Use of artificial intelligence in libraries: a systematic review, 2019-2023

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Artificial intelligence (AI) has recently become a topic of interest for the nations, leading to research. In the case of libraries, data collection on AI use was conducted until 2020, raising the possibility of changes in research characteristics. This systematic review of open access articles on the use of AI in libraries provides an overview of the study of this technology in the library field in recent years. This quantitative study has a descriptive scope that focused on the analysis of the results obtained through a systematic review in the Web of Science (WoS) database for the period 2019-2023 on the use of AI in libraries. For this research, a characterisation of the articles on the use of AI in libraries was carried out and the following factors were analysed: geographical distribution of publication, language, institutions, journals, and publishers involved. The study shows a rise in research on AI and its use in libraries since 2022, a year that coincides with an increase in the publication of legislative proposals, laws, policies, and national strategies on AI worldwide.

Keywords: Artificial intelligence, libraries, systematic review, machine learning, technology

1 Introduction

In the field of Library and Information Science (LIS), Eito (2021) explains that artificial intelligence (AI) has been applied for about 50 years in recommendation systems, rule-based expert systems and others. However, AI is currently being used through technologies for pattern recognition in images, computer vision, speech recognition and machine learning. Similarly, Das and Islam (2021:13) state that the application of AI and machine learning in libraries is an emerging trend that has caught the attention of practitioners and academics. In this context, AI has focused on the area of knowledge organisation through classification schemes, thesauri, and ontologies, where algorithms are able to assign terms and represent the content of documents (Vizoso & Grazia 2022). These and other examples of AI uses are evidenced in the International Federation of Library Association (IFLA) Statement on Libraries and Artificial Intelligence (2020:14), which includes a section outlining some of its uses, such as the automation of the Dewey Decimal Classification at the National Library of Norway, the development of projects exploring the application of AI in libraries for internal information processing and collection discovery and analysis at Stanford University Library, the creation of an AI laboratory at the University of Rhode Island, open to the entire community and many others. In this context, it brings the question about the existence and characteristics of publications related to experiences of AI use in libraries in the world in recent years.

While looking at the status of the legal framework on AI use in different nations around the world, there is a trend towards the creation of national strategies, which are available for the Kingdom of Bhutan (2014); the People's Republic of China (2017); the United Arab Emirates (2018), which has a Ministry of State for AI, Digital Economy and Remote Work Office applications; the Republic of Korea (2019); the Kingdom of Norway (2020); the Republic of Bangladesh (2020); the Federative Republic of Brazil (2021); the Republic of Peru (2021); Japan (2022), although it presents plans from 2019; the Republic of Armenia (2022); Canada (2022); the Dominican Republic (2022); the Commonwealth of Australia (2022) and Taiwan (2023). The second type of document found were national policies available for Republic of Colombia (2019); Iceland (2021); Republic of Chile (2021); Dominican Republic (2021), within its Action Plan 2021-2024 for the 2030 Agenda; Sultanate of Oman (2022); Hashemite Kingdom of Jordan (2020); Republic of Kazakhstan (2006); Kyrgyz Republic, (2022); Republic of Uzbekistan (2022), mainly focused on the development of digital government; the State of Israel (2022) and New Zealand (2023).

As for AI laws per se, two were found: one in Peru (2023), the only national law published at the time of the study, and one in the People's Republic of China (2023), which is an interim law on generative AI. As for other types of national

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documents on AI, there are proposed laws in the Federative Republic of Brazil (2020), the United States of Mexico (2023), the Eastern Republic of Uruguay (2023), the Republic of Costa Rica (2023) and the European Union (2023), which would represent the position of the 27 countries that make up the European Union: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Sweden and Spain.

Regarding decrees of law, they can be found in the Federative Republic of Brazil (2021), the Republic of Chile (2021) and the Republic of Colombia (2022). There are also ethical frameworks for Hong Kong (2023), the kingdom of Thailand (2019), the Republic of Malta (2019), the Commonwealth of Australia (2019) and Canada (2023). In terms of laws related to the use of AI that do not fall into the above two categories, the Republic of El Salvador (2023) presents laws to encourage it in the country's tech industry, while the Russian Federation (2020) and the Republic of Argentina (2023) opted to make amendments to their data security laws.

Based on this information, it was observed that AI is not fully regulated by law worldwide, as only two countries, Peru and China, could be found with laws in force on AI regulation in their territories, both published in 2023. Yet, the interest in establishing ethical regulations has been present over the last ten years in the different nations and over the last five years in the different countries. In addition, in 2019 and 2022, there was a notable increase in the number of publications on the subject under inquiry.

The aim of this research was to identify the characterisation of open access articles on the use of AI in libraries, published in the Web of Science (WoS) database, between 2019 and 2023. The study sought to present an overview of the publications and their topics, year of publication, language, geographical distribution of the publication, types of libraries researched, types of AI researched, journals, publishers, keywords and institutions and funding agencies.

2 Literature review

According to Cabanelas (2019), AI is any machine or system that resembles human intelligence based on the data it collects. The way it collects this data is based on mathematics, using specialised algorithms to store, remember and recognise this data to generate possible answers to different situations.

Concerning systematic and literature reviews on the use of AI in libraries, three articles published between 2020 and 2023 were found, although the data retrieved for them were compiled up to 2020. The first article is "Application of AI and machine learning in libraries: a systematic review" (Das & Islam 2021), the second is "Is adopting artificial intelligence in libraries urgency or a buzzword? A systematic literature review" (Harisanty et al., 2023) and the last one is “Understanding AI in research libraries: an extensive literature review" (Gasparini & Kautonen 2022).

The authors agree that AI in libraries corresponds to an emerging and exploratory field that has the potential to facilitate the development of activities in information units. They also agree that it has been investigated in theory, although in less proportion, practical ways. Another observation of the three systematic reviews was the uncertainty generated among professionals and the community by the introduction of this type of technology in the information units.

This type of reaction to the use of new technologies corresponds with theories such as the Technology Acceptance Model, which explains the motivation of users by three factors: perceived usefulness, perceived ease of use and attitude toward use (Taherdoost 2018) and the Unified Theory of Acceptance and Use of Technology, which suggests that the actual use of technology is determined by behavioural intention (Marikyan & Papagiannidis 2023).

3 Methodology

The study followed a quantitative approach with a descriptive scope, focused on the analysis of the results obtained through the systematic review of open access articles on the use of AI in libraries, indexed on the WoS database in the period 2019 to 2023. Previous systematic reviews focused only on data compiled up to 2020 and the state of global legislation on AI disclosed increased in the years after this date.

A total of 56 articles were retrieved from the WoS search, which were organised through a data matrix that synthesises the following elements: internal identification number, bibliographic reference standardised in American Psychological Association 7th edition citation format, article abstract, research topic, year of publication, language of the article, geographical distribution of the publication, type of library researched, type of AI researched, journals and publishers in charge of publication, institutions and funding agencies in charge of publication, and keywords provided by the author.

Out of the 56 documents retrieved, 26 were considered suitable after being reviewed. Table 1 shows the search strategy conducted during October 2023 on the WoS database of scientific publications.

Table 1: Search strategy systematic review of open access article on AI in libraries WoS-indexed (2019-2023)

Search strategy	
"Artificial intelligence" AND ("library" or "libraries") (All Fields) and Open Access and 2019 or 2020 or 2021 or 2022 or 2023 (Publication Years) and Article (Document Types) and Information Science Library Science (WoS Categories)	
Search filters	
Open access; 2019-2023; Article; Information Science Library Science	
Number of documents recovered	**Number of items relevant to the review**
56	26

Source: Author(s) own elaboration

5 Results

This section presents the results of the study.

5.1 Characterisation of articles retrieved the use of AI in libraries for the period 2019-2023

An analysis of 26 articles revealed that the use of AI in libraries was taking place through chatbots, ethical and gradual integration of AI, the development of national policies, together with libraries, support in subject indexing through prototype programmes using AI, augmented reality, virtual reality, natural language processing, machine learning, explainable AI and generative AI. The following articles were reviewed:

Eight studies (Ali et al. 2024; Cox 2022; Cox 2023; Cox & Mazumdar 2022; Cox, Pinfield & Rutter 2019; Harisanty et al 2022; Ridley & Pawlick-Potts 2021; Schaab 2023) reflect on definitions, perceptions, ethical use and impact of AI related to libraries and their services, analysing its strengths, weaknesses, opportunities and threats to its implementation, and its conscious and relevant use for the information professional.

Four articles (Demner-Fushman, Mrabet & Ben Abacha 2020; Ehrenpreis & DeLooper 2022; Tait & Pierson 2022; Wang 2022) mention the use of chatbots, digital assistants and/or robots within libraries. The conclusions of these articles are similar, as they indicate the importance of their ethical and gradual integration, as well as a crucial integration to keep library activity up to date and relevant.

Three articles (Asula et al. 2021; Chou & Chu 2022; Kragelj & Borštnar 2020) mention the use of AI to facilitate subject indexing and thus reduce time, cost and bias by applying prototypes such as Kratt and BERT models using machine learning and natural language processing, achieving initial results that are not satisfactory but encouraging for future integration in libraries.

Three articles (Bradley 2022; Ridley 2022; Stepanov 2019) mention the role of libraries in the transition to mass use of AI and how they should be part of national regulatory and public policy plans, as well as the role of libraries in the transitional period towards the knowledge society. Ridley (2022) was the only one of the 26 articles to mention XAI, the field of explainable AI.

Three articles (Demner-Fushman et al. 2020; Ekstrand & Strandberg 2023; Kiester & Turp 2022) mention the integration of AI in medical libraries for improvement in addressing patients' questions and improvement in medical library tools.

Two articles mention the use of machine learning, one of which (Krickl, Mayer & Zangger 2022) uses it for provenance research of collections at the Austrian National Library. The other (Schneider et al. 2019) explores the application of the ePADD software to address challenges in relationship with e-mail within contemporary literary collections.

Regarding the last four articles, one mentions the use of augmented AI in libraries (Wójcik 2020), while the others classify generative AI and graphics technologies as relevant in the future of libraries (Scholze 2023). One article that presents the use of virtual reality, together with AI and natural language processing, for the creation of a prototype community memory archiving system to provide digital oral history in public libraries (Matsubayashi et al. 2022). The article by Kaiser (2023) focuses on digitisation and the importance of digital collections, arguing that one of its benefits is the possibility it offers to apply machine learning and AI methods.

5.2 Year of publication of articles

In terms of the years of publication of open access articles on the use of AI in libraries, 2022 is the predominant year with a total of 13 articles. It is followed by 2023 with five articles, then 2021 with four articles, 2019 with three articles and, lastly, 2020 with one article published. The distribution by year of these publications is shown in Figure 1. The results for the year 2023 may be affected given the cut-off date for the compilation of the data in October 2023.

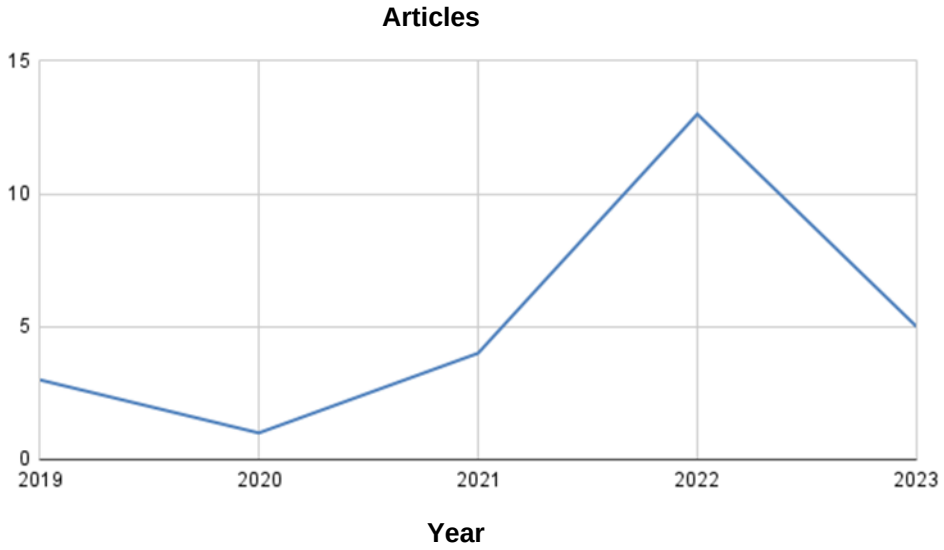

Figure 1: Article published per year on the use of AI in libraries indexed in WoS for the period 2019-2023

Source: Articles published per year on the use of AI in libraries indexed in WoS for the period 2019-2023: Author's own elaboration.

5.3 Language of publication of open access articles on the use of AI

The study established that English was the predominant language with 22 articles (88.5%) and German with three articles (11.5%).

5.4 Geographical distribution of the publication of open access articles on the use of AI

The countries considered for the study of geographical distribution were those corresponding to the country of the publisher in which the articles were published. Thus, between 2019 and 2023, England was the prevalent country with a total of 14 articles (53.8%), followed by the United States of America with six articles (23.1%), Germany with four articles (15.4%) and, lastly, Russia and Singapore with one article each (3.8%).

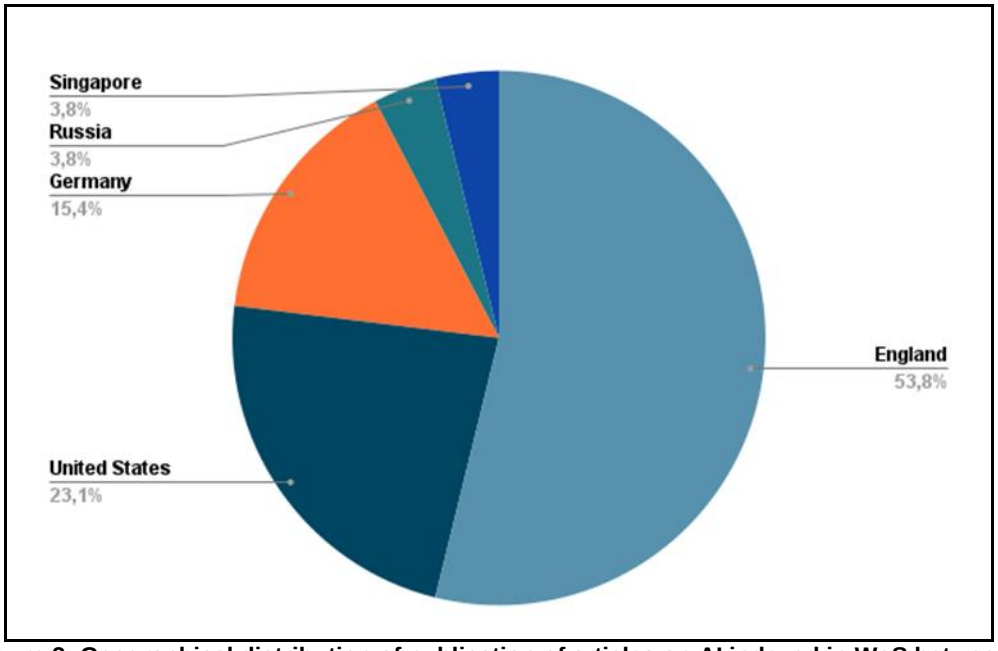

Figure 2: Geographical distribution of publication of articles on AI indexed in WoS between 2019-2023

Source: Geographical distribution of publication of articles on AI use in libraries indexed in WoS for the period 2019-2023: Author's own elaboration

5.5 Type of library referred to in articles

In relation to the types of libraries studied, there were national libraries (Krickl et al. 2022; Scholze 2023), public libraries (Kaiser 2023; Stepanov 2019; Tait & Pierson 2022), medical libraries (Demner-Fushman et al. 2020; Ekstrand & Strandberg 2023; Kiester & Turp 2022) and academic libraries (Ali et al. 2022; Cox 2023; Cox et al. 2019; Ehrenpreis & DeLooper 2022; Harisanty et al. 2022; Ridley & Pawlick-Potts 2021; Schaab 2023). It is also possible to find documents that refer to libraries in general (Asula et al. 2021; Bradley 2022; Chou & Chu 2022; Cox 2022; Cox & Mazumdar 2022; Kragelj & Borštnar 2020; Matsubayashi et al. 2022; Ridley & Pawlick-Potts 2021; Schneider et al. 2019; Wang 2022; Wójcik 2020). The number of items retrieved by each type of library can be found in table 2.

Table 2: Number of articles by type of library to which the document refers

Library type	Articles
National library	2
Public library	3
Medical library	3
Academic library	7
Libraries in general	11
Total items	26

Source: Author's own elaboration

5.6 Journals and publishers

A total of 16 journals were found, with the highest number of articles published in the journals *Library Hi Tech* (Cox et al. 2019; Harisanty et al. 2022; Wójcik 2020), followed by *Information Technology and Libraries* (Ridley 2022; Ridley & Pawlick-Potts 2021; Wang 2022), *Bibliothek Forschung und Praxis* (Kaiser 2023; Krickl et al. 2022; Schaab 2023; Scholze 2023) and *Journal of the Australian Library and Information Association* (Bradley 2022; Cox 2022; Tait & Pierson 2022). The first two are international library technology journals. The total breakdown of 16 articles retrieved is depicted in table 3.

Table 3: Open access articles on AI in libraries by journals indexed in WoS 2019-2023

Journal	Number of published articles
Bibliothek Forschung und Praxis	4
Information Technology and Libraries	3
Library Hi Tech	3
Journal of the Australian Library and Information Association	3
Cataloguing & Classification Quarterly	2
Global Knowledge Memory and Communication	1
Health Information and Libraries Journal	1
Journal of Documentation	1
Journal of Librarianship and Information Science	1
Journal of the American Medical Informatics Association	1
Journal of the Association for Information Science and Technology	1
Journal of the Medical Library Association	1
Journal of Web Librarianship	1
Libres – Library and Information Science Research Electronic Journal	1
Nauchnye I Tekhnicheskie Biblioteki-Scientific and Technical Libraries	1
Archives and Manuscripts	1
Total items	26

Source: Author's own elaboration

As highlighted above, these journals had relationships with some of the publishers that had the largest number of associated articles. These included Routledge (Asula et al. 2021; Bradley 2022; Chou & Chu 2022; Cox 2022; Ehrenpreis & DeLooper 2022; Schneider et al. 2019; Tait & Pierson 2022), Emerald Group (Ali et al. 2024; Cox et al. 2019; Harisanty et al. 2022; Kragelj & Borštnar 2020; Wójcik 2020), Walter de Gruyter (Kaiser 2023; Krickl et al. 2022; Schaab 2023; Scholze 2023), American Library Association (Ridley 2022; Ridley & Pawlick-Potts 2021; Wang 2022), Wiley (Ekstrand & Strandberg 2023; Cox 2023), Medical Library Association (Kiester & Turp 2022), Nanyang Technological University Library (Matsubayashi et al. 2022), Oxford University Press (Demner-Fushman et al. 2020), Russian Natl Public Library Science & Technology (Stepanov 2019) and Sage Publications Ltd (Cox & Mazumdar 2022). The publishers do not show a trend in their subject matter. The relationship extent of the articles with some publishers is detailed in table 4.

Table 4: Publishers that have published open access articles on AI in libraries, indexed in WoS (2019-2023)

Publishers	Articles
Routledge Journals, Taylor & Francis Ltd	7
Emerald Group Publishing Ltd	5
Walter De Gruyter Gmbh	4
American Library Association	3
Wiley	2
Medical Library Assoc	1
Nanyang Technological University Library	1
Oxford University Press	1
Russian Natl Public Library Science & Technology	1
Sage Publications Ltd	1
Total Items	26

Source: Author's own elaboration

5.7 Funding institutions and agencies

In the context of the open access articles retrieved, the study found that funding institutions and agencies consist mainly of open access initiatives and national agencies for the promotion of research and technological development in their countries. Programmes and projects such as the Intramural Research Programme from the United States (Demner-Fushman et al. 2020), JSPS KAKENHI from Japan (Matsubayashi et al. 2022) and Projekt Deal (Cox 2023) from Germany were found. In academic institutes, there is the Institute of Museum and Library Services (United States) (Schneider et al. 2019), for research agencies there is Slovenian Research Agency (Slovenia) (Kragelj & Borštnar 2020), for ministries there is Ministry of Education, Culture, Research, and Technology (Indonesia) (Harisanty et al. 2022) and, finally, for funds there is European Regional Development Fund (European Continent) (Asula et al. 2021).

5.8 Type of AI investigated

In terms of the types of AI covered in the articles, machine learning was found to have the highest number of articles. Then, in equal proportion between them, are AIs of virtual assistant, AI models, NLP, AI indexing, AI and robots, augmented intelligence, generative AI, virtual reality, AI applied in algorithms and chatbots. The remaining articles referred to the use of AI in libraries in general terms. These results indicate that there are no prevalent trends in terms of the type of AI investigated for use in libraries in the sample studied, with a variety of AI types investigated in the sample.

AI researched	Number of items with AI
Machine learning	4
Virtual assistant	1
AI/PNL model	1
Explainable IA (XAI)	1
Indexing AI (Kratt)	1
AI and robots	1
Augmented AI	1
Virtual reality	1
Generative AI	1
Chatbots	1
AI applied in algorithms	1
AI unspecified	12
Total Items	26

Source: Author's own elaboration

5.9 Keywords used

AI is the most-used keyword assigned to 73% of the 26 articles (Ali et al. 2024; Asula et al. 2021; Bradley 2022; Chou & Chu 2022; Cox 2022; Cox et al. 2019; Cox & Mazumdar 2022; Demner-Fushman et al. 2020; Ehrenpreis & DeLooper 2022; Harisanty et al. 2022; Kaiser 2023; Kiester & Turp 2022; Kragelj & Borštnar 2020; Krickl et al. 2022; Ridley & Pawlick-Potts 2021; Scholze 2023; Stepanov 2019; Tait & Pierson 2022; Wójcik 2020), followed by machine learning assigned to 23.07% of the articles (Asula et al. 2021; Cox & Mazumdar 2022; Cox et al. 2019; Kragelj & Borštnar 2020; Krickl et al. 2022; Schneider et al. 2019), natural language processing used in 19.2 % of the articles (Asula et al. 2021; Chou & Chu 2022; Demner-Fushman et al. 2020; Ehrenpreis & DeLooper 2022; Schneider et al. 2019).

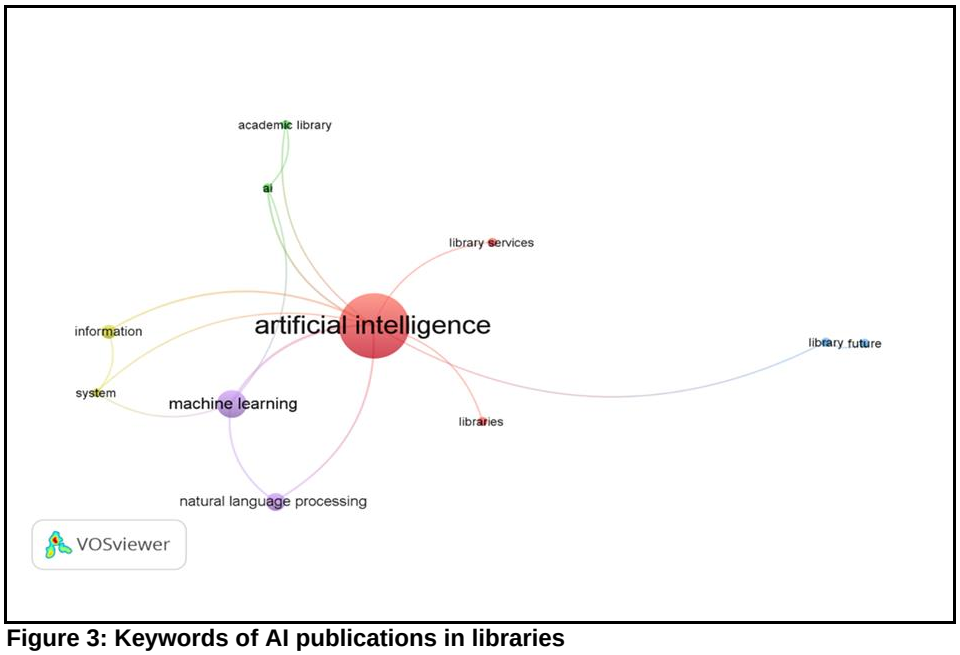

Figure 3: Keywords of AI publications in libraries

Source: Keywords of AI publications in libraries, according to articles indexed in WoS (2019-2023). Author's own elaboration

6 Conclusion and discussion

The characterisation of the open access articles about AI use in libraries published on the WoS database between years 2019 and 2023 and its comparison to previous systematic review research on the topic, affirm that the studies of AI in libraries have increased since the last systematic reviews conducted until 2020. The results of this study were consistent with other studies about AI, which revealed the potential of AI to transform their information units (Gasparini & Kautonen 2022; Harisanty et al. 2023), and a range of tools and uses in which it can be applied (Das & Islam 2021; Gasparini & Kautonen 2022; Harisanty et al. 2023). Divided opinions were noted among the studies due to the uncertainty about the use of such technology in the work areas and the fact that AI is beginning to be implemented in libraries, but is not yet fully established (Das & Islam 2021; Gasparini & Kautonen 2022; Harisanty et al. 2023).

While it is true that the number of articles related to the practical use of AI in libraries has increased, this study is a point of reference presenting concrete examples of how technology has been applied in different areas. The amount of research published to date does not allow the establishment of trends or lines of research that suggest an advanced state of knowledge on the subject. Therefore, it remains a topic and study of descriptive scope, bearing on the study of Hernández, Fernández and Baptista (2014:14) that it seeks to specify the properties, characteristics and profiles of people, groups, communities, processes, objects, or any other phenomenon that is subject to an analysis. This scope intends only to measure or collect information, independently or jointly, about the concepts or variables to which they refer, without indicating how these are related. The articles refer to tests of use of new AI-related tools that are still in early stages of development. In addition, the search terms and categories registered corresponded to general terms, despite the variety of AI tools reported and the information units studied.

Notwithstanding the above views, it is important to note that the topics covered, and tools investigated by the articles retrieved for this study are more defined than those reported in previous systematic reviews. Although they do not extend far enough to go beyond the descriptive scope, they are evidence of progress in AI research in libraries. This progress is reflected in the nature of the topics extracted from this review compared to those extracted by the systematic reviews consulted previously.

The relevant aspects that are the subject to interest are related to the role of libraries in the transition towards the use of AI and how these should be part of national regulatory plans and public policies (Bradley 2022), as well as the role of libraries in the transition period towards the knowledge society (Stepanov 2019). In the same vein, components such as ethics in use are elements present in an article (Cox 2022), since this one is also of interest to nations. Ethics in AI use could be a key component of future research or a research line to follow for AI in libraries, especially those that manage sensitive information, such as national libraries.

Regarding the objective of this research, the characterisation of the articles analysed in this study, these are 88.5% in English and 11.5% in German. A total of 53.8% of the articles were published in England and 23.1% in the United States.

Germany followed with 15.4%, Russia with 3.8% and Singapore with 3.8%. Fifty per cent of the articles studied were published in 2022.

The studies retrieved were mainly directed at the use of AI in libraries in general terms, although it is possible to find studies focused on academic, medical, national, and public libraries. In terms of journals, 18.75% are librarianship journals related to technology. As far as publishers are concerned, a variety of institutions can be observed with no marked trend. In the case of funding, the articles came from programmes and projects, academic institutes, research agencies, ministries and funds, and the keywords assigned to these were mainly *artificial intelligence* or *AI*, *machine learning* and *natural language processing*. From the keywords observed in this research, it can be noted that there is a lack of standardisation in terms of research on libraries and AI tools. Both in the keywords and in the abstracts of the articles, there are no standardised terms, which could optimise the search for this type of research on similar topics, if present.

As regards the limitations of the study, language and the definition of each country's legislation types could compromise the quality of the data due to the translation and administrative differences between each nation, while relating to the articles per se, there are no normalised types of AI yet. Another limitation is that part of the documents corresponds to debate and opinion about the topic. Because this study focused on practical use, these were not included, nor were documents under payment requirement. Both are pertinent topics to analyse in future research, as the metrics of other types of documents.

In general terms, the study of the use of AI in libraries is beginning to make its way into the research pipeline for LIS as a set of tools for the development of information units subject to scrutiny and debate about the applications and uses of AI.

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