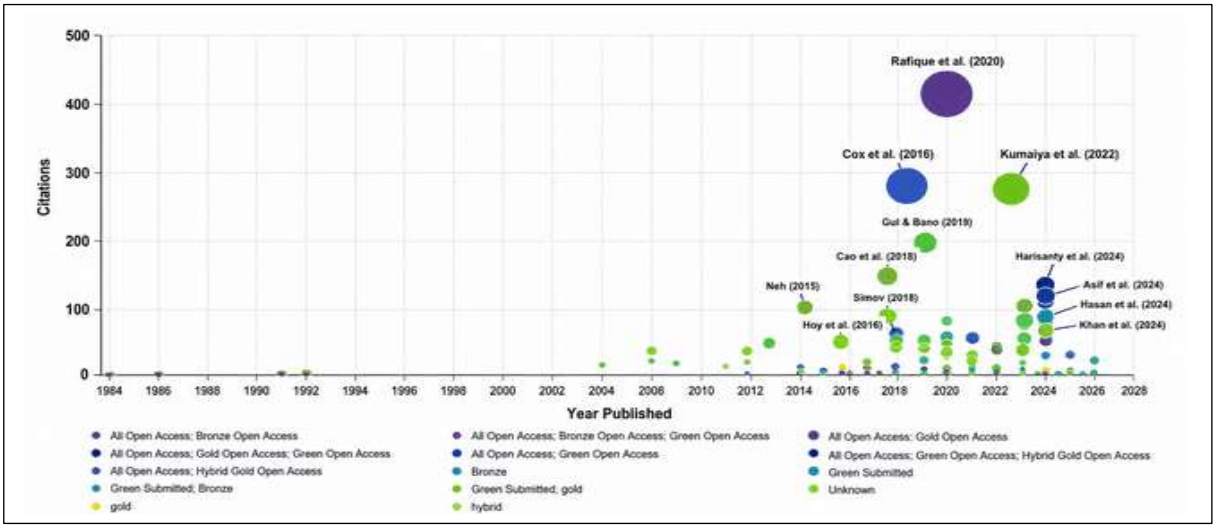

Figure 5. Citations Over Time
Source: Generated by the author(s) using BiblioSpy® (Ahmi, 2026).

Figure 6 presents the most prolific authors in smart library research ranked by total publications. Shahzad, Khurram emerges as the standout contributor with 12 publications, more than double the output of the second-ranked author, Iqbal, Abid with 5 publications, indicating a highly concentrated leadership at the top of the productivity hierarchy. A small cluster of authors — Bai, Zhongxian; Duncan, Adrian St. Patrick; and Khan, Shakeel Ahmad — each contribute 4 publications, followed by a larger cohort of 10 authors recording 3 publications each, including Yunus, Norhazura; Asim, Muhammad; Zhao, Lei; and Ajani, Yusuf Ayodeji, among others. The geographic diversity within this group is notable, with authors affiliated with institutions from Pakistan, Malaysia, China, Nigeria, and South Korea, reflecting the truly international character of smart library scholarship. The relatively modest publication counts beyond the top author also suggest that the field has yet to develop a deep bench of highly prolific researchers, presenting opportunities for emerging scholars to establish stronger footprints in this growing domain.

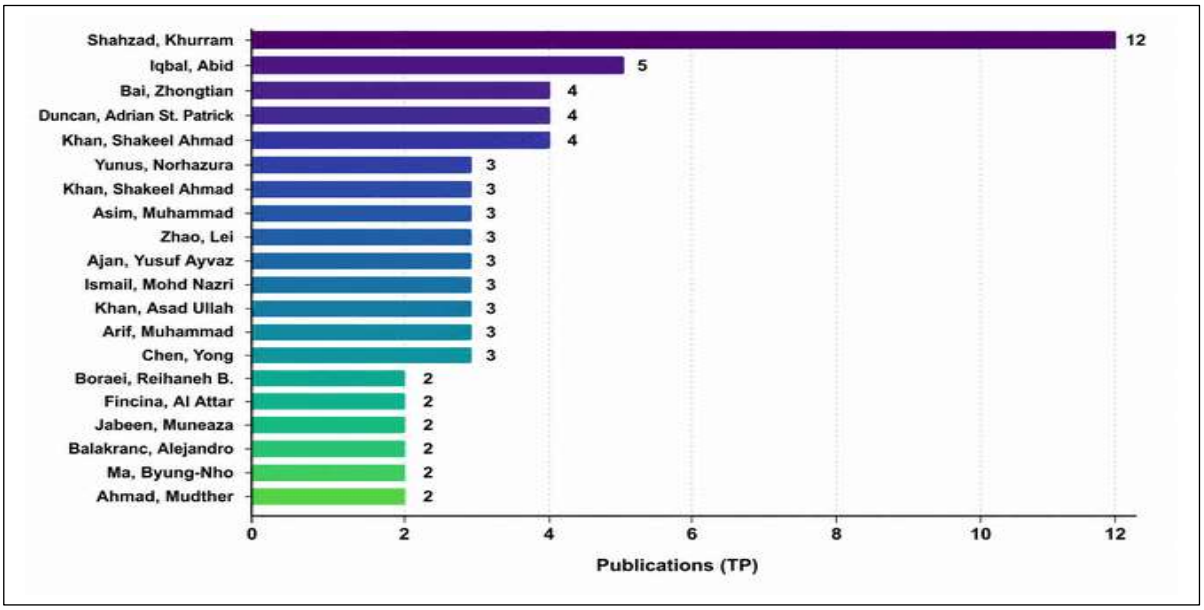

Figure 6

Figure 7 illustrates the distribution of smart library publications by number of authors per document. Single-authored papers account for the largest share at 30.1% (77 documents), followed closely by two-author collaborations at 27.0% (69 documents), collectively indicating that nearly six in ten publications in this field are produced by one or two researchers working independently or in small teams. Three-author collaborations represent the third most common pattern at 19.1% (49 documents), while four-author teams account for 10.9% (28 documents). Larger collaborative groups of five, six, and seven authors constitute progressively smaller proportions of 7.0%, 4.7%, and 1.2% respectively. The overall distribution suggests that smart library research remains predominantly an individually or small-team driven endeavour, with limited large-scale multi-author collaborations. This pattern may reflect the field's relatively early stage of development, where research networks and institutional partnerships have yet to mature into the larger collaborative structures more commonly observed in established interdisciplinary fields.

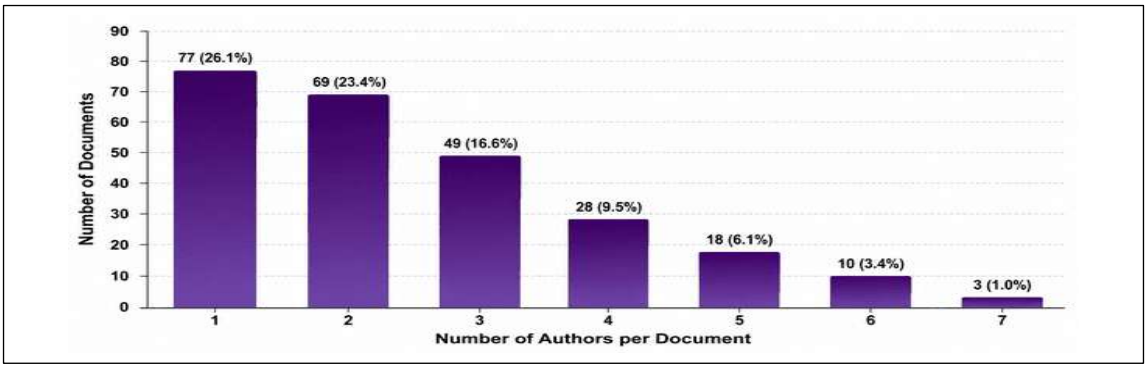

Figure 7. Authorship
Source: Generated by the author(s) using BiblioSpy® (Ahmi, 2026).

Figure 8 presents the most productive institutions in smart library research by total publications. Allama Iqbal Open University leads with 6 publications, followed by Government College University Lahore and Islamia University of Bahawalpur Pakistan, each contributing 5 publications. A second tier of seven institutions — including Communication University of Zhejiang, Nanjing University, Shanghai Jiao Tong University, and University of Ilorin — each record 4 publications, reflecting meaningful contributions from both Chinese and African university systems. The dominance of Pakistani institutions in the top three positions is particularly striking and aligns with the high individual productivity of Pakistani-affiliated authors observed in Figure 6, suggesting a concentrated and well-organised research community around smart library topics within Pakistan's higher education sector. Chinese institutions constitute the largest national group within the mid-tier, with at least four universities represented, reflecting China's broad institutional investment in smart library infrastructure and research. The remaining institutions contributing 3 publications each span a diverse range of countries including Nigeria, South Korea, Saudi Arabia, Malaysia, India, Kazakhstan, Spain, and Jamaica, underscoring the genuinely global reach of smart library scholarship, albeit with clear regional concentrations that point to where the field's most active research ecosystems currently reside.

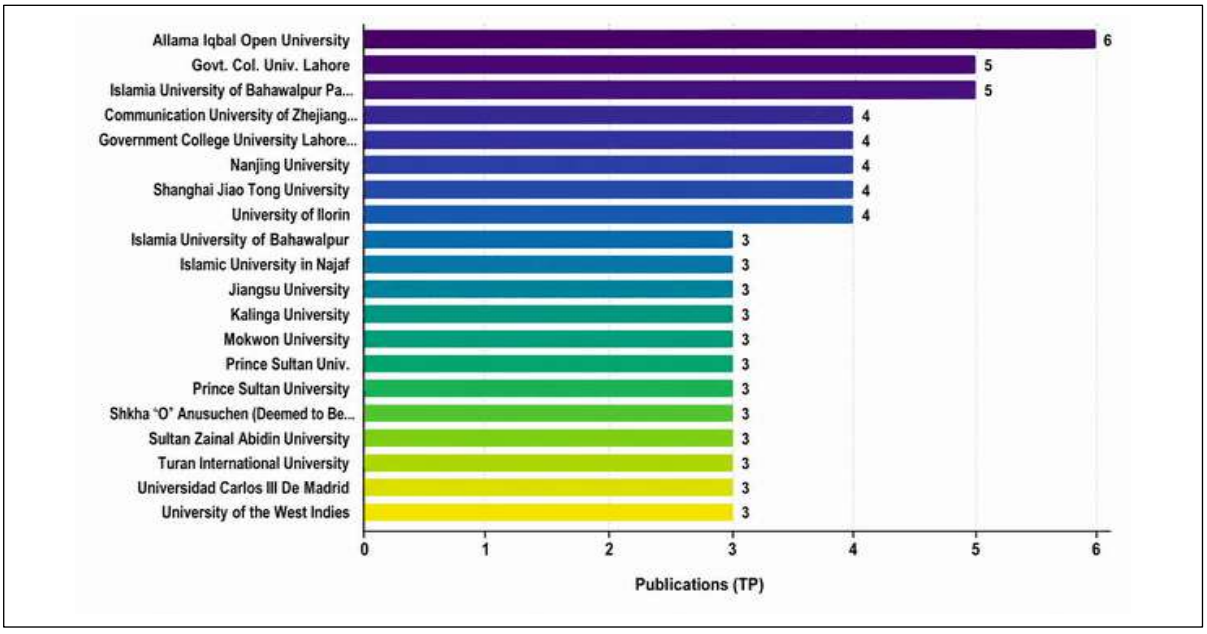

Figure 8. Top Institutions
Source: Generated by the author(s) using BiblioSpy® (Ahmi, 2026).

Figure 9 displays the national distribution of smart library publications, revealing a highly skewed concentration of research output across countries. China dominates the field by a considerable margin with 89 publications, nearly two and a half times the output of the second-ranked country, India, which contributes 36 publications. Pakistan ranks third with 23 publications, followed by Malaysia and the United States each contributing 11, and Nigeria and Saudi Arabia each recording 10. This top-tier grouping points to a strong Asian

and South Asian axis at the heart of smart library scholarship, driven largely by national priorities around digital transformation, smart campus development, and technology-enhanced education. The presence of the United States and United Kingdom (4 publications) within the ranking reflects Western scholarly interest in the field, though their relatively modest output suggests that smart library research has gained comparatively stronger traction in the Global South and East Asia. The broader distribution across 21 countries — spanning Africa, the Middle East, Southeast Asia, Europe, and the Caribbean — confirms the field's genuinely global footprint, while also highlighting significant disparities in research capacity that may warrant targeted international collaboration and knowledge-sharing initiatives to foster more equitable participation in smart library scholarship worldwide.

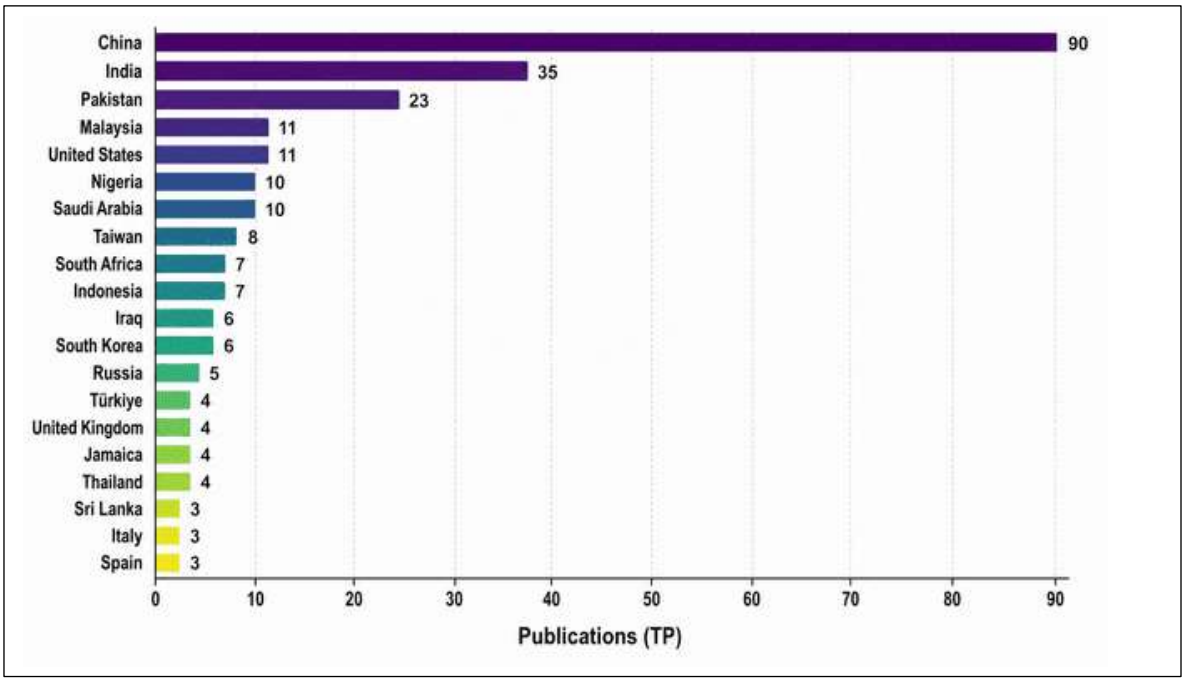

Figure 9

Figure 10 presents a word cloud of the most frequently occurring keywords in smart library research, with font size proportional to keyword frequency. As expected, "smart library" and "smart libraries" dominate the visualisation, confirming their central role as the defining descriptors of the field. Immediately surrounding these core terms are high-frequency keywords including "artificial intelligence," "internet of things," "academic libraries," and "university libraries," reflecting the field's primary technological drivers and its predominant institutional setting. The prominent presence of "machine learning," "big data," "RFID," "IoT," and "library 4.0" further underscores the technological orientation of smart library scholarship, indicating that research in this domain is heavily anchored in the exploration and application of emerging digital technologies within library environments. Conceptually adjacent terms such as "digital library," "intelligent library," "library services," and "library management" point to the operational and service dimensions of the field,

while "fourth industrial revolution," "collaborative filtering," and "data mining" signal its broader theoretical and methodological connections. Collectively, the word cloud provides an intuitive and accessible snapshot of the field's thematic architecture, confirming that smart library research sits at the intersection of technology, information services, and academic library practice.

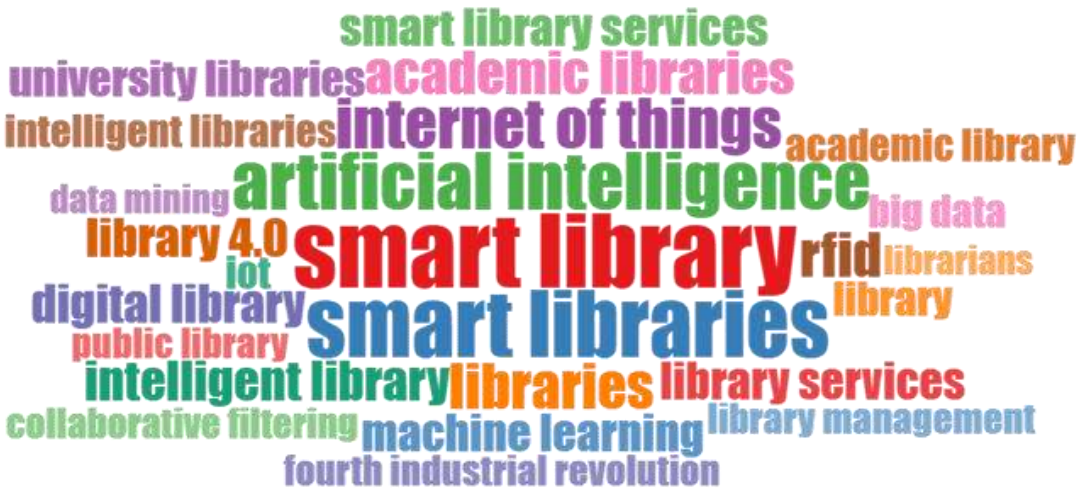

Figure 10. Word Cloud
Source: Generated by the author(s) using BiblioSpy® (Ahmi, 2026).

Discussion

The findings of this bibliometric study on smart library research offer a rich and multidimensional portrait of a field that is growing rapidly in both volume and intellectual sophistication. The following discussion interprets the results across the twelve research questions, drawing connections between the quantitative findings and the broader theoretical and practical implications for library and information science scholarship.

RQ1: Annual Publication Output and Citation Trends

The pronounced inflection in publication output from 2019 onwards reflects the growing institutional urgency surrounding smart library adoption, as universities and public libraries worldwide began operationalising AI and IoT strategies in earnest. That 2020 and 2021 generated the highest citation volumes in the dataset is significant — it suggests that the field's most enduring intellectual contributions emerged precisely when practitioners and scholars were grappling most intensely with the practical and conceptual challenges of library transformation. The sustained growth in output through 2024 and 2025 confirms that smart library research has achieved durable momentum, no longer reliant on a handful of pioneering works but supported by a broadening community of active contributors.

RQ2: Yearly Bibliometric Indicators

The progressive strengthening of bibliometric indicators over the study period signals that smart library research is building genuine scholarly depth rather than simply accumulating volume. The h-index, reaching its zenith at 11 in 2024, reflects a field capable of producing sustained citation impact across a meaningful body of work. More tellingly, the high citations-per-publication values for the 2018–2020 cohort indicate that quality and output grew in tandem during the field's most critical formative phase. The m-quotient data further confirm that works from 2020 and 2021 continue to attract citations at above-average rates relative to their age, pointing to their enduring foundational status within the literature.

RQ3: Relative Citation Impact (RCI)

The RCI findings carry significant implications for how the smart library field positions itself within the wider academic community. An RCI substantially above the global benchmark for publications from 2018 to 2022 — most pronounced in 2020 — demonstrates that the field's output during this window attracted scholarly attention far exceeding what its modest publication volume might suggest. This disproportionate influence is consistent with a field whose research questions resonate across multiple disciplinary communities, including computer science, education, and information systems. The subdued RCI values for more recent cohorts reflect insufficient time to accumulate citations rather than any diminution in research quality, and continued monitoring of these values will be important as the literature matures.

RQ4: Distribution Across Journal Quartile Rankings

The quartile trajectory observed across the study period tells an encouraging story about the field's rising scholarly ambition. The sustained dominance of Q2 publications reflects the field's strong roots in established LIS journals, while the consistent growth in Q1 output — growing from a single paper in 2017 to a substantial cohort by 2025 — signals that smart library researchers are increasingly capable of meeting the rigorous standards of the most selective international journals. This upward quality shift suggests that the field is transitioning from a stage of exploratory inquiry to one of consolidated, methodologically rigorous scholarship. The manageable proportion of unranked publications across most years further confirms that this growth has not diluted the field's overall quality orientation.

RQ5: Top Publication Sources

The clustering of output around Library Hi Tech, Library Hi Tech News, and The Electronic Library reflects a field that has found a secure institutional home within the LIS journal ecosystem. While this concentration provides stability and disciplinary coherence, it also carries risks of insularity if the field's most significant contributions remain confined to venues whose readership is predominantly library-specialist. The notable presence of engineering and applied mathematics journals among contributing sources is therefore a welcome sign of interdisciplinary diffusion, suggesting that smart library research is

beginning to permeate communities beyond traditional librarianship. Strategically targeting high-impact venues in computer science, educational technology, and information systems could further amplify the field's reach and influence.

RQ6: Most Highly Cited Papers

The citation leadership of Rafique et al. (2020) by a considerable margin over all other works underscores the field's appetite for theoretically grounded empirical research that speaks directly to practical questions of user adoption. The paper's deployment of an extended TAM framework provided the field with a replicable and transferable methodological template, contributing to its exceptional citation longevity. The strong representation of AI-focused works in the top citation tier signals that artificial intelligence has become the defining intellectual preoccupation of smart library scholarship. Importantly, the normalised citation data suggest that more recently published works are accumulating influence at trajectories that may eventually challenge the dominance of earlier landmark papers, pointing to a dynamic and self-renewing citation landscape. This trajectory is consistent with the thematic shift identified by Khan et al. (2025) in their bibliometric and thematic mapping of smart library technologies between 2013 and 2022, which similarly found that the field's citation core has progressively migrated from foundational IoT and RFID applications toward AI-centred and, more recently, emerging technologies such as blockchain and immersive interfaces.

RQ7: Citation Trajectories Over Time

The citation trajectory analysis exposes a structural characteristic of the field that warrants attention — namely, the concentration of scholarly influence within a very narrow cluster of papers, with the remainder of the literature attracting comparatively modest citation activity. This pattern, consistent with the Matthew effect in science, suggests that the field's intellectual authority currently rests on a limited set of foundational texts. While this is not unusual for a young field, it does point to the importance of cultivating the next generation of landmark contributions, particularly in underexplored thematic areas such as smart library ethics, governance frameworks, and user experience design. The early citation traction visible in several 2023 and 2024 publications is an encouraging sign that new intellectual anchors are beginning to take shape, exemplified by Jha's (2023b) early treatment of blockchain applications in library and information centre services and Margam's (2024) exploratory account of metaverse technologies as a frontier for elevating library user engagement; both works occupy thematic territory that has not yet produced a landmark paper but appears well positioned to do so as the underlying technologies mature.

RQ8: Most Prolific Authors

The authorship data reveal both a strength and a structural vulnerability in smart library research. The presence of a highly productive scholarly leader with a commanding lead over all other contributors provides the field with a visible and influential champion capable of setting research agendas and mentoring emerging scholars. However, the

relatively thin spread of productivity across the broader author cohort suggests that the field's human capital base remains underdeveloped relative to its growth ambitions. Building a deeper pool of prolific, internationally networked researchers — through targeted funding, collaborative grants, and early-career development programmes — is essential if the field is to sustain and accelerate its current growth trajectory.

RQ9: Authorship Patterns

The prevalence of solo and two-author publications, together representing a majority of total output, raises important questions about the structural capacity of smart library research to address increasingly complex, multi-faceted problems. Large-scale challenges such as the ethical deployment of AI in libraries, the design of interoperable smart library ecosystems, or the evaluation of technology impact across diverse user communities inherently require collaborative teams with complementary expertise. The relative scarcity of larger authorial groups in the current dataset suggests that the field has not yet fully leveraged the collaborative models that characterise more mature interdisciplinary research domains. Deliberate investment in multi-institutional research networks and international collaborative projects would strengthen the field's capacity to tackle its most pressing and complex questions. This authorship pattern may also reflect the field's continuing conceptual consolidation: Kwanya et al. (2013) observed early on that intelligent libraries were still being defined relative to earlier Library 2.0 and 3.0 paradigms rather than as a settled paradigm in their own right, while Igwe and Sulyman (2022) more recently characterised smart libraries as a still-shifting reconfiguration of library service paradigms; fields in this kind of conceptual flux often attract individual exploratory contributions before they mature into the large, structured collaborations typical of more settled research areas.

RQ10: Most Productive Institutions

The institutional productivity data reveal a field whose leadership is geographically concentrated but whose broader contributor base is impressively diverse. The dominance of Pakistani universities at the top of the institutional ranking, complemented by the strong showing of several prominent Chinese universities in the mid-tier, reflects the institutional and policy environments of these countries, where smart library development has been explicitly embedded within national digital transformation agendas. The diversity of institutions contributing at the lower end of the productivity spectrum — spanning multiple continents and institutional types — suggests that smart library research has genuine global appeal. Strengthening institutional partnerships between leading and emerging research centres, particularly through South-South and South-North collaboration frameworks, could help distribute research capacity more equitably and enrich the diversity of perspectives in the literature. The presence of contributions from less frequently represented regions in the dataset, including Duncan's (2021) account of academic smart library opportunities in the Caribbean, Kulkarni and Dhanamjaya's (2017) historical perspective on smart libraries for Indian smart cities, and Adigun et al.'s (2024) framing of intelligent

libraries as instruments of sustainable knowledge systems within the emerging Fifth Industrial Revolution discourse, illustrates the kind of geographically and conceptually distinctive scholarship that the field's institutional diversification has begun to enable.

RQ11: National Distribution of Publications

China's commanding lead in national output, by a wide margin over all other countries, reflects the scale of its state-directed investment in smart library infrastructure and the size of its academic research community. The strong collective presence of South and Southeast Asian nations — including India, Pakistan, Malaysia, and Indonesia — distinguishes smart library research from many other LIS sub-fields in which Western scholarship has historically set the intellectual agenda. This geographic rebalancing is a significant and positive development for the field, bringing in diverse cultural, institutional, and policy contexts that enrich the literature's scope and applicability. However, the limited output from Latin America, Eastern Europe, and much of Sub-Saharan Africa points to persistent inequities in global research capacity that the smart library community should actively work to address through inclusive collaboration and capacity-building initiatives.

RQ12: Keyword Co-occurrence and Thematic Structure

The keyword landscape confirms that smart library research occupies a coherent and well-defined thematic space, anchored by a stable set of core concepts while simultaneously reaching outward into adjacent technological and disciplinary territories. The centrality of artificial intelligence, IoT, and machine learning as dominant keywords reflects the field's deep engagement with transformative technologies, while the prominence of terms such as "academic libraries," "library services," and "library management" anchors these technological interests within the practical realities of library operations. The appearance of "fourth industrial revolution" and "library 4.0" as significant conceptual markers situates the field within the macro-level discourse on institutional transformation, lending it broader theoretical relevance beyond the confines of library science. Emerging keywords at the periphery of the current landscape — including those related to large language models and generative AI — signal the directions in which the field is likely to develop, bridging theoretical development and operational practice in ways that will define smart library scholarship for years to come. The convergence of "library services" with adjacent educational-technology terminology is further substantiated by Shahzad and Khan's (2023) systematic review of e-learning technologies in university libraries, which found that smart library functions and e-learning infrastructure are increasingly treated as a single integrated domain in recent scholarship rather than as separate fields of practice, reinforcing the thematic bridging role that the keyword analysis attributes to the field's core operational vocabulary.

Conclusion

This study has presented a comprehensive bibliometric analysis of the smart library research landscape, drawing on peer-reviewed articles and review papers indexed in the

Web of Science and Scopus databases. Using BiblioSpy® (Ahmi, 2026) as the primary analytical platform, the study systematically addressed twelve research questions spanning publication trends, yearly bibliometric indicators, relative citation impact, quartile distribution, source productivity, highly cited papers, citation trajectories, authorship patterns, institutional and national contributions, and keyword co-occurrence structures. Together, these analyses provide an empirically grounded and multidimensional intellectual map of the field, illuminating how smart library knowledge has been produced, disseminated, and received over the study period.

With respect to the research questions, the findings reveal that smart library scholarship has grown substantially since 2017, with a pronounced acceleration from 2019 onwards (RQ1), and that yearly bibliometric indicators including the h-index, g-index, and citations per publication confirm a field of growing scholarly depth and sustained impact (RQ2). The RCI analysis demonstrates that publications from 2018 to 2022 attracted citations well above the global benchmark, attesting to the field's disproportionate influence relative to its publication volume (RQ3). The quartile distribution reveals an encouraging upward quality trajectory, with Q1 publications growing steadily over the decade (RQ4). Library Hi Tech, Library Hi Tech News, and The Electronic Library emerge as the dominant publication outlets, consistent with the field's strong grounding in the LIS journal ecosystem (RQ5). The citation analysis identifies Rafique et al. (2020), Cox et al. (2019), and Okunlaya et al. (2022) as the most influential works, with artificial intelligence emerging as the field's most cited thematic strand (RQ6). Citation trajectory analysis reveals a concentration of influence within a narrow cluster of landmark papers, consistent with the Matthew effect in science (RQ7). Shahzad, Khurram leads author productivity by a wide margin, though the broader authorship pool remains relatively thin (RQ8). The authorship pattern analysis reveals a predominantly solo and small-team research culture, with limited large-scale collaborative output (RQ9). Allama Iqbal Open University, Government College University Lahore, and Islamia University of Bahawalpur lead institutional productivity, reflecting Pakistan's strong national research presence in this domain (RQ10). China dominates national output by a considerable margin, followed by India and Pakistan, underscoring the centrality of Asian scholarship in driving the field forward (RQ11). Finally, the keyword analysis confirms that smart library research is anchored by a coherent thematic core centred on artificial intelligence, IoT, machine learning, and academic library services, with emerging terms signalling the field's future trajectory toward generative AI and large language model applications (RQ12).

Contributions

This study makes several important contributions to the library and information science literature. First, it provides the first comprehensive bibliometric mapping of smart library research drawn simultaneously from Web of Science and Scopus, offering a more complete and reliable picture of the field than any single-database analysis could achieve. Second, it contributes methodologically by demonstrating the analytical utility of BiblioSpy® as a unified platform capable of generating a wide range of bibliometric

performance indicators and science mapping outputs. Third, it delivers practical value for library practitioners, academic administrators, and policymakers by identifying centres of excellence, productive collaboration networks, and high-impact publication venues. Fourth, the keyword and citation analyses provide actionable intelligence for researchers seeking to position their work within the field's evolving thematic frontiers, serving as a navigational resource for both new and established scholars.

Implications and Recommendations

The findings carry important implications for both the scholarly and practitioner communities engaged with smart libraries. Theoretically, the concentration of citation impact within a narrow cluster of landmark works (RQ6, RQ7) and the relatively thin, geographically concentrated authorship pool (RQ8, RQ9, RQ10) suggest that smart library research remains an emerging rather than a mature specialty, one still organised around a small set of foundational studies rather than a broad, distributed body of cumulative knowledge; this points to a pressing need for theory-building work that consolidates the field's fragmented conceptualisations of AI, IoT, and big data into a more coherent disciplinary framework. Practically, the dominance of AI-themed publications and the keyword structure's pivot toward generative AI and large language model applications (RQ12) signal that library administrators and practitioners should prioritise staff training, infrastructure investment, and policy development around generative AI tools now, ahead of the wave of literature these findings suggest is forthcoming, rather than after adoption pressures intensify. For researchers, the geographic concentration of output in a small number of countries and institutions (RQ10, RQ11) represents both a gap and an opportunity: scholars based outside these established hubs, particularly in regions currently underrepresented in the dataset, are well positioned to make distinctive contributions simply by extending smart library research to new institutional, cultural, and policy contexts. Accordingly, three recommendations follow directly from these patterns: first, funding bodies and library associations should support cross-institutional and cross-national collaborative projects to counteract the field's currently fragmented authorship structure; second, LIS curricula and continuing-education programmes should be updated to build practitioner capacity in generative AI and data-driven service design; and third, future bibliometric studies should periodically revisit this mapping, given how rapidly the field's keyword structure is shifting, to track whether the conceptual coherence identified here strengthens or fragments as the literature matures.

Limitations

Despite its contributions, this study is subject to several limitations that should be acknowledged. First, the analysis is restricted to English-language articles and review papers indexed in Web of Science and Scopus, which may result in the underrepresentation of smart library scholarship published in other languages or indexed in regional databases such as CNKI, Scopus Arab, or ERIC. Second, the search strings, while comprehensive, may not have captured all relevant publications, particularly those using alternative or emerging

terminologies not included in the query. Third, bibliometric analyses are inherently retrospective and descriptive in nature; they reveal patterns in the existing literature but cannot fully explain the social, institutional, or disciplinary forces that produced those patterns. Fourth, citation counts are subject to temporal bias, as more recent publications have had less time to accumulate citations, potentially underrepresenting their true scholarly influence.

Future Research Directions

Several directions for future research emerge from the findings of this study. First, co-citation and bibliographic coupling analyses should be conducted to more precisely delineate the intellectual schools of thought within smart library research and trace how theoretical frameworks have evolved over time. Second, future studies should incorporate additional databases and non-English sources to provide a more globally inclusive picture of smart library scholarship. Third, qualitative content analysis of the most highly cited papers could complement the quantitative findings of this study by unpacking the theoretical and methodological contributions that have driven citation impact. Fourth, longitudinal monitoring of the emerging keywords identified in this study — particularly those related to generative AI, large language models, and federated learning — would help track how these nascent themes develop into fully formed research programmes. Finally, future bibliometric studies could adopt a comparative lens, examining how smart library research intersects with adjacent fields such as smart cities, digital humanities, and educational technology, to map the broader intellectual ecosystem within which the field is evolving.

Acknowledgement

The authors would like to express their gratitude to the Faculty of Information Science, Universiti Teknologi MARA, Malaysia; Faculty of Vocational Studies, State University of Malang, Indonesia and the Fakultas Ilmu Sosial, Universitas Islam Negeri Sumatera Utara, Indonesia, for their institutional support throughout this research. The authors also acknowledge the contribution of BiblioSpy® in facilitating the bibliometric analyses presented in this study.

Competing Interests

No potential conflict of interest was reported by the author.

Declaration Of Generative AI And AI-Assisted Technologies

The authors confirm that generative AI and AI-assisted writing tools were not used in the preparation of this manuscript. All analyses, interpretations, and written content are the original work of the authors.

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