



Integrating Latest Technology in Academic Libraries: A Systematic Review Using the PRISMA Method

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ABSTRACT

Purpose: This systematic review synthesizes recent evidence on the adoption and application of emerging technologies in academic libraries, with a special focus on the Indian and IIT context.

Methodology: Following the PRISMA framework, relevant studies (2015-2025) were retrieved from Scopus, Web of Science, and IEEE Xplore using combined search strings covering AI/ML, XR, IoT, cloud computing, RFID, big data analytics, and chatbots. After de-duplication and rigorous screening, 29 eligible studies were analyzed through a structured evidence matrix.

Findings: Publications have increased significantly since 2019, with most appearing in Library Philosophy and Practice. Research predominantly employed quantitative survey methods, while qualitative and implementation studies were limited. Reported benefits include efficiency gains, improved access and service quality, user satisfaction, workload reduction, and institutional visibility. Technology practices clustered into four domains: AI/analytics-driven services, infrastructure modernization, resource tracking and security, and mobile-first self-service. Persistent challenges relate to financial constraints, technical expertise, and policy alignment.

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Implications: <i>The study recommends a phased integration strategy combining low-cost open-source tools with selective AI and cloud investments supported by staff training and robust data-governance policies.</i>	
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Keywords: Emerging technologies in libraries, Academic libraries, Artificial intelligence (AI), Internet of Things (IoT), Cloud computing, Systematic literature review (PRISMA)

1. INTRODUCTION

In the twenty-first century, libraries are experiencing a deep transformation, shifting away from their historical roles as static storage places for physical items to dynamic, community-focused centres of information and knowledge production. This change is being propelled by the speed of technological development, which is providing unparalleled challenges to improve library services, standardise operations, and increase community outreach. New technologies, such as artificial intelligence (AI), virtual and augmented reality (VR/AR), the Internet of Things (IoT), and blockchain, are not novelties; they are force multipliers with the potential to radically redefine the contemporary library environment (Asim & Arif, 2023; Jadhav & Shenoy, 2020; Roy et al., 2022). These technologies hold the promise of offering more tailored user experiences, streamlining mundane tasks, and enabling novel means of information access and preservation (Kaushal & Yadav, 2022; Verma & Patnaik, 2024).

Yet, the implementation of these technologies comes with profound challenges. Data privacy and security concerns, digital inequality, the expense of implementation, and ongoing professional development are central issues that need to be addressed (Ansari & Ali, 2021; Dadhich et al., 2021; Sinha & Brar, 2024). As librarians and information professionals work in this multifaceted context, it is imperative to critically appraise both the potential advantages and the inherent challenges of technology integration.

This review paper presents an all-embracing review of the existing and future uses of emerging technologies within libraries. It is designed to first examine the main opportunities offered by these innovations, which involve better user services, greater operational effectiveness, and new opportunities for educational and cultural programming. Later, the paper explores the foremost issues that confront libraries in embracing these technologies, for example, ethical issues, fiscal limitations, and organisational and staff preparedness. Through an integration of existing literature and recent case studies, this paper seeks to provide a balanced viewpoint to lead the library community towards informed choices that utilize technology to serve their communities better while avoiding possible risks. Ultimately, this review adds to a greater understanding of how libraries can adapt to technological change to continue to be meaningful and integral institutions of the digital era.

2. RESEARCH QUESTIONS

With the accelerated rate of technological advancement in the field of library and information science, the current study attempts to present an exhaustive account of the utilisation of new-generation technologies in libraries and examines both the possible advantages as well as the major issues of embracing them. The individual goals of this systematic review are to:

Research question (RQ1): What are the emerging technologies (e.g., AI, extended reality, IoT) being implemented or in development in contemporary libraries?

Research question (RQ2): What are the main uses and possibilities these technologies offer for improving library services and operations?

Research question (RQ3): What are the main technical, organisational, and ethical challenges of implementing these technologies in libraries?

Research question (RQ4): How are libraries and information professionals understanding and responding to these technological changes?

This study is timely and relevant in light of the accelerated digital disruption facing libraries across the world. The embedding of clever and immersive technologies is not only transforming service provision but also the foundational architecture of how knowledge is generated, disseminated, and conserved. This work adds a critical perspective to how libraries are able to navigate innovation while ensuring responsible stewardship in increasingly sophisticated information environments.

3. RESEARCH METHODOLOGY AND DESIGN

We adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework to conduct a structured review of the relevant literature. PRISMA provides an evidence-informed checklist of minimum reporting standards that facilitates the critical appraisal of published work (Moher et al., 2009; Page et al., 2021). The process comprises four stages: identification, screening, eligibility, and inclusion. Although developed for health research, PRISMA has proven valuable across disciplines and has been effectively employed in recent Library and Information Science studies to guide systematic literature reviews (Ahmad & Rafiq, 2022; Asim & Arif, 2023; Mahmood, 2017; Rafique & Mahmood, 2018).

3.1 Search strategy

We performed a targeted search in three bibliographic databases - Scopus, Web of Science Core Collection (WoS), and IEEE Xplore - to retrieve peer-reviewed journal literature on emerging technologies in Indian educational libraries with a focus on IIT settings. Searches were executed on 10 September 2025 and restricted to English-language journal articles published 2015-2025. Search strings were constructed using three concept blocks: (emerging technologies) AND (library domain) AND (India/IIT).

Table 1: Inclusion and exclusion criteria

S.No.	Inclusion	Exclusion
1	Peer-reviewed journal articles (original research or reviews)	Conference papers, editorials, notes, book chapters.
2	Research papers in the English language	Non-English publications.
3	Published 2014–August, 2025	outside 2015–2025.
4	Focus on libraries (especially academic/digital libraries) in India and/or explicitly referencing IIT context	Non-library contexts (e.g., general campus IT without library relevance).
5	Addresses at least one target technology from the query (AI, ML, IoT, blockchain, AR/VR, big data/analytics, cloud, RFID, 3D printing, chatbots/virtual assistants).	Studies not about India/IIT or where India is only in author affiliation with no Indian library context.

Note. AI = artificial intelligence; ML = machine learning; IoT = Internet of Things; RFID = radio frequency identification; IIT = Indian Institute of Technology.

We employed database-specific field tags and filters; syntax was standardised for reproducibility. Results were exported (RIS/CSV) and de-duplicated in Zotero/EndNote, screened by title/abstract against a priori specified inclusion/exclusion criteria (below), then assessed for full-text eligibility. We also carried out backward/forward citation chasing on included studies. Search strategy as follow:

("artificial intelligence" OR "machine learning" OR "internet of things" OR "IoT" OR "blockchain" OR "augmented reality" OR "virtual reality" OR "AR/VR" OR "big data" OR "data analytics" OR "cloud computing" OR "RFID" OR "radio frequency identification" OR "3D printing" OR "chatbots" OR "virtual assistants") AND ("library" OR "libraries" OR "academic library" OR "digital libraries" OR "library science") AND ("India" OR "Indian Institutes of Technology" OR "IIT")

Searches using the finalised string were conducted across Scopus, Web of Science, and IEEE Xplore. The identical query and filters were applied in each database, and all retrieved records were exported and consolidated into a single Excel sheet, then deduplicated. Eligibility limits were set to journal articles published in English between 2015 and August 2025 and indexed under Computer Science or Social Sciences. Study selection followed the PRISMA stages - title/abstract screening, full-text eligibility assessment, and final inclusion. Data extraction was performed using a standardised Excel form and was double-checked to ensure accuracy and authenticity.

3.2. Inclusion and exclusion criteria

To ensure relevance and consistency, predefined inclusion and exclusion criteria were applied during screening (Xiao & Watson, 2019). Records that fulfilled all inclusion criteria were kept; those meeting any exclusion criterion were discarded. Table 1 summarises these criteria.

3.3. Filtering

A three-stage screening process (Figure 1) generated the final set of studies. The initial search gave 449 records. Following the removal of duplicates and obviously irrelevant items, titles and abstracts were screened. To reduce bias, predefined inclusion and exclusion criteria were used, and backward and forward citation searches were carried out to increase coverage. 94 articles went to full-text evaluation; a total of 59 studies were found relevant but 30 full text studies were excluded based on quality assessment. Finally, 29 studies provided concrete evidence to address this study's research questions.

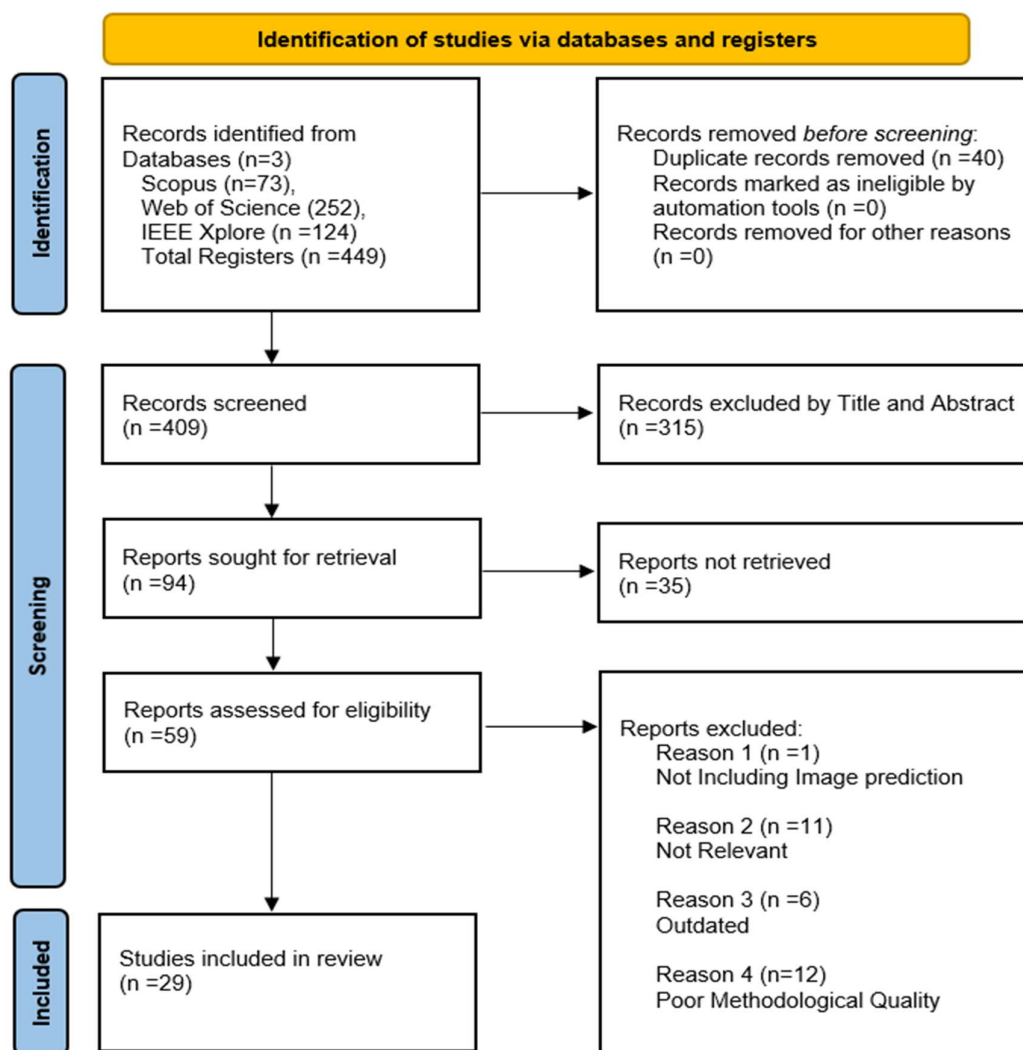


Figure 1: Phases flow diagram of PRISMA guidelines 2020

4. RESULTS AND INTERPRETATION

4.1. Methodologies employed in the selected studies

Table 2 presents the methodologies adopted to investigate emerging technologies in libraries. Figure 2 illustrates the distribution of research approaches used in the 29 selected studies with their respective proportions. Quantitative surveys were the most frequently applied method, often supported by descriptive and inferential statistics (Kalbande et al., 2024; Sinha & Brar, 2024; Subaveerapandiyan & Gozali, 2024; Sudhier & Seena, 2018). Algorithm and model development approaches were employed in a smaller group of studies, reflecting the technical orientation of some research (Alange & Vidya Sagar, 2023; Fernandez et al., 2023; Lodhi et al., 2018; Verma & Patnaik, 2024). Case study designs, both descriptive and qualitative, were reported in several studies (Chudasma et al., 2019; Jayakanth et al., 2022; Sengar et al., 2025; Singha & Verma, 2019), while implementation and framework proposals were adopted in others (De Sarkar & Shaw, 2021; Jadhav & Shenoy, 2020; Patra, 2021; Roy et al., 2022). Mixed survey-case methods were also used (Chudasma et al., 2019; Yadav & Mahawariya, 2021), and one study applied a high-order PLS-ANN model combining exploratory and confirmatory factor analysis (Dadhich et al., 2021). A qualitative exploratory study based on interviews and NVivo analysis was also noted (Kaushal & Yadav, 2022).

With respect to instruments, questionnaires were the most common tool, while interviews and observational data were used sparingly. The populations studied included LIS students, library professionals, and users, with sample sizes ranging from a maximum of $n = 780$ (Sinha & Brar, 2024) to small exploratory sets such as a five-member assessor panel (Jadhav & Shenoy, 2020). Sampling techniques included purposive (Chanda & Sinha, 2019; Kalbande et al., 2024; Kaushal & Yadav, 2022), stratified random (Sharma & Kandari, 2021; Sinha & Brar, 2024; Subaveerapandiyan & Gozali, 2024), and random or other non-probability methods (Ansari & Ali, 2021; Roy et al., 2022; Sharma & Kandari, 2022). Overall, the analysis reveals a dominance of quantitative survey-based research, with fewer qualitative and mixed-methods studies. This imbalance suggests that empirical validation of technology adoption in libraries is still limited, while conceptual, algorithmic, and implementation reports remain a significant strand of the literature.

Table 2: Methodological nature of the selected studies (n = 29)

Title	Authors	Year	Technology name	Research approach / methodology	Instrument	Population	Sample size	Sampling technique	Formula(s) used / reported	DOI / URL
An automatic college library book recommendation system using optimized Hidden Markov based weighted fuzzy ranking model	Monika Verma; Pawan Kumar Patnaik	2024	AI (Recommender: HMM + Weighted Fuzzy Ranking + Discriminant Analysis)	Algorithm design & evaluation on real circulation logs	Programmatic model; BIT Durg circulation dataset	BIT Durg college library transactions	X	X	Pearson correlation; HMM; Weighted Fuzzy Ranking; Accuracy, Kappa	10.1016/j.engappai.2023.107664
AI literacy of library and information science students: A study of Bangladesh, India and Pakistan	Zakir Hossain; Md. Sakib Biswas; Ghalib Khan	2025	AI / GenAI literacy (LIS)	Cross-sectional online survey (3 countries)	Structured online questionnaire	LIS students (Bangladesh, India, Pakistan)	632	Purposive sampling	X	10.1177/09610006241309323
AI in Indian Libraries: Prospects and Perceptions from Library Professionals	A. Subaveerapandian; Alfian Akbar Gozali	2024	AI (adoption & tools in academic libraries)	Quantitative survey; descriptive + independent-samples t-tests	Questionnaire (Google Forms)	Library professionals (India)	386	Stratified random sampling	t-test; means/SD; p-values	10.1515/opis-2022-0164
Integration of AIDC Technology in Mobile via QR Code for Enhancing the Library Services: A Case Study of Don Bosco College Central Library, Arunachal Pradesh	Sur Chandra Singha; Manoj Kumar Verma	2019	AIDC / QR Code	Qualitative case study (website deployment)	QR generator + mobile scanning workflow	Don Bosco College Central Library users	X	X	X	10.51983/ijiss.2019.9.2.626
Exploring the Integration of Artificial Intelligence in Academic Libraries: A Study on Librarians' Perspectives in India	R. Kalbande; S. Choudhari; P. Vijayadhab; S. Bondre	2024	AI (perceptions & readiness)	Quantitative survey; SPSS-based descriptive/inferential	Questionnaire (Google Forms)	LIS professionals (India)	259	Purposive sampling	X	10.2478/OPIS-2024-0041
StuA: An Intelligent Student Assistant	Pooja Lodhi; Omji Mishra; Shikha Jain; Vasvi Bajaj	2018	AI (Rule-based voice assistant; CLIPS + Java)	Design & implementation; verification/validation incl. library FAQs	CLIPS KB + Java UI; user testing	Final-year students (incl. library queries)	70 experts; 836 queries (829 correct)	X	Confidence Level = 1 - 1/2^N	10.9781/ijimai.2018.02.008

Title	Authors	Year	Technology name	Research approach / methodology	Instrument	Population	Sample size	Sampling technique	Formula(s) used / reported	DOI / URL
Library Professionals' Adoption of Cloud Computing Technologies: A Case Study on Kerala University Library, India	K. G. Sudhier; S. T. Seena	2018	Cloud Computing (SaaS/PaaS/IaaS)	Cross-sectional survey; descriptive	Structured questionnaire (5-pt Likert)	Kerala University Library professionals	102 (112 distributed)	X	X	https://digitalcommons.unl.edu/libphilprac/1832
Impact of Automation on Users of Technical Institution Libraries of Delhi-NCR Region (India)	Gareema Sharma; Aditi Kandari	2021	Library Automation (ILS: Libsys, Koha, e-Granthalaya; ICT; RFID)	Survey across 5 technical-institution libraries; two questionnaires (users + libraries)	Questionnaires + interviews + observation	Users at IIT Delhi, NIT Delhi, DTU, IIIT Delhi, NSUT	125 (25/library)	Stratified sampling	X	https://digitalcommons.unl.edu/libphilprac/4956
Awareness and Perception of Students Toward Execution of Internet of Things in Library Services: A study of IITs of Northern India	Priyanka Sinha; Khushpreet Singh Brar	2024	IoT	Quantitative survey; stratified random sampling across 5 IITs; ANOVA/Chi-square; reliability via Cronbach's alpha	Structured questionnaire; SPSS/Excel	PG & research scholars at IIT Delhi/Kanpur/Roorkee (BHU)	780 (95.94% RR)	Stratified random sampling	Cronbach's alpha; ANOVA (F); Chi-square	10.1515/opis-2022-0167
Library Automation in India: Assessment of Library Services Platforms	A. K. Tyagi; V. Senthil	2015	Cloud / LSPs (Koha, e-Granthalaya, CYBRARIAN)	Exploratory assessment (vendor questionnaire + web scan)	Vendor questionnaire; desk research	LSP vendors/providers & installs (India)	X	X	X	X
A Model Approach to Cloud Implementation on Public Libraries with a focus on West Bengal, India	Tanmay De Sarkar; Jitendra Nath Shaw	2021	Cloud LMS (AWS EC2 Koha) + Private Cloud (VMware ESXi)	Model architecture + simulation; cost/security discussion	AWS EC2; VMware ESXi; Koha stack	West Bengal public libraries (system design)	X	X	X (percent reductions only)	https://digitalcommons.unl.edu/libphilprac/6270
Application of Cloud Computing in University Libraries: Case Study of Selected University Libraries in Gujarat	Pradipsinh Chudasma; Atul Bhatt; Dharmendra Trivedi	2019	Cloud Computing (SaaS/PaaS/IaaS)	Case study + cross-sectional survey (users & staff at 3 universities)	Two structured questionnaires	Library users & senior staff	225 (210 users + 15 staff)	X	X	https://digitalcommons.unl.edu/libphilprac/2744

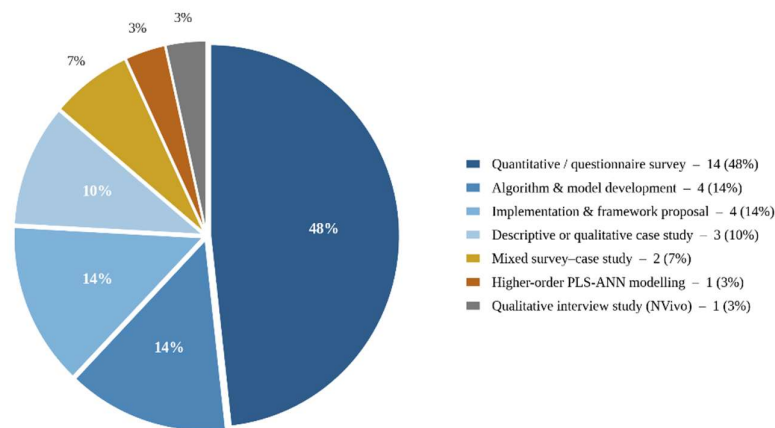
Title	Authors	Year	Technology name	Research approach / methodology	Instrument	Population	Sample size	Sampling technique	Formula(s) used / reported	DOI / URL
Application of Radio Frequency Identification Technology in libraries and information centres: An Indian perspective	Neeraj Kumar Singh; Preeti Mahajan	2017	RFID (self-check, book-drop, gates, shelf-reader)	Survey of 9 academic libraries; descriptive	Questionnaire + interviews + observation	9 Northern-India academic libraries	X	X	X	http://digitalcommons.unl.edu/libphilprac/1614
Consumerization of IT: Nexus of SMAC Technology adoption by the Indian libraries	Rajendra Babu H.	2020	SMAC (Social, Mobile, Analytics, Cloud)	Cross-sectional survey; descriptive	Online questionnaire	LIS professionals (India)	235	X	X	https://digitalcommons.unl.edu/libphilprac/4472
Determining the Factors Influencing Cloud Computing Implementation in LMS: A High Order PLS-ANN Approach	Manish Dadhich; Shalendra S. Rao; Surendra Sethy; Renu Sharma	2021	Cloud Computing (LMS adoption)	High-order PLS-ANN (SEM to ANN); EFA/CFA; fit/validity; cross-sectional survey	Structured questionnaire (TOE+Financial); SPSS/AMOS	Library professionals & users (Indian HEIs)	510	X	KMO 0.864; GFI 0.926; CFI 0.910; RMSEA 0.025; alpha, AVE, CR; beta, p<0.05	https://digitalcommons.unl.edu/libphilprac/6281
Disruptive Innovative Library Services @ International Nalanda University: Present and Future Roadmaps	Nihar K. Patra	2021	Multi-tech (Koha, Summon WSDS, portal, RemoteXS SSO, DSpace IR; roadmap incl. RFID/ERMS/cloud/AI/AR/VR/IoT/3D printing)	Descriptive implementation report (implemented + roadmap)	Implemented tools & workflows	Nalanda University community	X	X	X	https://digitalcommons.unl.edu/libphilprac/5634
Growth and Development of Central Secretariat Library, Ministry of Culture, Government of India: a study	Meera Yadav; Kimi Mahawariya	2021	Automation & ICT (Libsys, Koha; DSpace, ISYS, Greenstone; barcodes, CCTV, RFID, biometrics)	Descriptive case/trend (2010-2020); questionnaire + interviews + observation; official reports	Self-designed questionnaire; interviews; observation; MoC reports	Central Secretariat Library (New Delhi)	X	X	X	https://digitalcommons.unl.edu/libphilprac/6075
Librarians' Perception Towards Virtual Reference Service (VRS): Innovation and Knowledge Cluster Use Case	Atasi Sinhababu; Shiv Kumar	2021	VRS/DRS (synchronous chat proposed via tawk.to)	Quantitative survey; descriptive + inferential	Structured questionnaire + interviews/observation; SPSS	Librarians of CRIKC institutions	19 libraries/respondents	X	Mean, SD; Kruskal-Wallis H; Chi-square	https://digitalcommons.unl.edu/libphilprac/4967

Title	Authors	Year	Technology name	Research approach / methodology	Instrument	Population	Sample size	Sampling technique	Formula(s) used / reported	DOI / URL
RFID Technology in Academic Libraries of North-East India	Anupam Chanda; Manoj Kumar Sinha	2019	RFID (self-check, stock verification, gates, shelf reader, smart card)	Survey of RFID-implemented academic libraries; descriptive	Questionnaire + interviews + observation	Academic libraries (North-East India)	X	Purposive sampling	X	https://digitalcommons.unl.edu/libphilprac/3005
Security Challenges in Central University Libraries in India	Anam Jamal Ansari; P. M. Naushad Ali	2021	Security tech (CCTV; exit detection; RFID/biometrics proposed)	Survey across AMU & JNU	Two questionnaires (librarians & users)	Users & librarians (AMU, JNU)	228 users (270 distributed); librarians: X	Random sampling (users)	X	https://digitalcommons.unl.edu/libphilprac/5299
Theft and Mutilation of Library Resources in University Libraries of India: A Study	Sandip J. Pathak; Priyanki R. Vyas	2020	Security tech (CCTV, RFID, alarm gates, entry register/biometric)	Cross-sectional survey (Gujarat ULs); descriptive + one-sample t-test	Structured questionnaire; Excel & SPSS	Library professionals at 58 university libraries	120 (of 140)	Census / total enumeration	One-sample t-test (e.g., $t = 3.873$; $t = 1.930$)	https://digitalcommons.unl.edu/libphilprac/4371
Collection Development Using Data Analytics: A Case Study at IGDTUW, Delhi, India	D. S. Sengar; Komal Saxena; Ashok Kumar Rathore	2025	Data analytics (Python/Pandas) + ILMS (NewGenLib)	Case study using holdings & circulation (2022-2024); Trueswell 80/20	NewGenLib exports; Python (Pandas); Excel 365	IGDTUW Library records	30,612 holdings; 16,905 circulation	X	Trueswell 80/20; usage % calculations	10.14429/djlit.20885
Personalized ontology and deep training tree-based optimal GRU-RNN for prediction of students' behavior	F. M. H. Fernandez; T. V. Ramana; M. Shabana; V. Kannagi; M. Nalini	2023	AI (Personalized Digital Library ontology + GRU-RNN + DTT; BWO)	Algorithm design + evaluation for personalized digital library; 10-fold CV; 15-day student case study	Protege 4.3; MATLAB; SWRL rules; confusion-matrix metrics	Students using a digital library (incl. Northern Taiwan University)	162 evaluated; 150 in case study	X	GRU gate/update eqns; MSE/cross-entropy; Accuracy/Precision/Recall	10.1002/cpe.7420
Impact of Automation on the Library Services of Technical Institutions in Delhi-NCR Region	Gareema Sharma; Aditi Kandari	2022	Library Automation & RFID (Libsys 7; Koha 3.22.x; e-Granthalaya 3.0; RFID self-check/gates/smart cards)	Survey of five technical-institution libraries; before/after status	Questionnaire + interviews + observation	IIT Delhi, NIT Delhi, DTU, IIIT Delhi, NSUT	X	Random sampling (sites/users as stated)	X	X
Small files access efficiency in HDFS: a case study on British Library text files	Neeta Alange; P. Vidya Sagar	2023	Big Data / HDFS (VFS-HDFS wrapper; bucket-chain; caching; ensemble text classifiers)	Systems design + case study on British Library text datasets; single-node Hadoop testbed	Fedora 32; Hadoop 3.2.0; Java; SQL Server; NetBeans	British Library text datasets (.txt, .rtf)	114,254 files overall (.txt 112,521; .rtf 1,733)	X	Block/replication & metadata formulas; SD used	10.1007/s10586-023-03992-1
Measuring the smartness of a library	Dnyaneshwar Jadhav; Dinesh Shenoy	2020	Smart Library / Fuzzy logic LSI model (AI, IoT, RFID, analytics, etc.)	Model development + case application (large academic library)	Assessor questionnaire (7-point fuzzy scales); 5-member panel	Large state-funded academic university library	5 assessors (panel)	X	Fuzzy triangular numbers; aggregation eqns; Euclidean distance; centroid	10.1016/j.lisr.2020.101036

Title	Authors	Year	Technology name	Research approach / methodology	Instrument	Population	Sample size	Sampling technique	Formula(s) used / reported	DOI / URL
Migration of a Research Library's ICT-Based Services to a Cloud Platform	Francis Jayakanth; Ananda T. Byrappa; Filbert Minj	2022	Cloud (Azure IaaS/SaaS) for IR (EPrints), ETD (DSpace), ILMS (LibSys), website (Drupal), Shibboleth SSO	Implementation case report (phased on-prem to Azure migration)	Azure VMs/Monitor; EPrints; DSpace/Tomcat	JRD Tata Memorial Library (IISc) services	X	X	X	10.6017/ital.v41i1.13537
Building Immersive Library Environment to Access Virtual Reality Content - A Proposed Framework Model	Samrat Guha Roy; Uma Kanjilal; B. Sutradhar; S. K. Jalal	2022	AR/VR (WebAR, VR, data-visualisation) in academic library	Survey + framework proposal (DELOS digital-library model)	Questionnaire (5-pt Likert); Excel analysis	Central Library, IIT Kharagpur users	100 (of 135 approached)	Random sampling (invited users)	X	10.14429/djlit.42.3.17719
The Role of Chatbots in Academic Libraries: An Experience-based Perspective	Vaishali Kaushal; Rajan Yadav	2022	AI chatbots for academic libraries	Qualitative, exploratory; semi-structured interviews; CAQDAS (NVivo) analysis	Interview guide; audio/phone/Zoom; NVivo	Library stakeholders (staff, doctoral students, faculty)	33 interviews	Purposive sampling	X	10.1080/24750158.2022.2106403

Note. X = not reported or not applicable. LIS = library and information science; ILS = integrated library system; ILMS = integrated library management system; LSP = library services platform; IR = institutional repository; ETD = electronic theses and dissertations; SSO = single sign-on; HDFS = Hadoop Distributed File System; SEM = structural equation modelling; ANN = artificial neural network; EFA = exploratory factor analysis; CFA = confirmatory factor analysis; TOE = technology-organisation-environment; CV = cross-validation; CAQDAS = computer-assisted qualitative data analysis software.

Research methodologies used in the selected studies (n = 29)

*Figure 2: Research methodologies used*

4.2. Publication trends of Emerging Technology in the literature

First, this SLR study outlines the publication trends (in terms of year, journal, and geography where identifiable) in the existing body of literature on emerging technologies in libraries. Figure 3 shows that the 29 studies were published between 2015 and 2025. The earliest study in the dataset appeared in 2015 (Tyagi & Senthil, 2015), with a steady rise in subsequent years. Three studies each were published in 2019 and 2020, followed by a surge in 2021 with seven publications - the peak year in the dataset. Four studies each were reported in 2022 and 2024, while two appeared in 2023 and two in 2025 (Hossain et al., 2025; Sengar et al., 2025). Only one study each was published in 2015 and 2017 (Singh & Mahajan, 2017), and two in 2018 (Lodhi et al., 2018; Sudhier & Seena, 2018).

This distribution indicates that research interest in emerging technologies in libraries has accelerated, particularly since 2020, reflecting the growing attention to AI, IoT, cloud migration, RFID, and related tools in library contexts. The presence of consistent publications in recent years demonstrates that the topic remains current and evolving, especially in the post-pandemic period when digital transformation accelerated globally.

Although the country distribution is less explicitly reported in the metadata, author affiliations in the reviewed studies suggest contributions from India, Bangladesh, Pakistan, the United States, and Europe, with India accounting for a major share of empirical surveys and implementation case reports (Hossain et al., 2025; Sinha & Brar, 2024). Notably, India was also used as a primary filter in databases such as Scopus, Web of Science, and IEEE Xplore to retrieve papers directly related to Indian Institute of Technology (IIT) libraries and other Indian academic contexts. This strengthens the review's focus on India-specific developments and ensures relevance to the IIT setting.

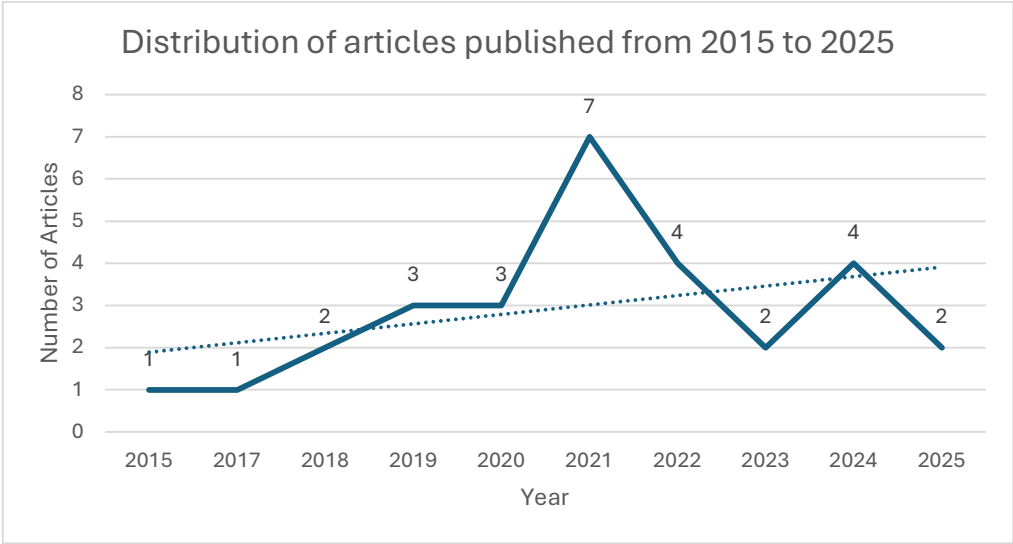


Figure 3: Distribution of articles published from 2015 to 2025.

Overall, Figure 3 highlights the publication trend line, showing that the majority of contributions appeared between 2019 and 2024, with 2021 standing out as the most productive year. This pattern indicates that the phenomenon is relatively novel, gaining significant traction in the last five years, and is likely to expand further as more empirical validation studies and cross-country collaborations emerge.

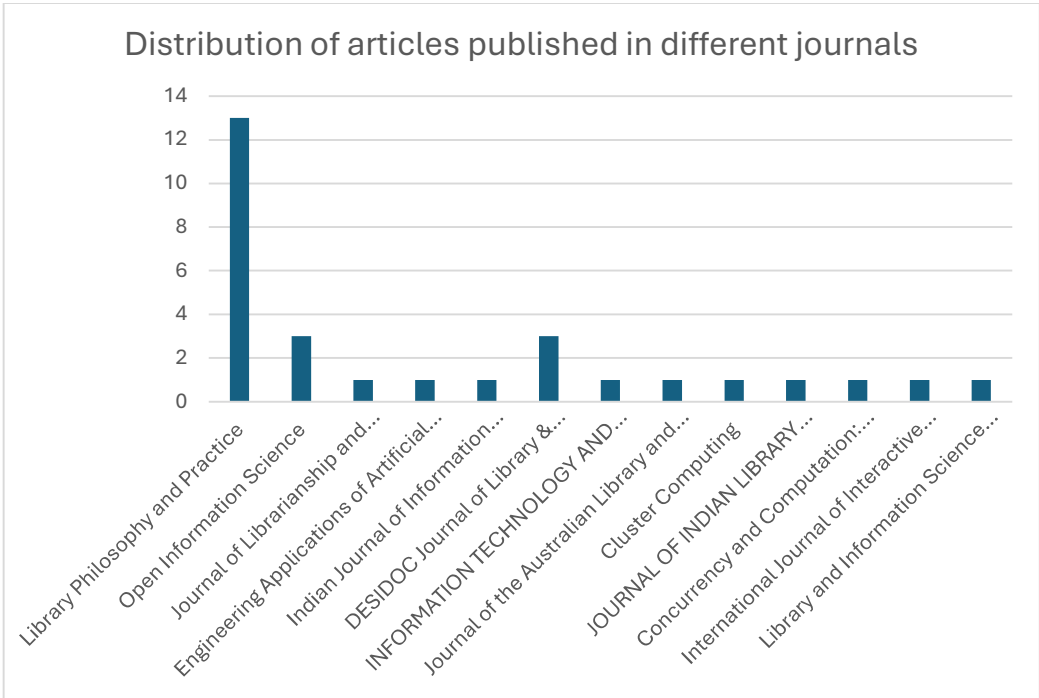


Figure 4: Distribution of articles published in different journals

Figure 4 presents the spread of articles on the adoption and utilization of new technologies in academic libraries across journals. The highest number of articles is found in *Library Philosophy and Practice* (13 articles). Two journals share second place: *Open Information Science* (3) and the *DESIDOC Journal of Library & Information Technology* (3). The other outlets produced one publication each: the *Journal of Librarianship and Information Science*, *Engineering Applications of Artificial Intelligence*, the

Indian Journal of Information Sources and Services, Information Technology and Libraries, the Journal of the Australian Library and Information Association, Cluster Computing, the Journal of the Indian Library Association, Concurrency and Computation: Practice and Experience, the International Journal of Interactive Multimedia and Artificial Intelligence, and Library & Information Science Research. This trend reflects strong concentration in *Library Philosophy and Practice*, with a long tail of publication across core LIS and proximate, interdisciplinary outlets.

4.3. Benefits/reasons of adopting emerging technologies in libraries (RQ2)

RQ2 looks at the main uses of, and possibilities offered by, emerging technologies, that is, the benefits and reasons for adopting them in libraries. Table 3 shows the main benefits and drivers found in the 29 studies. Fourteen studies specifically discussed why academic libraries should adopt these technologies. The most common benefits included saving time, improving performance and efficiency of routine operations, and enhancing service quality (Chanda & Sinha, 2019; Chudasma et al., 2019; Sharma & Kandari, 2021; Singh & Mahajan, 2017; Sudhier & Seena, 2018). Several papers pointed out increased accessibility of collections (Alange & Vidya Sagar, 2023; Sengar et al., 2025), broader reach of library services (Kaushal & Yadav, 2022; Sinhababu & Kumar, 2021), and a better experience for visitors and users (Roy et al., 2022; Singha & Verma, 2019). Other reasons for adoption included reducing the workload of library staff (Lodhi et al., 2018; Yadav & Mahawariya, 2021), cutting operational costs (De Sarkar & Shaw, 2021; Tyagi & Senthil, 2015), improving knowledge management practices (Jadhav & Shenoy, 2020), and boosting the library's image (Patra, 2021). A few studies also noted the importance of self-reliance in service delivery, fitting in with institutional digital transformation efforts, and staying competitive with global library trends (Babu, 2020; Patra, 2021).

In the case of Indian academic libraries and IITs, the drivers for adoption often relate to supporting research productivity, providing AI-enabled personalised services, improving access to e-resources, and meeting user expectations in a digital age (Fernandez et al., 2023; Kalbande et al., 2024; Sinha & Brar, 2024; Subaveerapandiyan & Gozali, 2024; Verma & Patnaik, 2024). Overall, the findings show that adopting new technologies is driven not only by the quest for efficiency and cost savings but also by the desire to make the library an innovative, future-ready space.

Table 3: Characteristics of extracted data from the selected studies (n = 29)

Reasons / benefits for adopting technology	Technology practice in library (as reported)	Challenges during implementation / use	Source
Personalized recommendations speed discovery; better use of collections	Hybrid CF/CBF recommender on circulation logs (HMM + DA + Weighted Fuzzy Ranking)	Sparsity/cold-start; computational complexity	Verma & Patnaik (2024)
Prepares future librarians; informs training/service design	Education-side evidence of GenAI use by LIS students	Integrity/privacy/bias; uneven curricula	Hossain et al. (2025)
Better decision-making/UX/accessibility; willingness to adopt AI	Smart shelving, OCR, chatbots, RS, NLP reported in libraries	Cost; skills; privacy/ethics; org support	Subaveerapandiyan & Gozali (2024)
Low-cost mobile access; supports CAS/SDI; extends reach	QR on library website; scan-and-use workflows	App compatibility; connectivity; user awareness	Singha & Verma (2019)
Positive readiness & perceived usefulness	AI usage/awareness across academic libraries; interest in training	Employment concerns; budget/privacy/trust	Kalbande et al. (2024)
24×7 low-cost assistance; reduces hesitation for routine queries	Rule-based VA answering academic & library FAQs	Hand-crafted KB; limited domain; need for NLP/learning	Lodhi et al. (2018)
On-demand, scalable services; supports OPAC/discovery	Cloud in OPAC, circulation, acquisition, hosting	Low awareness/competency; infra/training gaps	Sudhier & Seena (2018)
Automation improves academic/research activities; higher satisfaction	Five Delhi-NCR tech-inst. libraries using Libsys/Koha/e-Granthalaya; OPAC, renewals, alerts	Lack of awareness; poor internet; ICT skill & funding constraints	Sharma & Kandari (2021)

Students favour IoT; expect real-time access & productivity	Internet/Wi-Fi, biometrics, kiosks, QR payments; strong acceptance	Low IoT integration; training needs; visit patterns	Sinha & Brar (2024)
Cloud/LSP benefits: lower local IT burden/costs; 24×7; interoperability	Koha via support firms; e-Granthalaya 4.0; CYBRARIAN™ SaaS	Early stage; legacy ILS; proprietary limits	Tyagi & Senthil (2015)
Cost/hardware reduction; union OPAC; centralized workflows	Proposed SaaS cloud LMS (AWS EC2/private cloud)	Need apex unit; bandwidth; recurring O&M; security	De Sarkar & Shaw (2021)
Services & satisfaction improved using cloud	Gmail/Drive/YouTube; cloud for cataloguing, acquisitions, backup	Mixed security perception; need orientations	Chudasma; Bhatt; Trivedi (2019)
RFID: shorter queues; time saving; stronger security	Self-check/book-drop; gates; shelf readers; SIP2	High cost; staff resistance; privacy; false alarms	Singh & Mahajan (2017)
SMAC helps modernise services; mobile/social reach; analytics for decisions	Adoption of Social, Mobile, Analytics, Cloud across Indian libraries	Skills gaps; budget; integration across SMAC components	Rajendra Babu H. (2020)
Strong drivers for cloud LMS; usefulness/usability; ROI	Cloud services present in many libraries; RFID noted (context)	Security concerns; vendor/admin dependence; varied ICT capacity	Dadhich et al. (2021)
Unified discovery; off-campus access; IR preserves output	Implemented: Koha, Summon, portal, RemoteXS SSO, DSpace IR; roadmap to RFID/ERMS/cloud/AI/AR/VR/IoT/3D	Budget/infrastructure dependencies	Patra (2021)
Automation & ICT broaden services; digitization/preservation; resource sharing	Libsys→Koha; DSpace; automated circula on (from 2017–18); CCTV/RFID/biometrics	Staffing & budget declines; equipment gaps	Yadav & Mahawariya (2021)
VRS benefits: quick ready-reference; wider reach; 24×7 potential	CRICK mostly email/phone; synchronous chat rare (one used tawk.to)	Tooling gap; poor stats; policy/training needs	Sinhababu & Kumar (2021)
RFID in N-E India: faster self-service; theft control; high satisfaction	Tags, staff stations, smart cards, antennas, gates, UPS; kiosks; vendor installs	AMC issues; kiosk/handheld problems; power; tag removal; data collation; gate tuning	Chanda & Sinha (2019)
Security tech deters theft/mutilation/misplacement	Single entry/exit; guards; ID checks; CCTV; magnetized strips	Mutilation > theft; no separate security budget; outsider issues	Ansari & Ali (2021)
Security policies & tech reduce theft/mutilation	Adoption levels: CCTV 93%, entry register 88%, RFID 26%, gates 29%	Budgets; manpower shortages; policy gaps; user behaviour	Pathak & Vyas (2020)
Data-driven collection management; relevance & space gains	Export holdings/circulation → Python/Excel analytics → policy tweaks	Faculty resistance; 2022–24 window; eresources excluded	Sengar; Saxena; Rathore (2025)
Personalized digital-library services; high predictive accuracy	Ontology-driven profiles; SWRL rules; GRU-RNN + DTT + BWO	Small datasets; risk of overfitting; generalization	Fernandez et al. (2023)
Positive impact across services; higher usage & visits	Full ILS modules; OPAC (intranet/internet); RFID at several sites	Space limits; low user awareness; ICT skills/staff support (site-specific)	Sharma & Kandari (2022)
Faster access & lower metadata overhead for small files	VFS layer atop HDFS; category containers; caching; bucket chains	Higher RAM footprint; single-node study; classifier training	Alange & Vidya Sagar (2023)
Benchmark “smartness” to plan improvements	Fuzzy LSI across 5 elements/15 subelements by assessor panel	Old building; no makerspace; need RDS/IPR services; training	Jadhav & Shenoy (2020)
Less downtime; scalability; easier monitoring/backups	Phased migration of IR/ETD/ILMS/website/IdP to Azure VMs	Tomcat/DSpace resource contention; DNS/ports; VM/storage tuning	Jayakanth; Byrappa; Minj (2022)
High user satisfaction with immersive services; VR aids learning	WebAR/VR/data-viz space; Oculus Go; A-Frame; Unity/Unreal/Vuforia	Privacy/health concerns; network/phone calibration; cost/training/integration	Roy; Kanjilal; Sutradhar; Jalal (2022)
24×7 assistance; triage of routine queries; personalised help	Intent recognition; multilingual; OPAC/LIS/CRM integration; human handoff	Privacy; functional limits; cost; employment concerns; skills/infra gaps	Kaushal & Yadav (2022)

Note. HMM = hidden Markov model; CF/CBF = collaborative filtering / content-based filtering; DA = discriminant analysis; NLP = natural language processing; OCR = optical character recognition; CAS = current awareness service; SDI = selective dissemination of information; OPAC = online public access catalogue; SIP2 = Standard Interchange Protocol version 2; LSP = library services platform; ILS = integrated library system; IR = institutional repository; ERMS = electronic resource management system; VRS/DRS = virtual/digital reference service; AMC = annual maintenance contract; O&M = operations and maintenance; SWRL = Semantic Web Rule Language; GRU-RNN = gated recurrent unit recurrent neural network; DTT = deep training tree; BWO = black widow optimisation; LSI = library smartness index; RDS = research data services; IPR = intellectual property rights; IdP = identity provider; VM = virtual machine.

4.4. New technology practices in academic libraries (RQ1)

RQ1 asks which emerging technologies are being implemented or developed in contemporary libraries. A range of practices were extracted from the 29 selected studies and are listed in Table 3. As summarised in Figure 5, these practices cluster into four broad categories: (1) AI/analytics-enabled library software and services, (2) building/infrastructure modernisations, (3) track-and-trace with AIDC/RFID/QR, and (4) mobile-first self-service and user experience.

Library software + AI/analytics. Reported practices include recommender systems for reading and acquisitions (e.g., HMM- and fuzzy-ranking-based recommenders) (Fernandez et al., 2023; Verma & Patnaik, 2024), automated alerts/notifications for check-out, due/overdue, and new arrivals (Sharma & Kandari, 2021), chatbot/virtual-reference for FAQs (Kaushal & Yadav, 2022; Lodhi et al., 2018; Sinhababu & Kumar, 2021), and data-driven decision support (e.g., Trueswell-style holdings/circulation analyses (Sengar et al., 2025), text-mining on large corpora (Alange & Vidya Sagar, 2023)) to optimise collections and discovery. Broader surveys confirm that smart shelving, OCR, and NLP are increasingly reported by Indian library professionals (Kalbande et al., 2024; Subaveerapandiyan & Gozali, 2024).

Building/infrastructure. Studies describe modernisation of back-end infrastructure - most notably cloud migration of library systems (on-prem to Azure) (Jayakanth et al., 2022) and deployment of secure access gates (Ansari & Ali, 2021; Yadav & Mahawariya, 2021) - aimed at resilience, uptime, and scalable service delivery for e-resources and discovery layers. Further cloud deployments are documented for cataloguing, acquisitions, backup, and OPAC hosting (Chudasma et al., 2019; Dadhich et al., 2021; De Sarkar & Shaw, 2021; Sudhier & Seena, 2018).

Track-and-trace (AIDC/RFID/QR). Practices include RFID-enabled self-service (self-check-in/out), inventory and shelf management, resource security (Chanda & Sinha, 2019; Pathak & Vyas, 2020; Sharma & Kandari, 2022; Singh & Mahajan, 2017), and QR/AIDC integrations to streamline identification, circulation, and transaction logs across user and item lifecycles (Singha & Verma, 2019).

Smartphone-centric UX & self-service. Reported practices span mobile-based seat reservations, fine payment, self-guided navigation/tours, and using the phone as a service interface to trigger notifications and interact with library systems (Singha & Verma, 2019; Sinha & Brar, 2024).

Together, these categories show libraries coupling AI-enhanced software with cloud/infra upgrades, RFID/AIDC tracking, and mobile experiences to deliver faster transactions, richer discovery, and operational efficiency - while laying a scalable foundation for future services. Immersive practices remain comparatively rare, with WebAR and VR reported in a single implementation (Roy et al., 2022) and multi-technology roadmaps in others (Babu, 2020; Patra, 2021).

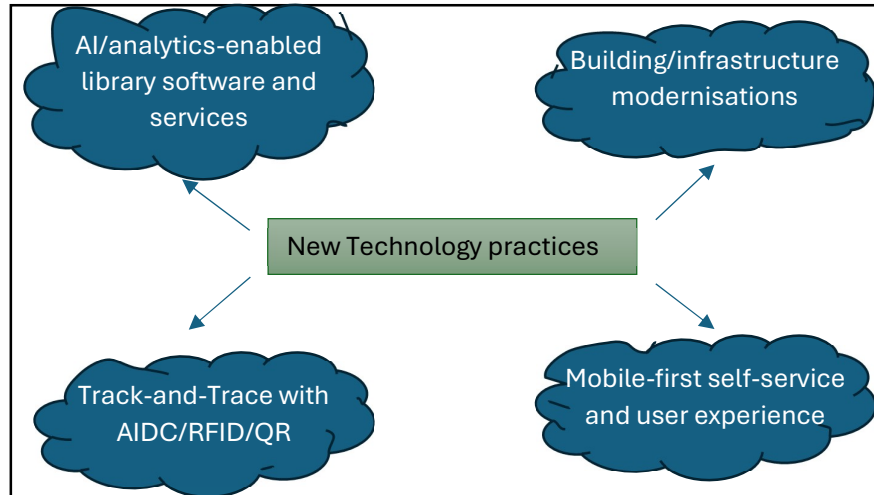


Figure 5: New Technology practices

4.5. Challenges in the adoption and use of new technologies in academic libraries (RQ3)

RQ3 concerns the technical, organisational, and ethical challenges of implementing these technologies. Table 4 outlines the key challenges reported across the 29 studies. Broadly, these issues fall into four categories: technological, financial, organisational, and policy-related.

Table 4: Major Challenges in the adoption of new technologies

Category	Challenges Identified in Studies
Technological	Lack of robust ICT infrastructure; low network bandwidth; system reliability and downtime; interoperability problems; rapid obsolescence of technologies; security and privacy risks in RFID, AI tools, and cloud migration.
Financial/Resource	High cost of devices (RFID, IoT hardware), software licensing, and subscription fees; limited library budgets; difficulty sustaining recurring expenses for maintenance and upgrades.
Organisational/Human	Lack of trained technical personnel; insufficient staff awareness of emerging technologies; resistance to change; limited time for training; low management support or prioritisation in some institutions.
Standards/Policy	Absence of clear institutional policies for adopting AI, IoT, and Big Data; lack of interoperability standards across platforms; procurement delays; concerns about data privacy, ethics, and legal frameworks.

4.6. Professional and user responses to technological change (RQ4)

RQ4 examines how libraries, library users, and information professionals are understanding and responding to these technological changes. A distinct group of studies within the dataset addressed perceptions, readiness, and attitudes rather than the technologies themselves. Taken together, they present a picture of broad receptiveness combined with specific and well-founded concerns.

Among library professionals, readiness and perceived usefulness are consistently positive. Kalbande et al. (2024) found favourable attitudes towards the integration of AI among 259 Indian LIS professionals, along with a clear interest in training, but also recorded concerns about employment security, budget, privacy, and trust. Subaveerapandiyan and Gozali (2024) reported a comparable willingness to adopt

AI among 386 professionals, tempered by concerns about cost, skills, privacy and ethics, and the level of organisational support available. Working qualitatively across 33 interviews, Kaushal and Yadav (2022) found that practitioners valued chatbots for handling routine queries while remaining uneasy about privacy, functional limitations, and the implications for staffing.

Awareness and competency emerge repeatedly as the binding constraint on adoption. Sudhier and Seena (2018) attributed limited uptake of cloud technologies in a university library principally to low awareness and competency among staff rather than to infrastructure. Sharma and Kandari (2021) similarly identified a lack of awareness alongside ICT skill and funding constraints across five Delhi-NCR technical institution libraries. Sinhababu and Kumar (2021) found that librarians in CRIKC institutions recognised the value of virtual reference services, yet had adopted only email and telephone channels, with synchronous chat implemented in a single library.

On the user side, receptiveness is stronger still. Sinha and Brar (2024) found that postgraduate and research scholars across northern Indian institutions favoured IoT-enabled services and expected real-time access, while noting that actual integration in their libraries remained low. Roy et al. (2022) recorded high user satisfaction with immersive services at IIT Kharagpur, although privacy and health concerns were also raised. Further upstream, Hossain et al. (2025) surveyed 632 LIS students across Bangladesh, India, and Pakistan and found generative AI already in use, but supported by uneven curricular provision and unresolved questions about academic integrity and bias.

Read together, these studies indicate that the principal constraint on technology adoption in academic libraries is not resistance from users or professionals. Demand is present and attitudes are favourable. What is lacking is structured training, institutional policy, and sustained funding, which is consistent with the organisational and policy-related challenges identified in Section 4.5.

5. DISCUSSION ON FINDINGS

The library world is increasingly focusing on the challenges and opportunities that come with adopting new technologies. Similar to earlier discussions about IoT, AI, cloud computing, and big data (Asim & Arif, 2023), these technologies are transforming how libraries provide services and engage users. The 29 papers included, identified by PRISMA guidelines, show that the literature on this topic has rapidly expanded over the past decade, with most studies published since 2019. Most research used quantitative surveys and descriptive analyses. A few studies explored conceptual frameworks, case implementations, or algorithmic models. Only a small number of studies used qualitative methods (Kaushal & Yadav, 2022), indicating that empirical depth is still somewhat limited.

A closer look at technology practices reveals four main categories: (1) AI and analytics-driven services, (2) cloud and automation platform-based upgrades to infrastructure, (3) tracking and resource security using RFID, QR codes, and AIDC, and (4) mobile and user-centric applications. AI-based practices included purchase recommendation systems, automatic reminders for due or overdue books, and user support chatbots (Kaushal & Yadav, 2022; Sharma & Kandari, 2021; Verma & Patnaik, 2024). Upgrades to infrastructure were shown in case studies on cloud migration and system integration (Chudasma et al., 2019; Jayakanth et al., 2022; Sudhier & Seena, 2018). RFID and QR technologies were used for tracking, inventory control, circulation, and access (Chanda & Sinha, 2019; Singh & Mahajan, 2017; Singha & Verma, 2019), while mobile applications facilitated seat reservations, fine payments, and virtual tours of the library (Sinha & Brar, 2024). Together, these practices indicate that libraries are gradually embracing the digital space, striving for high standards in service innovation and efficiency.

The motivations and benefits of adopting these technologies were well-documented in the studies. Libraries reported time savings, better performance, improved service quality, increased access to collections, and a better user experience as key reasons for adoption (Sengar et al., 2025; Sharma & Kandari, 2022; Sudhier & Seena, 2018). Institutional benefits were also significant: reduced staff workload, cost savings, improved knowledge management, and an elevated public image for the library (Jadhav & Shenoy, 2020; Patra, 2021; Yadav & Mahawariya, 2021). For IITs and other Indian institutions, the push to adopt new technologies typically linked to enhancing research productivity and keeping pace with global trends ensured that scholars and students had access to competitive resources and services (Roy et al., 2022; Sinha & Brar, 2024).

Despite these benefits, adoption faced several challenges. The issues noted in the literature can be grouped into four broad categories: technological, financial, organisational, and policy-related. Technical problems included issues with interoperability, insufficient ICT infrastructure, and concerns about reliability and security (Jayakanth et al., 2022; Tyagi & Senthil, 2015). Financial challenges included high device, license, and subscription costs, especially for resource-constrained institutions (Chanda & Sinha, 2019; Patra, 2021). Organisational issues comprised shortages of specialized staff, resistance to change, and limited training opportunities (Kalbande et al., 2024; Sharma & Kandari, 2021; Sudhier & Seena, 2018). Lastly, policy challenges involved the absence of institutional policies, lack of interoperability standards, slow procurement processes, and data privacy concerns (Ansari & Ali, 2021; Hossain et al., 2025; Sinha & Brar, 2024). Overall, these challenges show that while libraries are keen on innovation, their ability to sustain and scale technological adoption is limited.

The findings suggest that future technologies have great potential for libraries, but their impact will depend on how effectively institutions can address these challenges. Libraries in resource-rich settings are likely to adopt advanced AI and cloud-enabled technologies, while those in less developed environments may benefit more from affordable, high-impact technologies like open-source automation systems (e.g., Koha) (Sharma & Kandari, 2021; Tyagi & Senthil, 2015; Yadav & Mahawariya, 2021), QR-based services (Singha & Verma, 2019), and mobile applications (Sinha & Brar, 2024). As academic libraries seek to redefine themselves as centres of digital scholarship, policymakers, administrators, and librarians must tackle infrastructure gaps, secure consistent funding, and provide ongoing staff training. Only then can the potential of emerging technologies be fully realized to strengthen the library's role as a knowledge centre in the 21st century.

6. IMPLICATIONS OF THE STUDY

This SLR demonstrates that emerging technologies have the potential to significantly transform academic libraries by enhancing efficiency, improving accessibility, and enriching user experiences. At the same time, it highlights that adoption is uneven, as institutions with strong financial and infrastructural support are able to implement advanced systems such as AI-driven services, cloud platforms, and RFID (Jayakanth et al., 2022; Roy et al., 2022), while others rely on more cost-effective solutions like open-source automation and mobile applications (Sharma & Kandari, 2021; Singha & Verma, 2019). The findings underscore that without adequate funding, skilled personnel, and supportive institutional policies, the benefits of these technologies cannot be fully realised. By identifying both the advantages and the barriers, this study provides library professionals, policymakers, and administrators with valuable insights into how emerging technologies can be strategically integrated to deliver sustainable, innovative, and user-centred services in academic libraries.

7. LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

This study is limited to selected databases and English-language publications, and thus some relevant literature may have been missed. The majority of literature considered was conceptual or descriptive with fewer empirical studies, restricting the strength of evidence for actual effects on implementation. Future research should broaden its scope to include other databases, non-English language publications, and grey literature, as well as employing diverse methodologies - quantitative, qualitative, and mixed methods. Future studies may explore individual themes such as AI readiness, cloud and big data deployment, blockchain for resource management, green computing, and integrating the smart library system to better understand the deployment of technology by academic libraries.

8. CONCLUSION

Recently, there has been a marked rise in literature on the use of emerging technologies (AI, cloud, RFID/AIDC, mobile, analytics) in academic libraries. However, there remains a gap in systematic literature reviews that consolidate adoption and use across these tools. This SLR provides a comprehensive overview of current work on technology integration in academic libraries. The selected studies highlight multiple benefits and reasons for adoption, including saving time, enhanced performance and operational efficiency, improved service quality, easier collection access, broader service reach, richer user experience, reduced staff workload and costs, stronger knowledge management, and an improved institutional image (Chanda & Sinha, 2019; Jadhav & Shenoy, 2020; Sengar et al., 2025; Sudhier & Seena, 2018; Tyagi & Senthil, 2015).

This review also identifies a spectrum of technology practices in libraries: auto-notifications for check-out/check-in/overdues and new arrivals (Sharma & Kandari, 2021); AI-enabled recommendation and virtual-reference services (Sinhababu & Kumar, 2021; Verma & Patnaik, 2024); self-service through kiosks and mobile apps (Sinha & Brar, 2024); RFID/QR-based inventory, tracking, and security (Chanda & Sinha, 2019; Singha & Verma, 2019); cloud migration and systems integration (Jayakanth et al., 2022); and smartphone-centric features such as virtual tours, seat reservations, and fine payment. In addition, building and infrastructure upgrades (secure access gates, environment monitoring, and other automation) are increasingly reported (Ansari & Ali, 2021; Yadav & Mahawariya, 2021).

Despite these advances, major challenges persist: security and privacy risks, high costs of devices, licenses, and subscriptions, lack of clear standards and policies, dependence on highly integrated ICT environments, limited management support, insufficient staff skills and training, shortages of technical personnel, and interoperability or complexity across platforms (Dadhich et al., 2021; Kalbande et al., 2024; Pathak & Vyas, 2020; Roy et al., 2022). Together, these findings map the current landscape of technology adoption in academic libraries and clarify where effort is needed to translate pilots into sustainable, user-centred, and future-ready services.

Declaration on the Use of Generative Artificial Intelligence

The author declares that generative artificial intelligence was used solely for grammatical correction. Specifically, OpenAI's ChatGPT was used only to check and correct grammar, spelling, punctuation, and minor stylistic clarity in the language of the manuscript. It was not used for any other purpose.

No portion of the literature search, screening, literature review, content, data analysis, results, interpretation, or references was generated by artificial intelligence. All ideas, data interpretation, and conclusions presented in this paper are the author's own. The author reviewed and edited all language corrections and takes full responsibility for the content of this publication.

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