

MAPPING THE THEMATIC EVOLUTION OF EMERGING TECHNOLOGIES IN LIBRARY MANAGEMENT AND SERVICES

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Abstract :

The rapid development of digital technologies has transformed libraries into increasingly digital, connected, and technology-enabled knowledge environments. This study maps research on emerging technologies in library management and services during 2020–2025, with attention to artificial intelligence (AI), digital transformation, intelligent library systems, automation, big data, deep learning, natural language processing, chatbots, robotics, and smart library services. A bibliometric approach supported by VOSviewer is used to examine keyword co-occurrence and collaboration at author, country, and organizational levels. The supplied VOSviewer maps show that digital transformation and artificial intelligence occupy prominent and highly connected positions in the conceptual network. The country network is internationally interconnected, while author and institutional maps reveal multiple collaboration communities. The findings indicate that emerging-technology research in libraries is increasingly interdisciplinary and socio-technical, combining technological innovation with digital literacy, privacy, transparency, trust, professional capability, and user-centered service design.

Keywords : Emerging technologies; Artificial intelligence; Digital transformation; Intelligent libraries; Library management; Library services; Bibliometric analysis; VOSviewer; Co-authorship; Keyword co-occurrence; Research collaboration

Introduction :

The rapid development of digital technology and Information and Communication Technology (ICT) has brought many important changes in the field of Library and Information Science (LIS). Earlier the main function of libraries was to collect, maintain printed books and other information resources and provide services to the users manually. But today libraries are not just limited to books, but they are increasingly turning into digital knowledge centers. Facilities such as digital libraries, e-resources, online information



services, digital repositories and remote information access have made it much easier and faster for users to access information. Along with this, the use of emerging technologies like Artificial Intelligence (AI) Machine Learning, Big Data, Cloud Computing, Internet of Things (IoT) and Blockchain is also increasing in library management and information services. These technologies have not only changed the way libraries work, but have also made significant changes in the ways information is collected, organized, discovered, disseminated, and used. (Cox, Pinfield, & Rutter, 2019).

Recent developments in Artificial Intelligence (AI) have created significant possibilities for libraries to enhance the quality of user-oriented services and improve administrative and operational processes. Technologies such as AI-based chatbots, personalized recommendation systems, automated indexing, and semantic search are increasingly being incorporated into contemporary library environments to support information discovery and improve service delivery (Asemi, Ko, & Nowkarizi, 2021).

The adoption of smart library technologies, including Radio Frequency Identification (RFID), the Internet of Things (IoT), and cloud-based Integrated Library Management Systems (ILMS), has significantly transformed library operations by supporting automation, improving resource management, and enhancing users' access to library collections and services (Hashem et al., 2015).

The COVID-19 pandemic accelerated the adoption of artificial intelligence (AI) and other emerging technologies across various sectors, including libraries and information services. Advances in cloud computing, machine learning, deep learning, and neural networks have enabled the efficient processing and analysis of large volumes of data, facilitating faster information retrieval, knowledge discovery, and decision-making. These technological developments have also created new opportunities for libraries to enhance digital services, automate routine operations, support personalized information services, and improve users' access to scholarly resources. Consequently, the growing integration of AI and other emerging technologies has contributed to the transformation of traditional library practices and has strengthened the role of technology-driven approaches in library management and services.

The present study examines emerging trends in LIS during 2020–2025, with particular focus on Artificial Intelligence and digital transformation in library management and services. It explores research trends, technological developments, opportunities, and challenges associated with the development of intelligent library systems.

Review of Literature :

Madhusudhan and Pandey (2023) reviewed the integration of emerging technologies into library services and highlighted the changing expectations of library users and professionals. Their review covered technologies including artificial intelligence, the Internet of Things, augmented reality, virtual reality, blockchain, chatbots, and robotics. The study demonstrates



that emerging technologies are increasingly influencing the design and delivery of library services rather than functioning only as technical tools. This perspective directly supports the present study's VOSviewer finding that emerging technologies, digital transformation, innovation, automation, robotics, and smart library services form interconnected themes.

Ayinde, Ebiefung, and Oladokun (2026) conducted a systematic review of AI adoption in academic libraries using literature published from 2020 to 2024. Their review identified applications across technical services, reference and information services, administration and circulation, collection development, information literacy and user education, and professional development and collaboration. This broad application of AI is consistent with the present bibliometric map, where **artificial intelligence** is one of the largest and most centrally positioned keywords. The findings reinforce the argument that AI should be considered a strategic component of library transformation rather than a single service technology.

Yan, Zhao, and Mazumdar (2023) systematically reviewed research on chatbots in libraries. Their review identified 19 relevant studies after screening a much larger initial literature set. They found that existing research focused mainly on chatbot implementation, design, maintenance, evaluation, characteristics, and applications. They also concluded that chatbot research in libraries was still developing. This finding is important for the present study because **chatbots** appear as a distinct technology-related theme in the VOSviewer keyword network and are closely associated with artificial intelligence, digital transformation, and smart library services.

Objectives :

1. To analyze research trends in emerging technologies in library management and services during 2020–2025.
2. To identify major research themes using keyword co-occurrence analysis.
3. To examine the structure of the research field using VOSviewer visualization.
4. To analyse author, country, and institutional collaboration patterns.
5. To identify prominent and emerging themes and discuss their implications for library services.

Research Methodology :

This study adopts a bibliometric research design using VOSviewer for network visualization. Bibliographic data were collected from the Web of Science (WoS) database for the period 2020–2025. A total of 1,068 documents were retrieved and exported in the Full Record and Cited References format.

Four units of analysis were considered: keywords, authors, countries, and organizations. Keyword co-occurrence analysis was used to identify conceptual relationships and major research themes, while co-authorship and collaboration maps were used to examine research networks among authors, countries, and organizations.



Interpretation is based on node size, relative position, colour-coded clusters, and visible links in the supplied VOSviewer figures. Because the underlying bibliographic export file was not supplied, exact publication counts, citation counts, link strengths, and cluster sizes are not reported. The author labels “hughes, laurie” and “hughes, d. laurie” also suggest a name-normalization issue that should be checked before final quantitative analysis.

Results and Findings :

1. Keyword Co-Occurrence Analysis :

The keyword co-occurrence map is dominated by “digital transformation” and “artificial intelligence,” which appear as large, centrally positioned nodes with numerous connecting relationships. “Emerging technologies” and “innovation” are also prominent. The surrounding network includes “big data,” “chatbots,” “deep learning,” “natural language processing,” “automation,” “smart library services,” “digital literacy,” “privacy,” “transparency,” and “trust.” This pattern indicates that the field combines technological innovation with organizational change, professional practice, user capability, and governance.

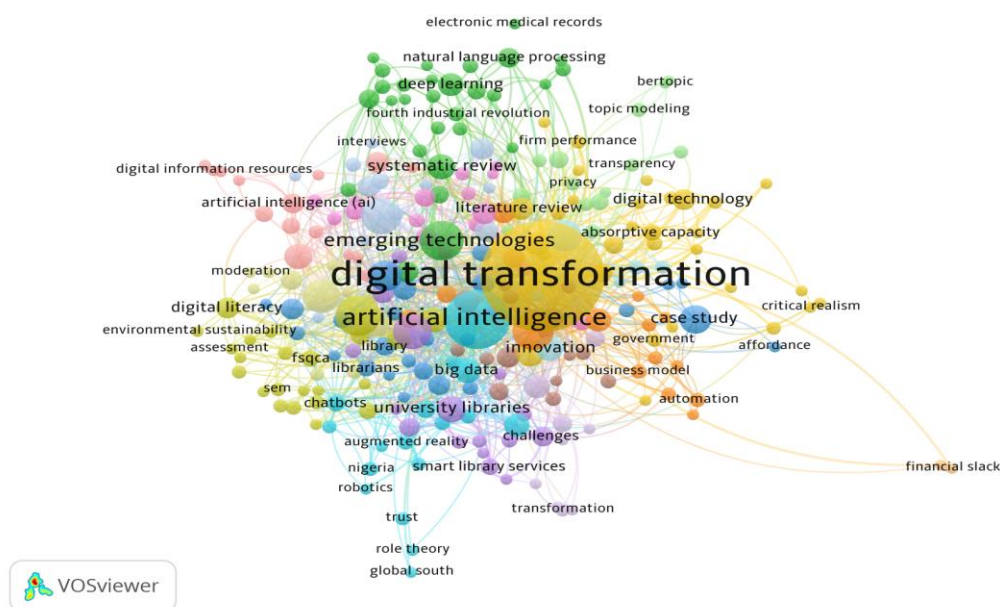


Figure 1. VOSviewer keyword co-occurrence network. Source: VOSviewer output.

Table 1. Major keyword themes visible in the VOSviewer map

Theme/Cluster focus	Representative terms visible in map	Interpretation
Digital transformation	digital transformation; emerging technologies; innovation	Broad organizational and technological change is a central research focus.
Artificial intelligence	artificial intelligence (AI);	Research addresses



	deep learning; natural language processing	intelligent systems and AI-enabled information functions.
Library technologies	chatbots; robotics; automation; smart library services	Specific technologies are examined in relation to library service delivery.
Data and digital resources	big data; digital information resources; electronic medical records	Data-intensive information environments are part of the wider technology landscape.
Human and governance dimensions	digital literacy; privacy; transparency; trust	Technology adoption is linked to skills, ethics, governance and user confidence.

2. Country Collaboration Analysis :

The country collaboration map shows a broad international research network. The USA is one of the largest and most central visible nodes, while China and Germany are also prominent. Australia and Spain are substantial nodes, and India, Pakistan, France, Italy, South Korea, Brazil, South Africa, Nigeria, Japan, Indonesia, New Zealand, Norway, Sweden, Iran, Portugal, Poland and other countries are connected to the network. The geographical spread indicates that emerging-technology research is not confined to one region.

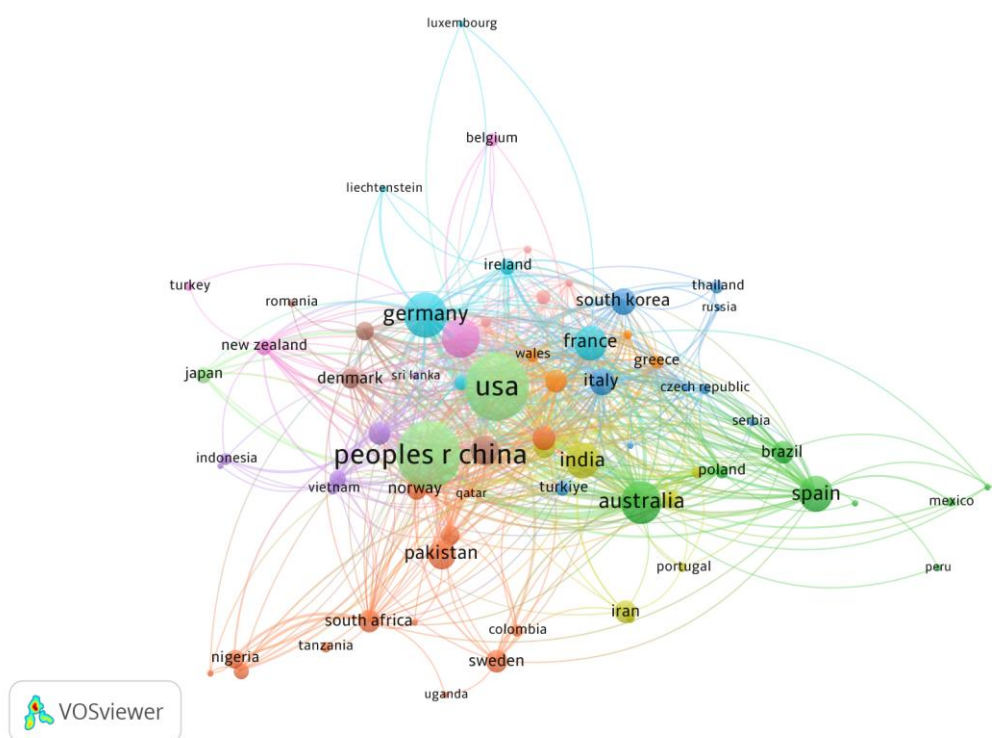


Figure 2. VOSviewer country collaboration network. Source: VOSviewer output.



Table 2. Country-level observations from the supplied map

Country/region visible	Observed network role	Interpretation
USA	Large, central node	Strong visual prominence and many connections in the displayed network.
China	Large, central node	Important contributor within the international collaboration structure.
Germany	Large, well-connected node	Prominent European participant with extensive visible links.
Australia	Large, connected node	Important node in the international network.
Spain	Large, connected node	Strongly connected within the European and wider network.
India	Prominent connected node	Visible participant linking with several countries.
Pakistan	Connected regional node	Part of the wider Asian and international collaboration structure.
Other countries	Distributed peripheral and intermediary nodes	Demonstrate broad geographic reach and cross-country collaboration.

3. Institutional Collaboration Analysis :

The institutional map contains multiple university and higher-education organizations. Wuhan University appears as a prominent central node. The University of Sheffield, Georgia State University, Nanjing University, University of Johannesburg, Government College University Lahore, RMIT University, Copenhagen Business School, Swansea University, Free University Berlin, University of Turin, University of Cagliari, University Carlos III Madrid, University of Murcia, Sultan Qaboos University and University of Sargodha are among the visible institutions. The network suggests substantial inter-institutional and international collaboration.



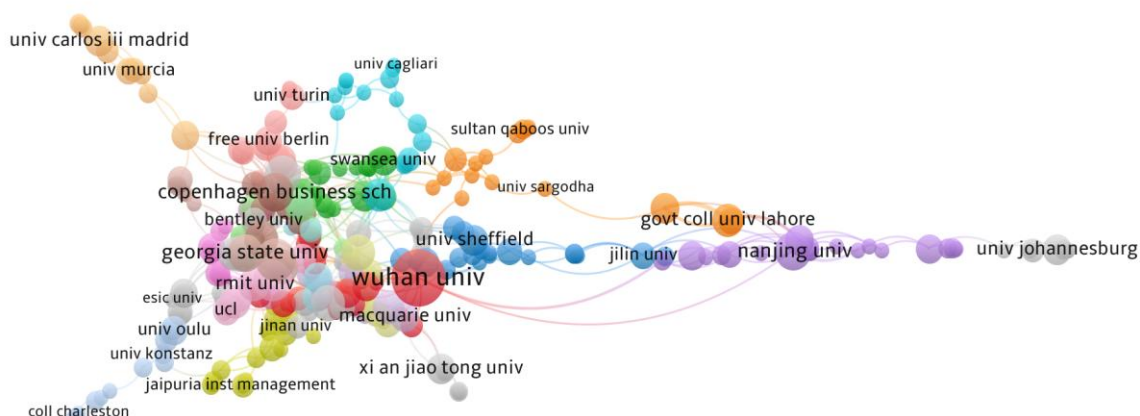


Figure 3. VOSviewer institutional/organization collaboration network. Source: VOSviewer output.

Table 3. Institutional collaboration observations

Institution visible in map	Observed position/pattern	Interpretation
Wuhan University	Prominent central node	Important visible institutional participant in the network.
University of Sheffield	Central connected group	Connected to several institutions in the broader network.
Georgia State University	Prominent left-side node	Part of a dense institutional collaboration area.
Nanjing University	Prominent right-side cluster	Participates in a connected institutional group.
University of Johannesburg	Right-side node	Shows the international reach of the collaboration network.
Government College University Lahore	Prominent connected node	Links the South Asian institutional network to other groups.
Other universities	Multiple regional clusters	Indicate a distributed and internationally connected research structure.



4. Author Co-Authorship Analysis :

The author co-authorship map displays several colour-coded collaboration communities. Visible groups include Luca Tangi and Marijn Janssen; Parijat Upadhyay, Yogesh K. Dwivedi and Arpan K. Kar; D. Laurie Hughes, Nripendra P. Rana and Yangqing Duan; Wendy Currie and Jan vom Brocke; Abayomi Baiyere, Tina Blegind Jensen and Hannu Salmela; and Jonny Holmström. The map shows both within-cluster relationships and links between clusters.

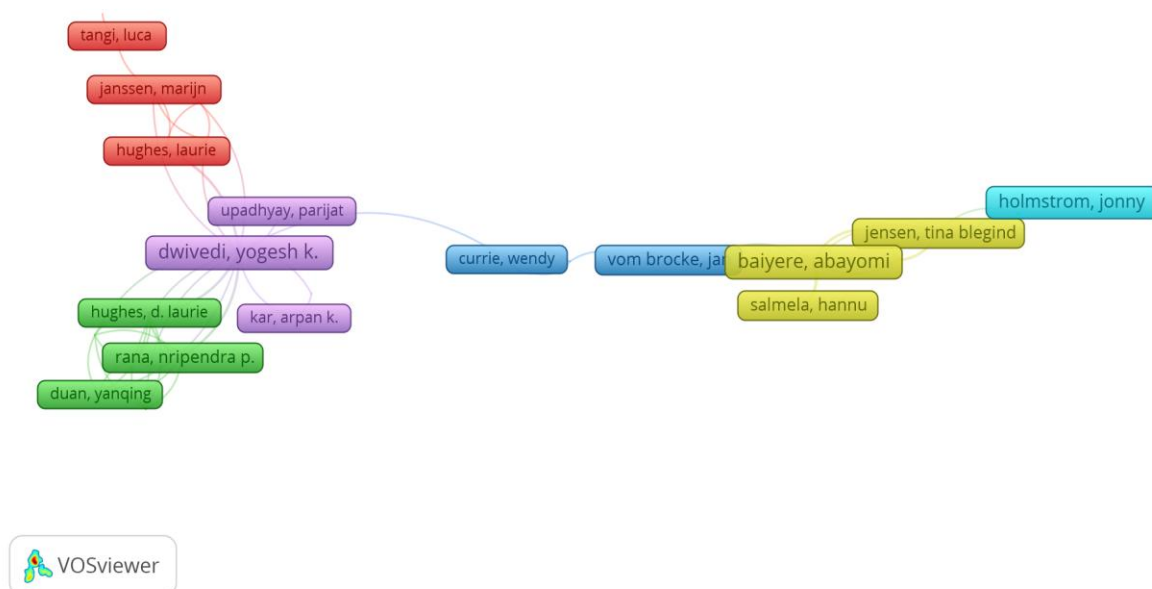


Figure 4. VOSviewer author co-authorship network. Source: VOSviewer output.

Table 4. Author collaboration clusters visible in the map

Cluster colour	Representative authors visible	Cluster-wise interpretation
Red	Luca Tangi; Marijn Janssen; Laurie Hughes	Compact collaboration group with several internal and external links.
Purple	Parijat Upadhyay; Yogesh K. Dwivedi; Arpan K. Kar	Central-left research community with links to neighbouring clusters.
Green	D. Laurie Hughes; Nripendra P. Rana; Yangqing Duan	Distinct collaboration group connected to the wider author network.



Blue	Wendy Currie; Jan vom Brocke	Smaller group positioned as part of the central-right network.
Yellow	Abayomi Baiyere; Tina Blegind Jensen; Hannu Salmela	Connected research community on the right side of the network.
Cyan	Jonny Holmström	Separate visible node connected to the adjacent collaboration structure.

5. Focused Author Network :

The focused author visualization provides a clearer view of selected collaboration relationships. Yogesh K. Dwivedi appears centrally positioned and is connected with several authors and groups. The red cluster contains Nripendra P. Rana, John S. Edwards, Ioanna Constantou, Yangqing Duan, D. Laurie Hughes and Ramakrishnan Raman, forming a comparatively dense visible collaboration structure. Luca Tangi and Marijn Janssen appear as a smaller blue pair, while Wendy Currie and Leslie Willcocks form another linked pair. Umar Bashir Mir and Arpan K. Kar are connected to the central green group.

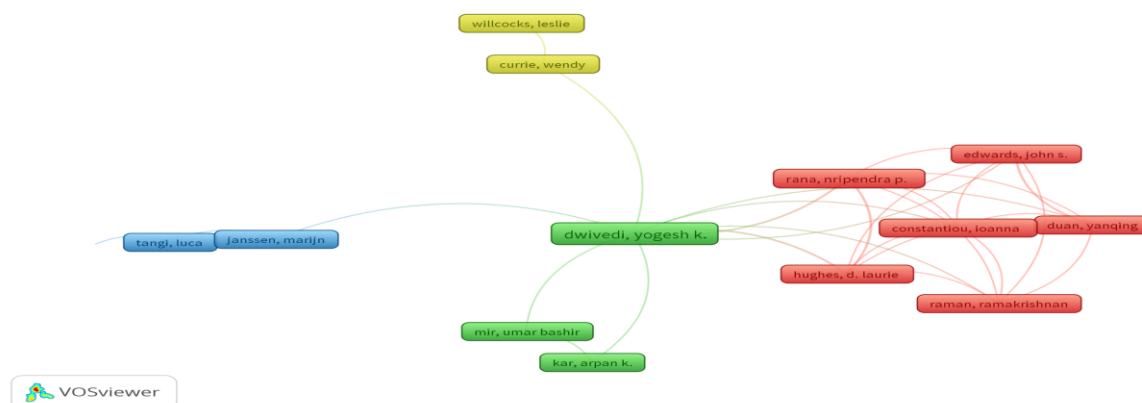


Figure 5. Focused VOSviewer author collaboration network. Source: VOSviewer output.

Table 5. Focused author-network observations

Visible group	Authors/nodes	Interpretation
Central green	Yogesh K. Dwivedi; Umar Bashir Mir; Arpan K. Kar	Dwivedi occupies a visually central position with links to multiple groups.
Red collaboration group	Nripendra P. Rana; John S. Edwards; Ioanna Constantou; Yangqing Duan; D. Laurie Hughes; Ramakrishnan Raman	Dense set of visible links suggests strong internal collaboration.



Blue pair	Luca Tangi; Marijn Janssen	Small, closely connected author pair.
Yellow pair	Wendy Currie; Leslie Willcocks	Connected pair linked to the central network.

6. Integrated Research Findings :

1. Digital transformation is the dominant conceptual anchor in the keyword network.
2. Artificial intelligence is a major technological theme closely connected to digital transformation and other emerging technologies.
3. Specific applications include chatbots, robotics, big data, deep learning, natural language processing and automation.
4. Library-oriented terms such as librarians, university libraries and smart library services connect technology research with professional practice.
5. Digital literacy, privacy, transparency and trust demonstrate attention to human, ethical and governance dimensions.
6. Country collaboration is broad and international, with the USA, China, Germany, Australia, Spain and India among the prominent visible nodes.
7. Institutional collaboration spans universities and higher-education organizations across several regions.
8. Author collaboration is organized into multiple interconnected communities rather than one single collaboration centre.
9. Author-name normalization should be completed before calculating final productivity or centrality statistics.

Discussion :

The combined maps suggest that emerging technologies in library research are increasingly understood as part of broader digital and organizational transformation. Artificial intelligence is a major anchor, while deep learning, natural language processing, chatbots, robotics and automation indicate a movement toward more intelligent and responsive information services.

At the same time, the presence of digital literacy, privacy, transparency, trust and professional library terms indicates that technology adoption has socio-technical dimensions. Successful transformation therefore requires not only technological infrastructure but also professional competencies, responsible data practices, user capability and institutional governance.

The country, institutional and author networks show that the field is internationally distributed. Cross-border and cross-institutional collaboration can support comparative research, knowledge exchange, and the development of transferable approaches to technology-enabled library services.



Conclusion :

The VOSviewer-based analysis demonstrates that research on emerging technologies in library management and services during 2020–2025 is broad, interconnected and international. Digital transformation and artificial intelligence occupy central positions, while big data, deep learning, natural language processing, chatbots, robotics, automation and smart library services form important supporting areas. The maps also demonstrate that research increasingly considers digital literacy, privacy, transparency, trust and professional practice. Overall, future research should focus on sustainable, user-centred, trustworthy and professionally supported digital transformation in libraries.

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