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Mapping the Knowledge Structure of Research Literature on Artificial Intelligence and Robotics in Libraries

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ABSTRACT

This study examines 126 research articles on Artificial Intelligence (AI) and robotics in libraries indexed in the Web of Science (WoS) database between 1989 and 2024. The analysis investigates publication growth, citation patterns, emerging research trends, co-citation networks, and collaborative authorship within the field. Findings indicate a consistent annual publication growth rate of 5.49%, with an average of 13.69 citations per document, reflecting the increasing scholarly interest in AI and robotics applications in libraries. Keyword analysis identifies "artificial intelligence" and "academic libraries" as the most prominent research themes. Co-citation analysis highlights that the most influential contributors in this domain. Although international co-authorship accounts for only 15.08% of the publications, the study reveals a growing trend of global collaboration, particularly among researchers from the USA, China, and Germany. Finally, the study provides a comprehensive bibliometric mapping of the conceptual, intellectual, and social dimensions of AI and robotics research in libraries, offering valuable insights for future research and development in this emerging area.

Keywords: Artificial intelligence; Robotics; Libraries; Scientometric; Knowledge Structure

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1. INTRODUCTION

Artificial Intelligence (AI) and robotics have emerged as transformative technologies that enhance human capabilities, improve productivity, and enable the development of systems capable of performing tasks with greater autonomy and intelligence. The integration of AI with robotics has significantly influenced various sectors by enabling machines to simulate human reasoning, learning, and decision-making processes. According to Perez et al. (2018), the convergence of AI and robotics continues to reshape the understanding and application of robotic intelligence across multiple emerging domains. Similarly, Bogue (2014) emphasised that the development of intelligent robots requires the integration of advanced AI technologies, establishing AI-driven robotics as a distinct and important field of research.

In recent years, libraries have increasingly adopted AI and robotic technologies to modernise traditional services and improve user engagement. The application of AI in libraries includes intelligent information retrieval systems, chatbots,

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recommendation services, reading assistance, and automated programming support. At the same time, robotics has been introduced to perform routine library operations such as shelving, circulation, navigation assistance, and user interaction. These technological advancements have enhanced operational efficiency, simplified access to information resources, and created more interactive and personalised learning environments for library users. Ajani et al. (2024) noted that integrating robotics and AI in libraries not only improves service delivery but also fosters innovative educational experiences and enhances user satisfaction.

Given the growing scholarly interest in this emerging area, it is essential to systematically examine the research landscape of AI and robotics applications in libraries. Therefore, the present study aims to explore the knowledge structure of research publications on AI and robotics in libraries using scientometric mapping techniques. The study analyses publication growth, citation patterns, authors' keywords, co-citation networks of authors and references, and collaborative research patterns among authors and countries using data retrieved from the Web of Science Core Collection (WoSCC) database. By examining these dimensions, the study provides insights into the conceptual, intellectual, and social structure of research on AI and robotic technologies in libraries. It identifies emerging trends and future research directions in the study domain.

2. REVIEW OF LITERATURE

A considerable number of research studies have examined the application of Artificial Intelligence (AI) and robotic technologies in libraries from different perspectives. Several studies have focused on librarians' perceptions, acceptance, and readiness for the implementation of AI technologies in library environments (Yoon et al., 2022; Hervieux & Wheatley, 2021; Ali et al., 2020). Shahzad et al. (2024) highlighted that the successful adoption of AI in libraries depends on factors such as professional training and education, knowledge sharing, awareness programmes, technical support, and the development of adequate technological infrastructure.

A growing body of literature has also explored the impact of AI on library services, operations, and management practices (Adewojo et al., 2025; Brzustowicz, 2023; Cox et al., 2019; Cox, 2023; Asim, 2023; Yusuf et al., 2022). These studies demonstrate that AI technologies improve information retrieval, user services, decision-making processes, and overall operational efficiency in libraries. Hussain and Ahmad (2023), in their bibliometric analysis of AI research in libraries from 2002 to 2022, reported that approximately 44.24% of publications were conference papers, indicating the field's rapidly evolving, technology-driven nature. Similarly, Borgohain et al. (2022) observed that the United States produced the most publications on AI in libraries between 2012 and 2021, while China emerged as the leading contributor at the institutional level. Compared to AI, the application of robotics in library and information science has received relatively limited scholarly attention, as robotics research is predominantly concentrated in computer science. Nevertheless, recent studies have begun to investigate the integration of robotic technologies into library operations. For instance, Lin et al. (2024) examined the attitudes and willingness of academic librarians in Hong Kong to learn Robotic Process Automation (RPA). Other studies have discussed the implementation of robotic technologies in various library activities, including automated services and user assistance (Guth & Vander Meer, 2017; Yueh et al., 2020). Basumatary et al. (2023) reported, through a scientometric analysis of the Scopus database, a 12.93% growth rate in research on robotic technology in libraries.

In addition, several scholars have explored the use of expert systems, AI applications, and robotic technologies for reading assistance, library management, and service enhancement (Kim, 2017; Asemi et al., 2021; Tait & Pierson, 2022; Yao et al., 2015). Despite the growing body of literature, there remains a need for a comprehensive scientometric mapping of research on AI and robotics in libraries to understand better the field's intellectual, conceptual, and collaborative structure. Such an analysis would provide valuable insights for researchers, practitioners, and policymakers and help identify

emerging trends and future research directions in this evolving domain.

3. OBJECTIVES OF THE STUDY

(i) To examine the publication trends and citation impact of research related to Artificial Intelligence (AI) and robotics in libraries.

(ii) To analyse authors' keywords in order to identify major research themes and explore the conceptual structure of the study domain.

(iii) To conduct a co-citation analysis of cited authors and references to understand the intellectual structure and influential contributions within the research field.

(iv) To investigate collaboration patterns among authors and countries in order to trace the social structure and research networking in the field of AI and robotics in libraries.

4. METHODOLOGY

The present study employed a scientometric approach to analyse research publications related to Artificial Intelligence (AI) and robotics in libraries. The data for this study were obtained from the Web of Science Core Collection (WoSCC) database on October 1, 2025. The analysis focused on publications from 1989 to 2024. In total, 126 relevant research documents were selected for the study. To ensure greater precision and relevance in data retrieval, a title-based search strategy (TI) was adopted. The search query was formulated using key terms related to AI and robotics in library contexts. The following search string was used: ("artificial intelligen*" OR "AI" OR "machine learning" OR "expert system*" OR "computational intelligen*" OR "robot*" OR "robotic technology") AND ("librar*") in the title field. Additionally, document types such as Early Access, Retracted Publications, and Retractions were excluded from the dataset. Publications from the final publication year 2025 were also excluded to maintain consistency and completeness in the analysis.

4.1 Data Collection

The initial search of the WoSCC database returned 405 documents on AI and robotics in libraries. After applying the predefined inclusion and exclusion criteria, the number of records was reduced to 308. Subsequently, all retrieved documents were manually screened and examined individually to ensure their relevance to the research topic. During this process, 182 records were identified as outside the study's scope and excluded from the final dataset. As a result, 126 relevant research publications were retained for further scientometric analysis. The final dataset was then exported and organized in MS Excel format for data cleaning, management, and analysis.

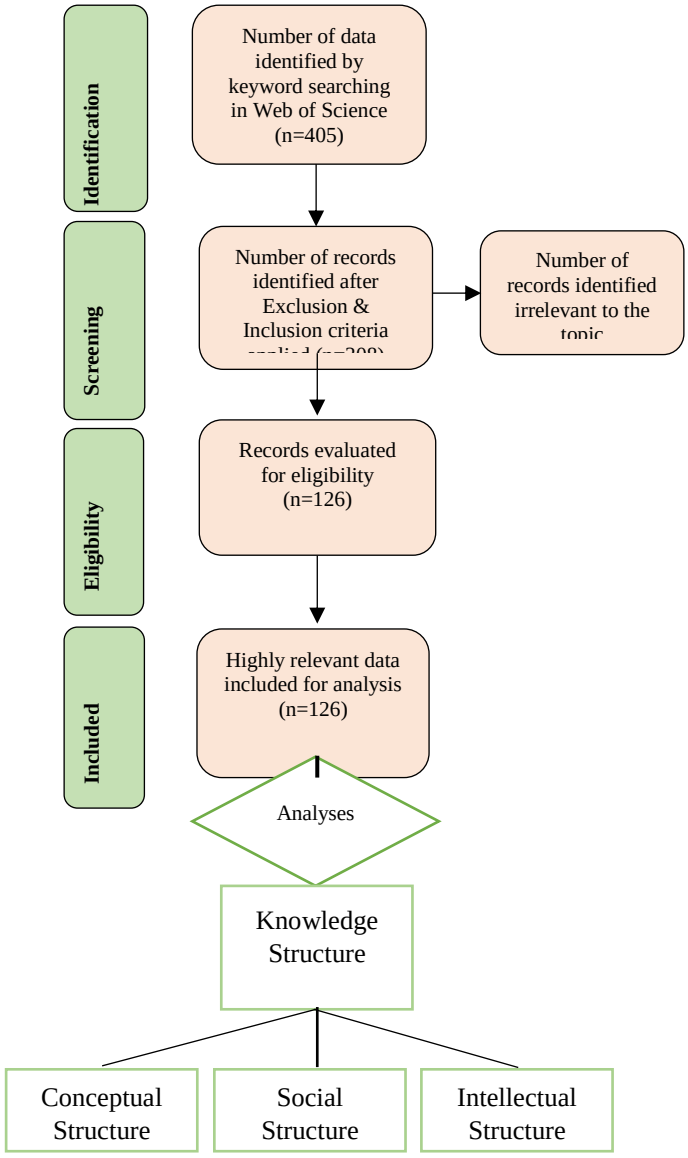


Figure 1. Flowchart of data collection and analysis.

Source: Author's own work.

5. ANALYSIS AND INTERPRETATION

5.1 Nature of Research Literature Publications

Table 1 presents an overview of 126 research publications related to the application of Artificial Intelligence (AI) and robotics in libraries published between 1989 and 2024. The literature reviewed spans diverse research fields and reflects the growing scholarly interest in integrating AI and robotic technologies into library environments. The analysis indicates an annual publication growth rate of 5.49%, demonstrating the gradual expansion of research activity in this domain. The study also reports an average citation rate of 13.61 citations per document, suggesting a moderate level of scholarly impact and academic recognition of the published works. A total of 264 authors contributed to the research publications included in the dataset. Among the 126 documents, 66 were single-authored publications, indicating a notable presence of individual scholarly contributions in the field. The analysis further reveals that international co-authorship accounted for 15.08% of the publications, reflecting a relatively limited but steadily developing trend of global research collaboration. In addition, the identified research articles were published across 55 different sources, highlighting the interdisciplinary and widely distributed nature of research on AI and robotics in libraries.

Table 1. The nature of AI and robotics in libraries

Description	Results	Description	Results
Timespan	1989:2024	**Authors Collaboration**	
Sources (Journals, Books, etc.)	55	Single-authored docs	66
Documents	126	International co-authorships %	15.08
Annual Growth Rate %	5.49	**Document Types**	
Document Average Age	14.3	Article	71
Average citations per doc	13.61	Article: proceedings paper	5
References	3506	Book review	26
Document Contents		Editorial material	8
Keywords Plus (ID)	127	Meeting abstract	2
Author's Keywords (DE)	187	News item	4
Authors	264	Note	2
Authors of single-authored docs	61	Review	8

Source: Author's own work.

5.2 Publication and citation impact

Table 2 and Figure 2 present the annual growth in publications and citation impact of research on Artificial Intelligence (AI) and robotics in libraries, as indexed in the Web of Science Core Collection (WoSCC) database, during the period 1989–2024. The analysis reveals that research activity in this field began modestly, with only four publications recorded in 1989. Between 1989 and 1993, the number of publications remained moderate, reaching an early peak of 12 publications in 1992. However, during the period from 1994 to 2018, research productivity remained very low, with annual publication counts ranging from 0 to 3. Notably, no publications were recorded in several years, including 2000, 2001, 2004–2007, and 2009–2013. The overall annual growth rate of publications was 5.49%. However, the low coefficient of determination value ($R^2 = 0.0756$) indicates that publication growth during the study period was inconsistent and irregular. This pattern suggests that research on AI and robotics in libraries received

limited scholarly attention during the earlier decades. A significant change was observed after 2019, when the field experienced a steady increase in research output. The highest number of publications was recorded in 2024, with 26 publications. This recent growth demonstrates a renewed, rapidly increasing interest in the application of AI and robotic technologies in library environments, particularly over the last five years of the study period.

The citation analysis further indicates that earlier publications in the field achieved considerable scholarly impact. Between 1989 and 1999, research papers received relatively high citation counts, with the maximum total citations (TC) of 118 recorded in 1999. In contrast, the period from 2000 to 2013 was characterised by limited research output and comparatively low citation impact. Several years during this period recorded no citations (TC = 0), although a few exceptions were observed in 2002 (TC = 110), 2003 (TC = 118), and 2008 (TC = 110). From 2014 onwards, the citation trend showed gradual improvement, reflecting increasing academic attention toward the field. However, citation counts declined again between 2019 and 2024, which may be attributed to the citation lag effect, as recently published articles have had less time to accumulate citations. The highly inconsistent nature of citation patterns is also reflected in the low R^2 value (0.026) for total citations, indicating substantial fluctuations in citation impact across different years. Overall, the findings suggest that while research on AI and robotics in libraries remained relatively dormant for many years, the field has recently experienced substantial growth and increasing scholarly recognition.

Table 2. Publications Dynamics

Year	TP	Cum. TP	TC	ACPP	%	Year	TP	Cum. TP	TC	ACPP	%
1989	4	4	73	18.25	3.17	2007	0	47	0	0	0
1990	4	8	73	18.25	3.17	2008	2	49	110	55	1.59
1991	6	14	60	10	4.76	2009	0	49	0	0	0
1992	12	26	48	4	9.52	2010	0	49	0	0	0
1993	8	34	56	7	6.35	2011	0	49	0	0	0
1994	2	36	110	55	1.59	2012	0	49	0	0	0
1995	3	39	104	34.67	2.38	2013	0	49	0	0	0
1996	1	40	118	1	0.79	2014	2	51	110	55	1.59
1997	2	42	110	55	1.59	2015	3	54	104	34.67	2.38
1998	1	43	118	118	0.79	2016	3	57	104	34.67	2.38
1999	1	44	118	118	0.79	2017	3	60	104	34.67	2.38
2000	0	44	0	0	0	2018	1	61	118	118	0.79
2001	0	44	0	0	0	2019	5	66	63	12.6	3.97
2002	2	46	110	55	1.59	2020	5	71	63	12.6	3.97
2003	1	47	118	118	0.79	2021	6	77	60	10	4.76
2004	0	47	0	0	0	2022	14	91	37	2.64	11.11
2005	0	47	0	0	0	2023	9	100	55	6.11	7.14
2006	0	47	0	0	0	2024	26	126	22	0.85	20.63

Source: Author's own work. *TP = Total Publication; Cum. = Cumulative; TC = Total Citation; ACPP = Average Citation per Publications

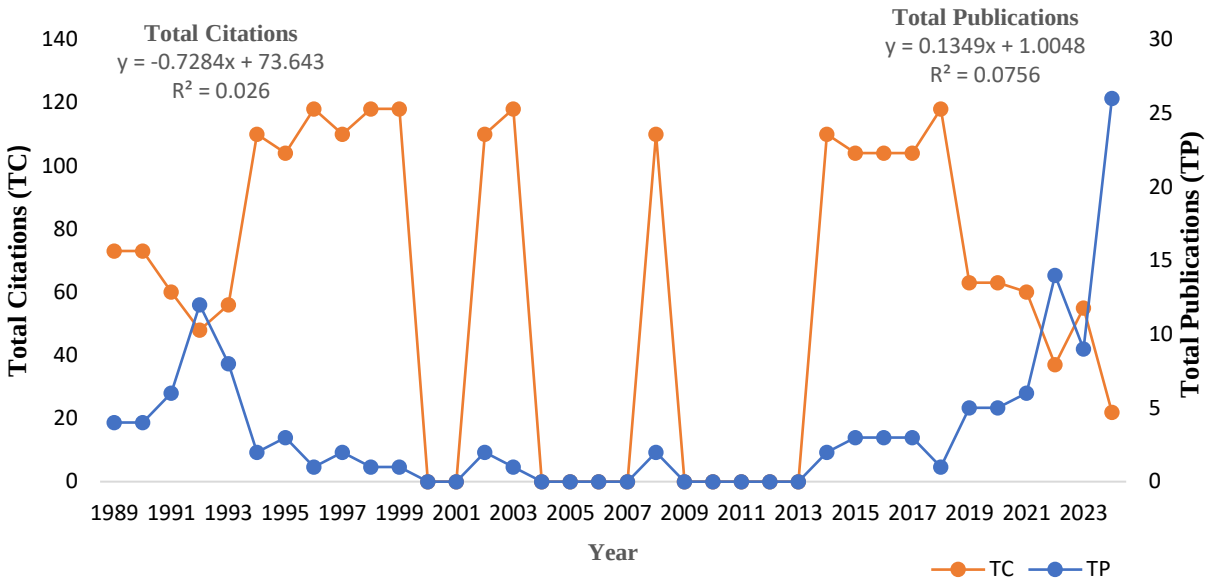


Figure 2. Publication and citation trends

Source: Author's own work.

5.3 Conceptual Structure of Research Publications

The conceptual structure of research in a specific field can be effectively examined by analyzing the authors' keywords used in scholarly publications. Keywords assigned by authors reflect the central themes, research focus, and emerging concepts within a specific discipline. In the present study, the conceptual structure of research on Artificial Intelligence and robotics in libraries was analyzed using author-provided keywords extracted from the selected publications.

Figure 3 presents a visual representation of the most frequently occurring keywords of the authors in library research on AI and robotics applications. The visualization was generated using VOSviewer, which maps relationships and co-occurrence patterns among keywords. A total of 307 keywords were identified from the 126 research documents included in the dataset. Among these, 18 keywords met the minimum threshold criteria and were selected for detailed analysis. In the keyword co-occurrence network, differently coloured bubbles represent the major keywords identified in the study. In contrast, the size of each bubble indicates the frequency of each keyword in the dataset. The connecting links between nodes illustrate the co-occurrence relationships among keywords, and the total link strength (TLS) reflects the extent of association between research themes in the published literature. The analysis revealed that the keyword "artificial intelligence" was the most dominant and frequently occurring term, appearing 26 times with a total link strength (TLS) of 45. This indicates its central role in the research domain. The second most prominent keyword was "academic libraries," with 10 occurrences and a TLS of 25, highlighting the strong focus on AI applications within academic library settings. Other significant keywords included "artificial-intelligence" (OC = 6, TLS = 9) and several related terms associated with emerging technological applications in libraries, as illustrated in Figure 3.

Keyword	Occurrences	Total link strength
artificial intelligence	26	45
academic libraries	10	25
artificial-intelligence	6	9
robots	6	8
technology	5	9
design	5	5
libraries	5	5
machine learning	4	13
ai	4	8
ai literacy	4	6
impact	4	4
university libraries	3	12
librarians	3	9
academic librarians	3	8

Figure 3. Network visualization of keyword co-occurrence (Source: VOSviewer)

5.3.1 Thematic Map

Figure 4 presents the thematic map of research on Artificial Intelligence and robotic technologies in libraries based on the co-occurrence analysis of authors' keywords. The thematic map categorizes research themes into four quadrants based on their centrality and development, thereby illustrating the field's major research directions, emerging areas, and conceptual evolution. In the upper-right quadrant, representing the Motor Themes, the keyword cluster centered on "artificial intelligence" is the most dominant and well-developed research theme. The inclusion of "academic libraries" within this cluster indicates a strong research emphasis on the application of AI technologies in academic library environments. Another important cluster, containing the keywords "technology," "impact," and "acceptability," reflects research on technological adoption, user acceptance, and the broader implications of AI integration in library systems. Similarly, the cluster comprising "design," "collection development," and "document retrieval" highlights research focusing on information organization, digital resource management, and accessibility of library collections through intelligent technologies. Near the central area of the thematic map, the cluster including "education," "digital transformation," and "emerging technologies" suggests an increasing research focus on technological innovation and digital transformation in libraries, particularly in relation to educational services and evolving information environments. These themes indicate the growing importance of AI-driven technologies in supporting modern library functions and digital learning ecosystems. The Niche Themes quadrant does not contain any significant keyword clusters, implying the absence of highly specialized or isolated research themes within the current literature. In the lower-left quadrant, representing Emerging or Declining Themes, keywords related to the general concept of "library" and basic access services appear with lower prominence. This suggests that researchers are gradually shifting their focus from traditional library concepts toward more technology-oriented applications and strategic innovations. The placement of keywords such as "RFID" and "human-robot interaction" in this quadrant indicates that these areas are still in the early stages of development and may represent emerging research topics in library automation and robotic applications. The lower-right quadrant, identified as the Basic Themes area, includes clusters related to "knowledge management" and "artificial intelligence." The presence of these keywords highlights the foundational role of AI technologies in enhancing knowledge management practices, information organization, and decision-making processes within libraries. Overall, the thematic map demonstrates that AI-driven digital transformation, intelligent information management, and emerging robotic applications constitute the major research directions in libraries.

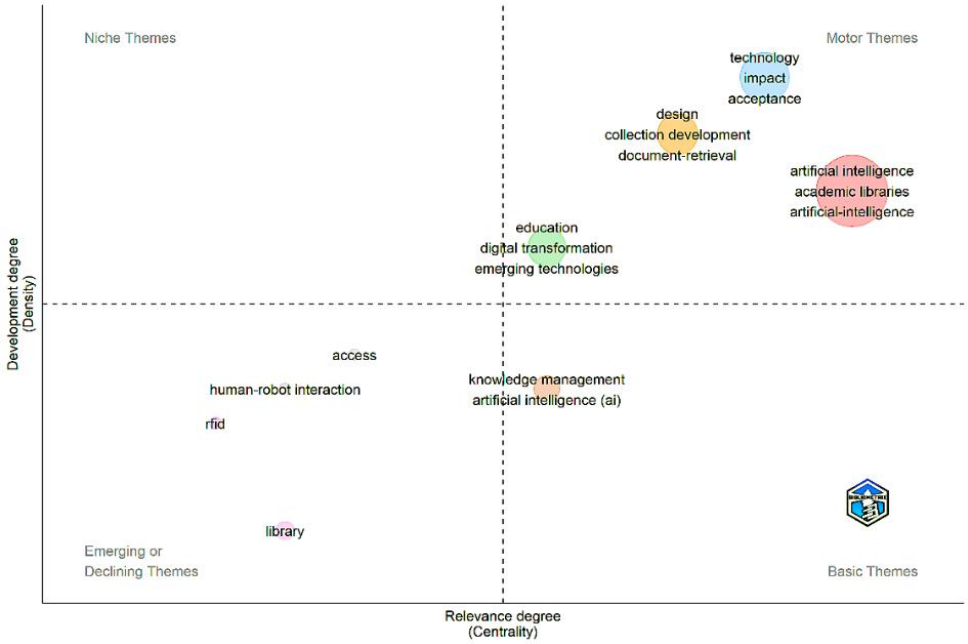


Figure 4. Thematic map of AI and robotics research in libraries.

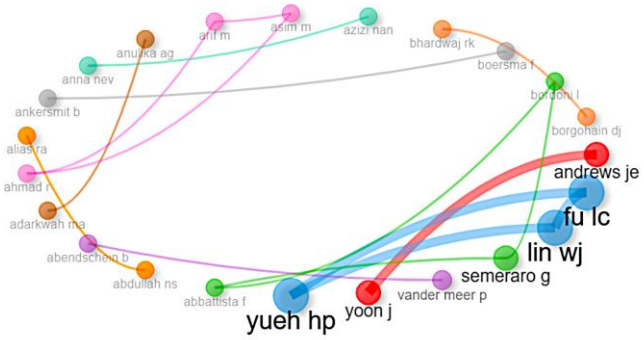
Source: Biblioshiny.

5.4 Social Structure of Research Publications

The social structure of a research field can be understood through the analysis of collaborative relationships among authors, institutions, and countries. Collaboration analysis helps to identify research networks, influential contributors, and patterns of scholarly interaction within a specific domain. In the present study, the social structure of research on Artificial Intelligence (AI) and robotics in libraries was examined through co-authorship analysis at the author and country levels.

5.4.1 Collaboration Networks of Authors

Figure 5 illustrates the co-authorship collaboration network among authors using the Biblioshiny analytical platform. In the visualization, the size of each circular node represents the extent of an author's collaborative activity, with larger nodes indicating authors with more co-authored publications in the dataset. The thickness of the connecting edges reflects the strength of collaboration between researchers, while different node and edge colours represent distinct collaborative communities or research groups. Authors represented by nodes of the same colour belong to closely connected clusters, suggesting that they frequently collaborate on similar research themes or within related subfields. The analysis reveals that the authors "Yueh HP," "Fu LC," "Lin WJ," "Yoon J," and "Andrews JE" are among the most highly connected researchers in the network. Their prominent positions indicate that they play significant roles in the field's collaborative structure and contribute extensively to research development through joint scholarly activities. The identified collaborative communities reflect different research subdomains within the broader area of AI and robotics applications in libraries. The highly connected authors act as central contributors and research leaders, facilitating knowledge exchange and collaboration across institutions and specialized research areas. Their strong collaborative links suggest an important role in advancing interdisciplinary research and strengthening the field's intellectual and social connectivity.



Author	Documents	Citations	Total link strength
anna, nove e. variant	2	77	6
firdaus, aji akbar	2	77	6
harisanty, dessy	2	77	6
putri, tesa eranti	2	77	6
fu, li-chen	2	61	4
iqbal, abid	2	7	4
khan, shakeel ahmad	2	7	4
lin, weijane	2	61	4
shahzad, khurram	2	7	4
yueh, hsiu-ping	2	61	4
andrews, james e.	2	158	2
mughari, shahzeb	2	13	2
rafique, ghulam murtaza	2	13	2
sanders, d	2	42	2
tewkesbury, g	2	42	2
yoon, jungwon	2	158	2

Figure 5. Collaboration network of authors

Source: Biblioshiny.

5.4.2 Collaboration Networks of Countries

Figure 6 presents the international collaboration network of countries involved in research on Artificial Intelligence (AI) and robotics in libraries using Biblioshiny, an R package within the Bibliometrix software (Aria & Cuccurullo, 2017). In the network visualization, each node represents a country, and its size indicates the extent of its collaborative research activity in the dataset. The thickness of the connecting edges reflects the frequency and strength of collaboration between countries, while nodes with the same colour represent collaborative communities or clusters. The analysis reveals that the United States occupies the most prominent position in the collaboration network, as indicated by the largest node size. This demonstrates the country's central role and extensive collaborative relationships with other nations in AI and robotics research in libraries. China ranks second among the most influential countries in the network, highlighting its growing contributions and active participation in international research collaborations. The thick connecting edge between the United States and China indicates a particularly strong collaborative relationship, suggesting that these two countries have produced more joint research publications than any other country pair within the network. The collaboration map further identifies several regional and thematic research clusters. The red cluster includes countries such as the United States, Korea, Spain, Italy, Israel, and France, indicating a strong collaboration network centred around the United States. The blue cluster comprises China, Singapore, the Philippines, Kenya, Ghana, Nigeria, Germany, and Australia, reflecting active collaboration among countries from the Asia-Pacific region and selected African nations, with China serving as a major collaborative hub. The green cluster represents a smaller European collaboration group consisting of Poland, the United Kingdom, and Ireland. This cluster indicates regional cooperation among European countries in AI and robotics research in libraries. In addition, some isolated collaborative groups were identified, including Finland and Norway, Indonesia and Malaysia, and Iran and Hungary. These clusters exhibit relatively limited international integration, suggesting more localised or region-specific collaborative patterns.

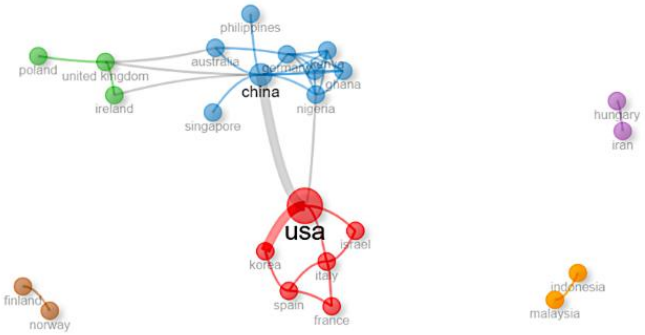


Figure 6. Collaboration network of countries

Source: Biblioshiny.

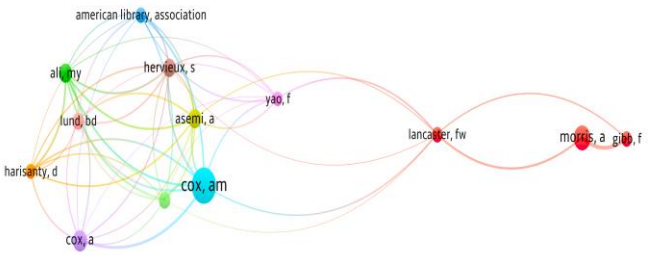
5.5 Intellectual Structure

Co-citation analysis is an important bibliometric technique used to examine the intellectual relationships among influential publications, authors, and research themes within a specific field of study. By identifying how frequently two authors or documents are cited together, co-

citation analysis helps map the intellectual structure of a research domain, identify core research areas, and recognise influential scholarly contributions. It also assists in detecting emerging research hotspots and understanding the development of knowledge within a discipline (White & Griffith, 1981; Calabretta et al., 2011).

5.5.1 Co-citation Analysis of Cited Authors

Figure 7 presents a network visualisation of cited authors in research publications on Artificial Intelligence (AI) and robotics in libraries. The analysis was conducted using VOSviewer software with the complete counting method, applying a minimum threshold of 10 citations per author. Out of a total of 2,928 cited authors identified in the dataset, 13 authors met the threshold criteria and were included in the final co-citation analysis. The selected authors are represented in the network visualisation as differently coloured circular nodes, with each node's size corresponding to the author's citation influence within the research field. Larger nodes indicate authors with higher citation frequencies and stronger intellectual influence. The connecting links among the nodes represent co-citation relationships, while the total link strength (TLS) reflects the degree of intellectual association between authors. The analysis identifies Cox, as the most influential and frequently cited author in the field, with 30 total citations (TC) and a total link strength (TLS) of 105. This demonstrates the significant intellectual impact of the author's contributions to research on AI and robotics in libraries. Morris, A., ranks second among the most influential cited authors, with 19 total citations and a TLS of 39, followed by Cox, who received 16 total citations and a TLS of 52. The strong co-citation relationships among these authors suggest that their works are closely interconnected and frequently referenced together, driven by similarities in research focus, theoretical perspectives, or subject areas within the discipline.



Author	Citations	Total link strength
cox, am	30	105
asemi, a	14	71
ali, my	14	70
hervieux, s	13	65
wheatley, amanda	12	61
lund, bd	12	57
american library, association	11	53
cox, a	16	52
harisanty, d	10	49
morris, a	19	39
gibb, f	11	33
yao, f	10	32
lancaster, fw	11	27

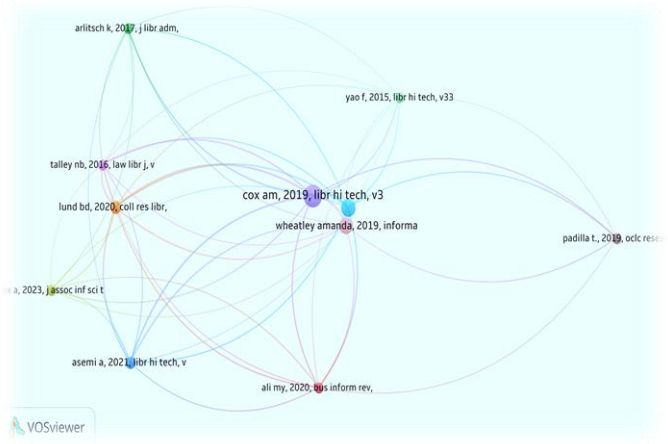
Figure 7. Co-citation network of cited authors.

Source: VOSviewer.

5.5.2 Co-citation Analysis of Cited References

The dataset, comprising 126 research documents, contained 3,492 cited references. To identify the most influential references in the field, a co-citation analysis of cited references was conducted using VOSviewer. The analysis employed the full-counting method with a minimum threshold of seven citations per reference. Based on this criterion, 13 cited references met the threshold and were included in the final visualization presented in Figure 8. The network visualization illustrates the intellectual relationships among the most frequently co-cited references in research on Artificial Intelligence and robotics in libraries. In the map, the size of each node represents the citation influence of a reference. At the same time, the connecting links indicate the

frequency with which two references are cited together in the selected publications. The total link strength (TLS) reflects the degree of intellectual association among the cited works. The analysis reveals that the most influential cited reference in the field is the article by Cox, et al. (2019), titled "The Intelligent Library: Thought Leaders' Views on the Likely Impact of Artificial Intelligence on Academic Libraries," published in Library Hi Tech, 37(3), 418–435. This publication received 19 total citations (TC) and recorded the highest total link strength (TLS = 61), indicating its central role in shaping research discussions on AI applications in academic libraries. The second most influential reference is the study by Hervieux, and Wheatley (2021), titled "Perceptions of Artificial Intelligence: A Survey of Academic Librarians in Canada and the United States," published in The Journal of Academic Librarianship, 47(1), 102270. This work received 13 citations and achieved a link strength of 46, demonstrating strong intellectual influence within the research domain. The co-citation network highlights the foundational studies and influential scholarly works that have significantly contributed to the development of AI and robotics research in libraries.



Cited reference	Citations	Total link strength
cox am, 2019, libr hi tech, v37, p418, doi 10.1108/lht-08...	19	61
hervieux s, 2021, j acad libr, v47, doi 10.1016/j.acalib.20...	13	46
wheatley amanda, 2019, information services & use, v3...	12	41
lund bd, 2020, coll res libr, v81, p865	9	40
asemi a, 2021, libr hi tech, v39, p412, doi 10.1108/lht-02...	8	31
ali my, 2020, bus inform rev, v37, p116, doi [10.1177/02...	7	27
talley nb, 2016, law libr j, v108, p383	7	25
arlitsch k, 2017, j libr adm, v57, p789, doi 10.1080/01930...	7	19
cox a, 2023, j assoc inf sci tech, v74, p367, doi 10.1002/a...	7	18
yao f, 2015, libr hi tech, v33, p245, doi 10.1108/lht-02-20...	7	17
padilla t., 2019, oclc research, doi [10.25333/xk7z-9g97, ...	7	11
aluri r, 1990, expert systems libra	7	1
morris a, 1992, application expert s	7	1

Figure 8. Co-citation network of cited references
Source: VOSviewer.

6. RESULTS AND DISCUSSION

A total of 126 research publications related to Artificial Intelligence (AI) and robotic technologies in libraries, published between 1989 and 2024 and indexed in the Web of Science database, were analyzed using scientometric techniques to map the conceptual, social, and intellectual structure of the research field. The major findings of the study are discussed below.

The analysis of publication and citation patterns (Table 2 and Figure 2) indicates that the field exerted relatively strong citation influence during the early phase of research, from 1989 to 1999. Although the number of publications during this period was limited, several studies achieved considerable scholarly impact through high citation counts. A significant increase in publication output was observed after 2019, reflecting growing academic interest in the application of AI and robotics in libraries. However, citation counts for recent publications were comparatively lower, which may be attributed to the citation lag effect associated with newly published research articles.

The keyword co-occurrence analysis (Figure 3) identified "artificial intelligence," "academic libraries," and "robots" as the most dominant conceptual themes within the study domain. These

keywords exhibited high frequency and strong linkages, demonstrating their central role in shaping current research trends. The findings suggest that contemporary research primarily focuses on implementing AI-driven technologies and robotic systems in academic library environments.

The thematic map analysis (Figure 4) further revealed that AI adoption in academic libraries is the field's principal research focus. Emerging themes such as "human-robot interaction," "RFID," and "digital transformation" were identified as promising areas of research with strong future potential. These themes indicate an increasing scholarly interest in intelligent automation, interactive technologies, and digitally transformed library services, which are likely to influence future research directions.

The collaboration network analysis (Figure 5) demonstrates the gradual development of research communities and scholarly collaboration within the field. At the international level, the United States and China emerged as the leading contributors and central collaborators in AI and robotics research in libraries, supported by collaborative networks involving European and Asian countries. This finding highlights the growing global nature of research activities in the field.

The co-citation analyses of authors and references identified the work of Cox et al. (2019), which discusses the implications of AI for academic libraries, as one of the most influential contributions within the research domain. The intellectual structure of the field is largely shaped by studies focusing on user perceptions of AI, technology adoption, professional competencies, digital transformation, and the practical integration of intelligent systems in library services and management. Overall, the findings indicate that research on AI and robotics in libraries is evolving rapidly and is increasingly driven by interdisciplinary collaboration, technological innovation, and the transformation of modern library environments.

7. CONCLUSION

The present scientometric study provides a comprehensive overview of research on Artificial Intelligence (AI) and robotics in libraries based on publications indexed in the Web of Science Core Collection (WoSCC) database during the period 1989–2024. The findings reveal that research in this area has evolved into a dynamic and rapidly expanding field, particularly after 2019, when a substantial increase in scholarly publications was observed. This growth reflects the rising global interest in applying AI-driven technologies and robotic systems to improve library services, information management, user engagement, and digital transformation initiatives. The study highlights the emergence of key conceptual themes, including artificial intelligence, academic libraries, knowledge management, digital transformation, and human-robot interaction. The intellectual structure analysis identified influential authors and foundational studies that continue to shape the field's development. In addition, the collaboration analysis demonstrates the growing importance of international research partnerships, with countries such as the United States and China playing leading roles in advancing collaborative research. The findings further suggest that researchers, academic institutions, policymakers, and funding agencies have an important role in promoting interdisciplinary collaboration, technological innovation, and inclusive research practices to strengthen the adoption and implementation of AI and robotic technologies in libraries. Emerging themes identified in the study also indicate significant opportunities for future research, particularly in intelligent automation, robotic assistance, user interaction, and digital library transformation. Finally, the study contributes valuable insights into the conceptual, intellectual, and social dimensions of AI and robotics research in libraries. It serves as a useful reference for researchers and practitioners interested in this evolving domain. However, the study is limited to publications indexed in the Web of Science Core Collection. Consequently, the findings may differ if other databases such as Scopus, Google Scholar, Dimensions, or PubMed are included in future analyses.

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