Journal of Information Systems and Informatics
Vol. 6, No. 4, December 2024 e-ISSN: 2656-4882 p-ISSN: 2656-5935
DOI: 10.51519/journalisi.v6i4.928 Published By DRPM-UBD

Evolution of AI in Information Systems: A Bibliometric Study

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Abstract

Significant challenges for traditional information systems are posed due to the ever-growing volume and complexity of data. Artificial intelligence has emerged as a powerful solution to address these challenges by adapting and making intelligent decisions. Valuable insights can be gained from data to automate repetitive tasks and optimize the operations. This study examines how the researchers are concentrating to explore multifaceted impact of AI on the design, implementation, and optimization of information systems. AI is transforming the landscape of information systems with progresses in machine learning, text mining, cognitive computing and other AI technologies by enhancing the efficiency and adaptability across various domains. This study delves into this emerging landscape by conducting a comprehensive bibliometric analysis of Artificial intelligence in Information systems research. This bibliometric study retrieved a dataset of publications from Scopus database spanning from 1960 to 2023 to find out the insights hidden within the scientific papers. The analysis encompasses key bibliometric indicators, such as citation patterns, co-authorship networks, and thematic clusters etc. to represent historical development of research in Artificial intelligence within the context of Information systems. This study fills a gap in AI and IS literature, drawing on 306 publications, with key contributions from the USA, China, UK, Germany, India and leading authors like OGIELA L (Lidia Ogiela) and CIMINO JJ (James J. Cimino). Co-authorship networks highlight the dominance of collaborative research hubs in countries like USA, China, Canada, Australia, while citation patterns underscore the influence of seminal works and cross-disciplinary contributions. The findings presented in this paper offer valuable insights for researchers, practitioners, and policymakers seeking a deeper understanding of the growing AI-IS landscape. As this is the first paper which takes the attempt to conduct a bibliometric analysis on artificial intelligence in information systems, this paper serves as a roadmap for navigating the rich tapestry of research, fostering collaboration, and guiding future investigations in this rapidly evolving and interdisciplinary field.

Keywords: Artificial intelligence, Information systems, Bibliometric analysis, R, VOSviewer

1. INTRODUCTION

Artificial Intelligence is indispensable in the realm of information systems, offering a multitude of benefits that significantly elevate operational capabilities. Artificial intelligence enables computers to deal with and evaluate massive amounts of data, enabling them to recognize trends and findings that would be impossible for people to detect [1, 2]. AI has the ability to comprehend user preferences and adjust content and recommendations based on that information, allowing for more personalized interactions with information systems. This improves the adoption and utilization of the system by increasing user satisfaction and engagement [3].

A significant impact of AI on information systems is improved decision-making. AI-based machine learning algorithms can rapidly evaluate enormous amounts of data, find patterns, and predict. This capacity greatly increases information system's decision-making quality and speed. From predictive analytics to automated decision support systems, AI helps organizations make data-driven decisions for better results [4]. AI-driven bots have the capability to streamline repetitive operations, hence lessening the burden on human operators and enhancing the overall efficiency of the system [5]. AI systems that are equipped with natural language processing (NLP) have the ability to comprehend and decipher human language. This allows for the implementation of features such as voice recognition, sentiment analysis, and language translation inside information systems [6, 7].

While various articles have delved into specific facets of AI and its applications in information systems [8-11], there is a notable absence of a comprehensive bibliometric analysis capable of assessing existing research trends and the overall progression of this field. To address these gaps, this study aims to perform a bibliometric analysis of artificial intelligence in information systems, identifying major trends, leading authors and journals, emerging research topics, and collaborative networks, and highlighting gaps for future research.. Notably, this marks the first endeavor of its kind to undertake such an extensive bibliometric and network analysis. The aspiration is that scholars, researchers, and industry professionals can draw insights from this research, inspiring them to embark on further investigations into the application of AI in the domain of information systems.

2. RESEARCH METHODOLOGY

2.1. Data source and Search strategy

Bibliometric methods, often known as "analysis," are increasingly widely used in research evaluation, particularly in scientific and practical disciplines [12-15]. The

scholarly literature for this bibliometric study was gathered from the world-renowned online library database "SCOPUS" on October 25, 2023. This study retrieved a total of 343 items based on the search query shown in Table 1. Following exclusions, 306 (Table 2) papers were selected for bibliometric analysis in the current study. The study just utilized the terms "AI OR Artificial Intelligence" and "IS OR Information System" exploring several keyword combinations in order to thoroughly address certain elements. Applying inclusion and exclusion criteria led to the identification of 306 research publications as unique and relevant; 37 publications were subsequently eliminated from the study.

Table 1. Search results of publications.

Keywords	Search Results (no. of articles)
KEY (("AI" OR "Artificial Intelligence") AND ("IS"OR "Information Systems))	343

Table 2. Filtered and refined results of publications.

Keywords	Filtered Results (no. of articles)
KEY (("AI" OR "Artificial Intelligence") AND ("IS"OR "Information Systems))	306

2.2. Research Protocol

In the first step (Figure 1), a keyword selection process was carried out to define the search terms. In the searching process the fields like title, abstract and keywords are considered. The study focused on literature from the renowned database SCOPUS, collected on October 25, 2023, covering 343 relevant publications from various disciplines. The selection criteria included articles, reviews, and conference proceedings, with exclusions applied for irrelevant or off-topic studies. Documents such as working papers, industry white papers, non-English articles, and duplicate papers, were eliminated in order to maintain the study's consistency within the scope of artificial intelligence in information systems. In this manner, each chosen article was carefully examined, and those that had a strong connection to artificial intelligence in the field of information systems were added. The 306 (288 articles & 18 review papers) papers for the analysis were chosen following the completion of the mentioned inclusion and exclusion criteria.

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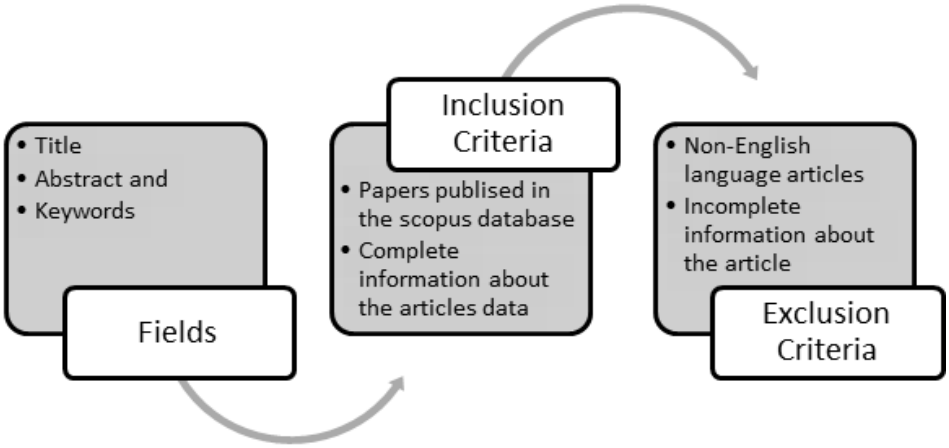

Figure 1. Searching, inclusion and exclusion criteria of the collected articles

2.3. Type of Documents

The collected articles in Table 3 highlights the significant role of journal publications in the field of artificial intelligence (AI) in information systems. Articles, as a type of document, are considered the most detailed and reliable sources of academic information. They are typically peer-reviewed, ensuring the quality and credibility of their content. In AI research, journal articles offer in-depth insights, including comprehensive methodologies, results, and discussions that contribute to a deeper understanding of the subject. The table likely specifies the number of journal articles collected, shedding light on their importance within the dataset. This figure not only reflects the prominence of articles in academic literature but also emphasizes their value in contributing to the scholarly discourse on AI in information systems. Articles are often central to research because they represent the culmination of rigorous academic work and are widely cited, indicating their influence in the field.

In comparison to other document types, such as conference papers or books, articles may dominate the dataset due to their comprehensive nature and high scholarly impact. They provide valuable contributions that guide future research and inform practical applications of AI in information systems. This dominance also underscores the preference of researchers to rely on peer-reviewed articles for reliable and validated information. Overall, journal articles play a pivotal role in advancing knowledge in AI and information systems. Their inclusion in the dataset highlights their importance in capturing critical developments, theoretical advancements, and innovative applications in the field. Understanding their contribution helps to evaluate the trends and scope of AI research within the broader context of information systems.

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Table 3. Main information about the collected articles of artificial intelligence in information systems

Main information	Explanation	No.
Timespan	Period of time	1960:2023
Documents	Total number of articles	306
Sources (Journals, Books, etc.)	The frequency distribution of sources (journals, books, etc.)	235
Annual Growth Rate	No of publication growth per year (%)	6.07
Average citation	Per doc citation	17.53
Author's Keywords	Total number of keywords	908
Authors	No. of total authors	866
Authors of single authored articles	The number of single author per articles	61
International Co-authorship	Percent of international co-publication (%)	20.59
References	Total references used by authors	11261
Document type		
Article		288
Review		18

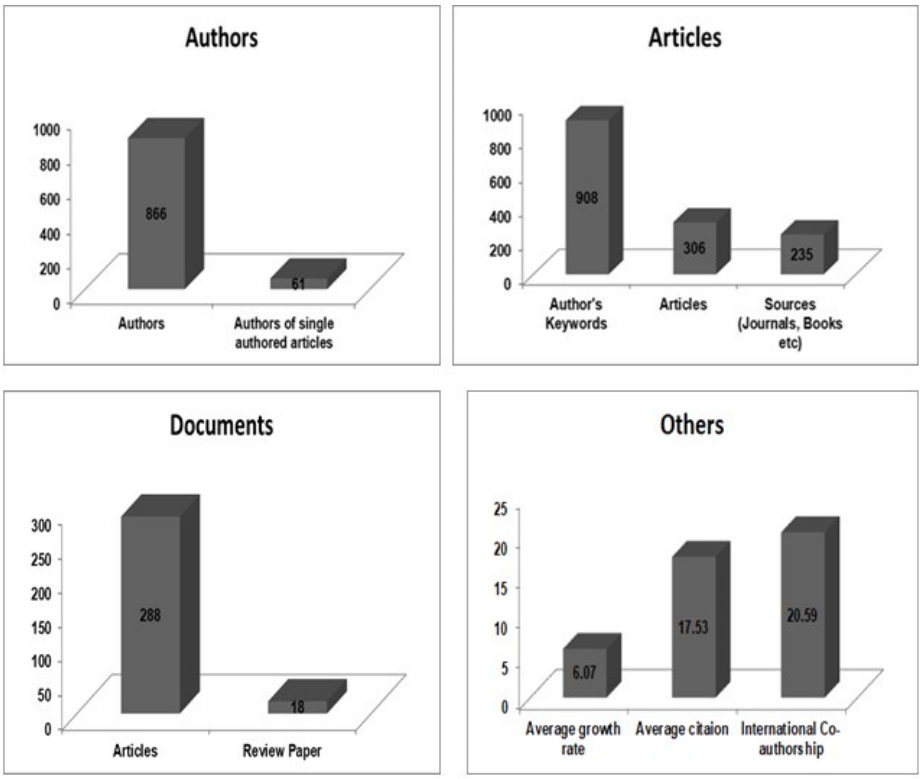

Figure 2. Main information about the collected articles of artificial intelligence in information systems

The descriptive information for the selected articles is presented in Table 3 & Figure 2. These 306 research articles were published by 866 authors who were working in the field of artificial intelligence's influence on information systems. Single authors contributed for 61 of those articles. Co-authorship in artificial intelligence in information systems has been placed at 20.59% on a global scale.

2.4. Bibliometric Analysis

In this study, the R and VOSviewer Bibliometrix package was used for analysis and visualization which can be utilized as part of a broader data analysis procedure [16-18]. R uses annual production, citation, co-citation, and co-authorship analysis with tools like bibliometrix, while VOSviewer focuses on visualizing networks like term co-occurrence and bibliographic coupling using clustering and density mapping. During the data collection stage, data was retrieved from the scopus database by loading and converting to CSV format. The data was analyzed to offer descriptive information such as notable authors, journals, countries, affiliations, and so on. In the final stage, data was visualized using network analysis. The parameters for VOSviewer were as follows: Use the fractional counting approach and limit the number of writers per document to 25.

3. RESULTS AND DISCUSSION

3.1. Analysis of yearly Research Volume

During 1960-1990 in Figure 3, AI in Information Systems garnered limited attention, with researchers exploring foundational concepts and theoretical frameworks. The scarcity of publications during this period suggests a nascent stage in the integration of AI technologies into information systems. During, 1990-2010 witnessed a gradual increase in publications, reflecting a growing interest in the practical applications of AI within information systems. Researchers delved into developing algorithms and models, laying the groundwork for subsequent advancements. From 2010 onwards, there has been an exponential rise in the number of publications, indicating a remarkable surge in interest and research activity. The total annual growth rate of 6.07% from 1960 to 2024 highlights the accelerating pace of research in AI and Information Systems

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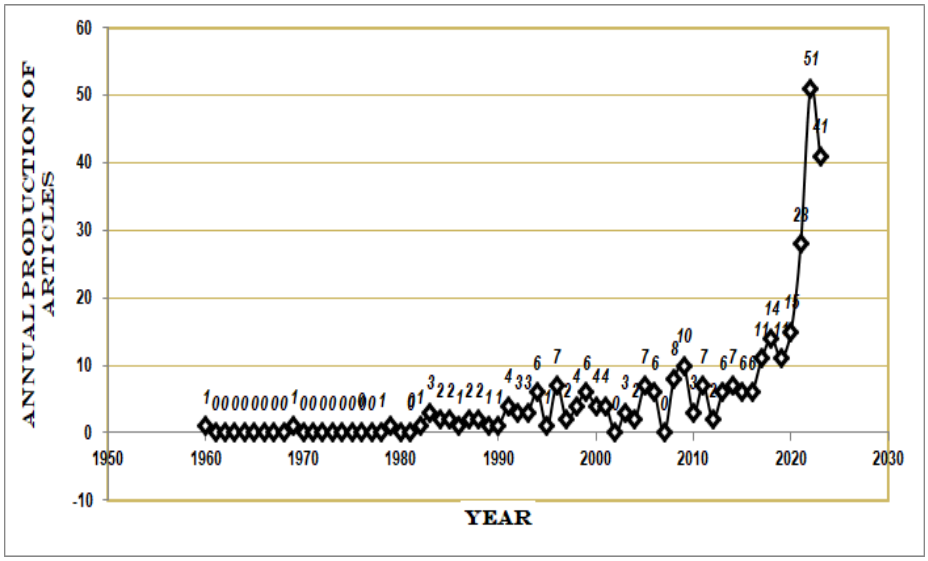

Figure 3. Yearly research volume of artificial intelligence in information systems

3.2. Authors who are highly productive and influential

By examining the overall number of publications in Table 4, it determined the author who has produced the highest quantity of research as well as the author who has had the greatest impact, as measured by the total amount of citations, in the era of AI in Information systems. The research findings indicate that OGIELA L (Lidia Ogiela) is the author with the highest productivity in the domain of AI in information systems, having published 4 articles and received 111 citations. On the other hand, CIMINO JJ (James J. Cimino), who is affiliated with Department of Medical Informatics, Columbia University, is the most renowned author in this field, with a total of 193 citations.

Table 4: Top productive and contributing authors of Artificial Intelligence in Information Systems

Rank	Authors	Affiliation	Country	h_index	TC	NP	PY_start
1	OGIELA L (Lidia Ogiela)	AGH University of Science and Technology	Poland	4	111	7	2008
2	IONESCU L (Luminița Ionescu)	Faculty of Economic Sciences, Spiru Haret University	Romania	3	54	4	2019
3	SIAU K (Keng Siau)	University of Nebraska-Lincoln	United States	3	62	4	2005
4	CIMINO JJ (James J. Cimino)	Department of Medical Informatics, Columbia University	United States	2	193	2	1996
5	CONBOY K (Kieran Conboy)	National University of Ireland, Galway	Ireland	2	162	2	2021

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Subsequently, this inquiry explored the collaborative network among writers who have had their publications published in the domain of artificial intelligence in information systems (Refer to Figure 4). The size of each node corresponds to the number of published papers, while the relationship between two authors represents their collaborative effort [19]. The collaboration network exhibits five distinct clusters based on authors, shown by different colors. The largest cluster is depicted with red color, the members of this cluster are Lidia Ogiela and Marek R. Ogiela and on all of their top-tier scientific papers, they worked together. Additionally, collaboration has been observed for other clusters as well.

Figure 4. Cluster of author's collaboration in artificial intelligence in information systems

3.3. Major journals for the published articles

A comprehensive list of reputable journals has been compiled that regularly publish scholarly articles in the emerging topic of artificial intelligence within the realm of information systems. According to the analysis, a total of 306 publications were published from 235 journals that were considered significant. Furthermore, 40 papers were published in the top 10 journals. Figure 5 presents the top 10 journals in the field of artificial intelligence in information systems. Among these journals, the most prominent sources are (i) Communication of the association for information systems (6 articles) (ii) Enterprise information systems (5 articles).

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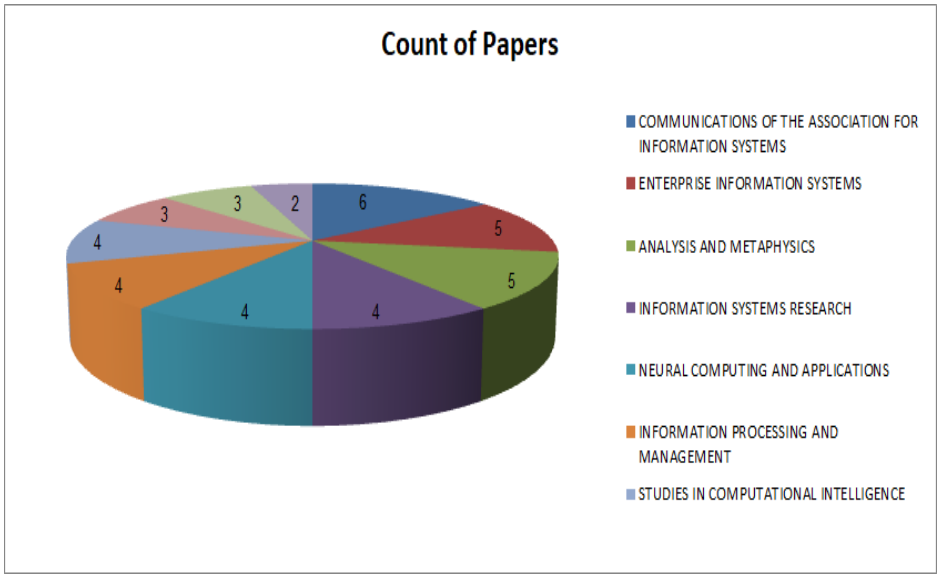

Figure 5. Top 10 journals for the published articles of artificial intelligence in information systems

3.4. Country-specific analysis of the articles

This ranking of countries in Table 5 was performed by utilizing R programming (Bibliometrix package) to take into consideration the cumulative count of publications for each country. The United States of America comes in first place, followed by China, Germany, India and United Kingdom.

Table 5. Top 5 highest productive countries of the articles of artificial intelligence in information systems

Rank	Country	Articles
1	USA	212
2	China	136
3	Germany	37
4	India	36
5	United Kingdom	35

Additionally, Figure 6 illustrates the global geographic distribution, which demonstrates how organizations and research centres from various countries are interested in artificial intelligence in information systems domain. The color shade of each country indicates the number of publications in that country, with the darker the color, the greater the number of publications in that country.

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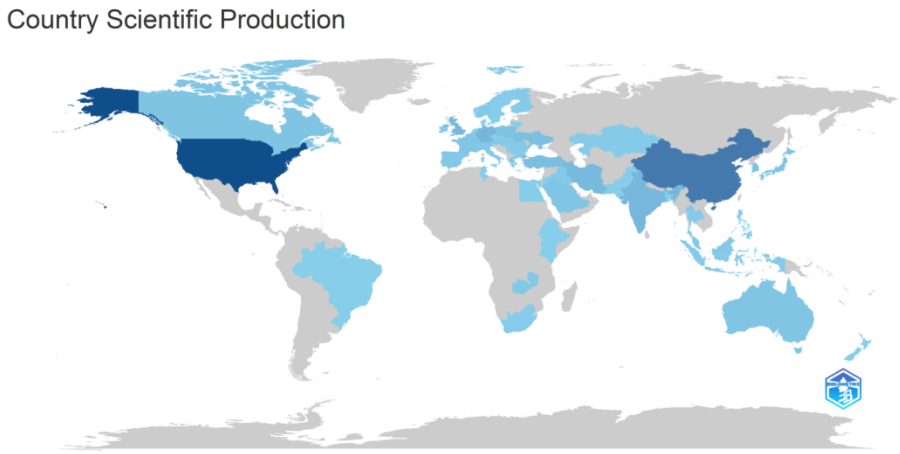

Figure 6. Geographical production of the articles of artificial intelligence in information systems

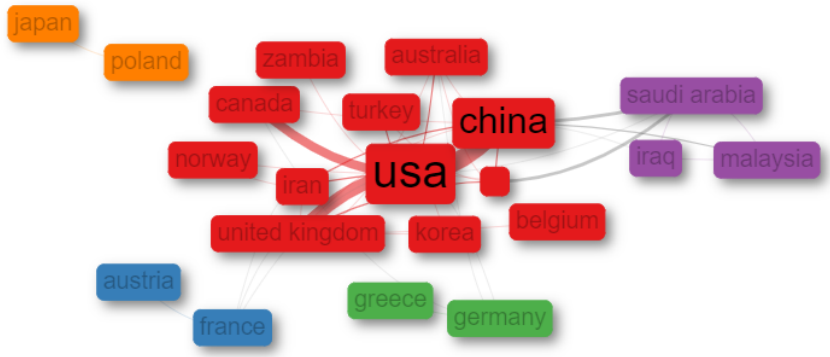

Figure 7. Cluster of collaborative countries of the articles of artificial intelligence in information systems

Subsequently, the collaboration networks established between nations have been identified in the realm of artificial intelligence in information systems. The network's associated countries that were not connected were excluded and retained for subsequent research. Figure 8 illustrates the countries that engage in collaborative efforts in the discipline of artificial intelligence in information systems. The node's size represents the combined number of publications, while the thickness of the linkages indicates the intensity of collaboration between countries. The collaborative clusters in Figure 7 are represented by different colors, with the USA dominating the Red cluster which is the largest cluster in the network.. The United States and China have the largest node size, indicating

their significant contribution to the country's publication count in the area of artificial intelligence in information systems.

3.5. Analysis of affiliations of the authors

Through this investigation, the most auspicious institute(s) has been found specializing in artificial intelligence in the realm of information systems. The top 10 affiliations were introduced whose academics have made a substantial number of contributions in terms of articles (refer to Table 6). AGH University of Science of Technology secured the first position with a total of 10 papers. Stanford University in United States is ranked second among the top contributing universities with 7 papers.

Table 6. Top 10 highest productive affiliations of artificial intelligence in information systems

Rank	Affiliation	Articles
1	AGH University of SCience and Technology	10
2	Stanford University	7
3	University of Evora	7
4	King Abdulaziz University	5
5	Chi Mei Medical Center	4
6	Indiana University	4
7	Kashan University of Medical Sciences	4
8	Kerman University of Medical Sciences	4
9	KYIV National University of construction and architecture	4
10	Ondokuz Mayis University	4

Institutional collaboration plays a crucial role in advancing research and innovation in the field of Artificial Intelligence (AI) in Information Systems. Bibliometric analysis of the relevant literature reveals that interdisciplinary partnerships between academic institutions, research centers, and industry are key drivers of progress. In Figure 8, there are 4 main clusters of institutions collaboration – Red, Blue, Green and Purple. The Red cluster represents the largest cluster and maximum nodes which indicate highest frequency of collaborate among the institutions of this cluster.

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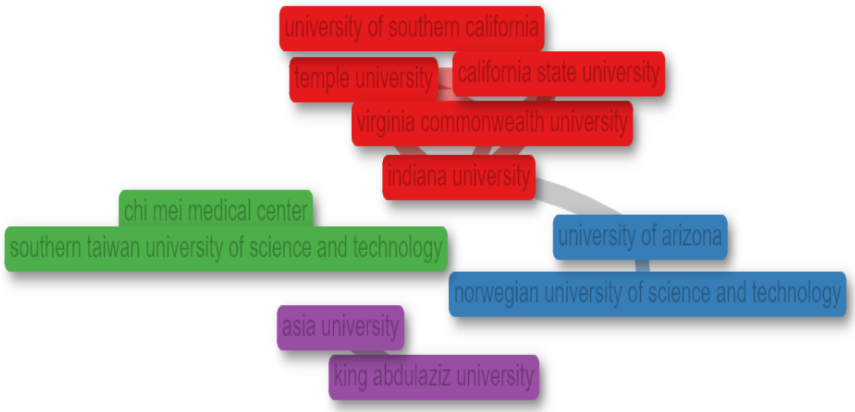

Figure 8. Institutional collaboration of the articles of artificial intelligence in information systems

3.6. Keyword Analysis

In order to create the word cloud in Figure 9, the following keywords were omitted from the analysis: artificial intelligence (AI) and information systems. This was done because these terms were used in the initial searches and article extractions. A few terms that were identical to one another were also omitted in order to avoid word plot redundancy. Following that, Figure 11 illustrates a word cloud that is made up of the 25 keywords that appear the most frequently, each of which was taken from a total of 306 articles.

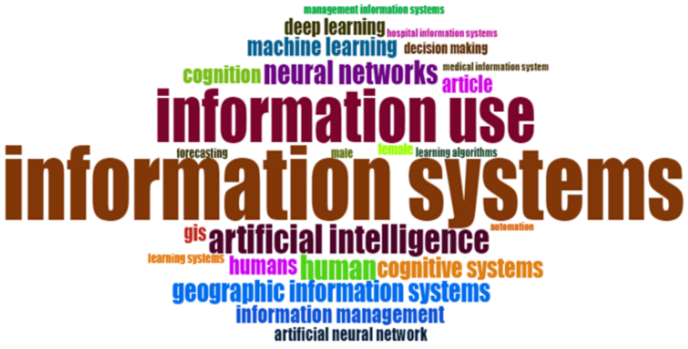

Figure 9. Top 25 author keywords of the articles of artificial intelligence in information systems

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3.7. Citation analysis of the articles

Citation analysis is performed in this study to figure out the frequency with which a certain article has been referenced in other academic works. Table 7 lists the top 8 papers based on the number of global citations. This table demonstrates that the field is still evolving and that scholars from various disciplines have not yet given it sufficient consideration.

Table 7. Top 8 papers based on citation measure of artificial intelligence in information systems

R_k	Papers	LC	GC	LC/GC Ratio (%)	NLC	NGC
1	[20]	2	12	16.67	11.2	0.99
2	[21]	2	107	1.87	7.5	7.54
3	[22]	2	36	5.56	6	1.76
4	[23]	2	32	6.25	7	0.82
5	[24]	2	36	5.56	3	1.96
6	[25]	1	10	10	5.6	0.82
7	[26]	1	11	9.09	6	1.05
8	[27]	1	15	6.67	5.6	1.23

Note: Rk mean Rank which is determined by citation measure, " LC: Local citation, GC: Global citation, NLC: Normalized local citation, NGC: Normalized global citation"

3.8. Journals co-citation analysis

Analyzing the journal co-citation network helps analyze the subject's structure and publication features. Figure 10 depicts a 27 node network of journal citations. The node size represents the journal's activity, i.e. the number of published articles on the subject. By analyzing the nodes, there may determine the number of citations between journals, with greater proximity indicating higher frequency. Five prominent clusters can be identified; the network shows that there is a higher number of citations between journals such as "MIS Quarterly," "Information Systems Research", "Information Management," "Journal of Management Information Systems," "International Journal of Information Management," and due to their proximity to each other.

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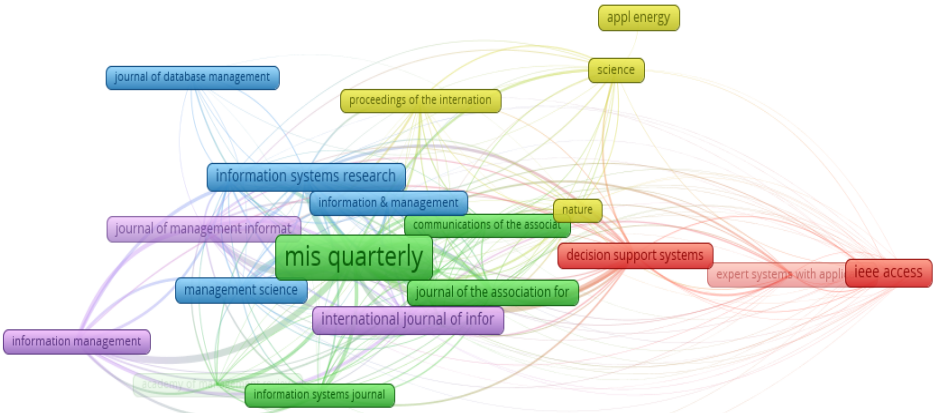

Figure 10. Journals co-citation analysis network of artificial intelligence in information systems

3.9. Co-occurrence network of keywords

In Figure 11 , Cluster 1visually indicated by the color Blue, is the most significant cluster in the keyword co-occurrence network. This cluster comprises a total of 10 nodes. It is evident that this cluster exhibits a moderate level of coherence inside the cluster. The two most prominent terms in this cluster are AI and machine learning and information systems. Cluster 2, distinguished by its Red color, consists of 3 nodes and is the next important grouping. The primary focal points in this cluster are hospital information system, cognitive walkthrough and intrusion user-computer interface. Cluster 3, often known as the Green cluster, consists of 3 nodes and the primary keywords linked to this cluster are gis, ann and neural networks.

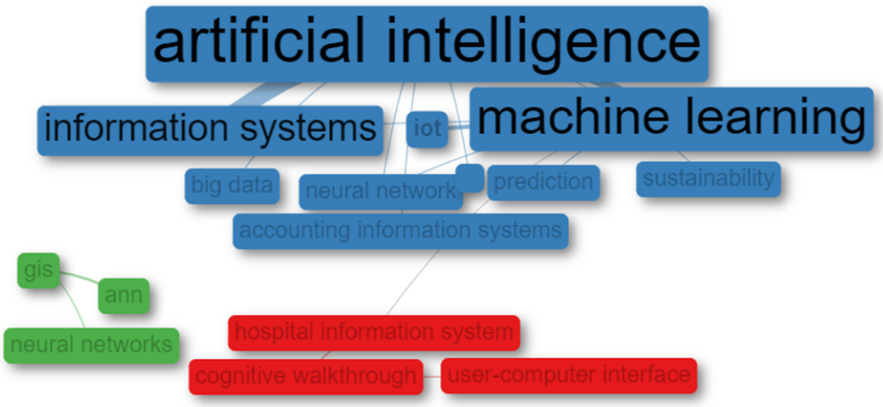

Figure 11. Top keywords of artificial intelligence in information system's co-occurrence network

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3.10. Keywords trends of the articles

In order to examine the trend of annual keyword usage, we calculated the number of times every keyword appeared in the gathered research articles and displayed the findings in Figure 12. Artificial intelligence, Information systems, Artificial neural network, Geographic information system, deep learning, machine learning and similar terms have recently seen a surge in popularity among those working in artificial intelligence and information systems, according to this research.

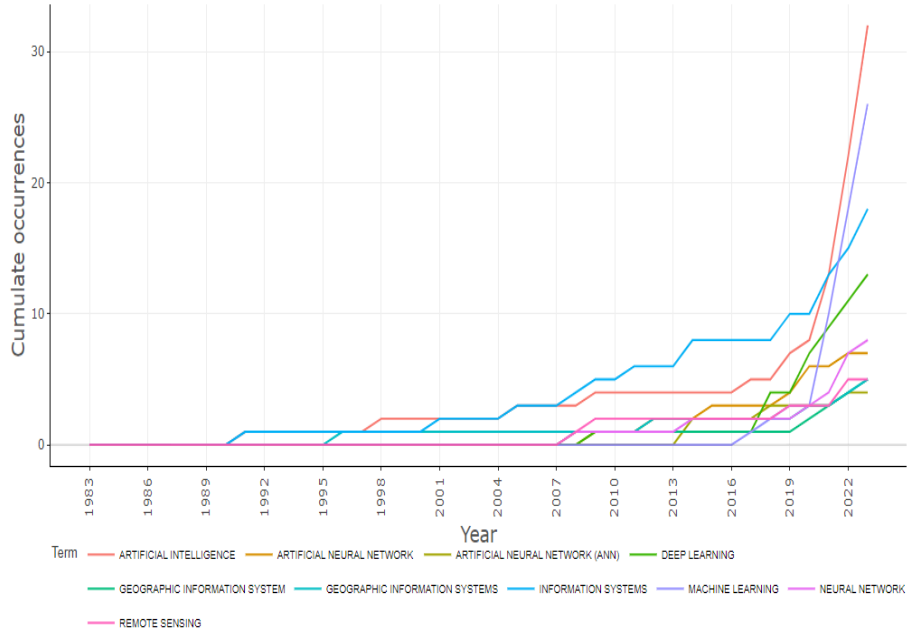

Figure 12. Top 10 trending keywords of the articles of artificial intelligence in information systems

3.2. Discussion

This study explores the trends, impact, and evolution of research in this interdisciplinary domain. It involves examining scholarly publications, citations, and collaborations to identify influential works, prominent authors, and key thematic areas. During 1960-1990, AI in Information Systems garnered limited attention but 1990-2010 witnessed a gradual increase in publications. From 2010 onwards, there has been an exponential rise in the number of publications in AI in information systems, indicating a remarkable surge in interest and research activity. The research findings indicate that OGIELA L (Lidia Ogiela) is the author with the highest productivity and CIMINO JJ (James J. Cimino) is the

author with highest citation. According to the analysis, a total of 306 papers were published from 235 journals that were considered significant. The United States of America comes in first place with highest number of production. Through this investigation, AGH University of Science of Technology has emerged as the most auspicious institute in this domain. In the citation analysis, there is a higher number of citations between journals such as "MIS Quarterly," "Information Systems Research", "Information Management," etc.

This study reveals unique trends when compared to studies in related fields like machine learning (ML) and data science. While ML research is heavily concentrated on algorithmic advancements and often led by tech giants [20] and data science emphasizes big data applications with strong industry ties [18, 28], AI in IS focuses on integrating AI into business and organizational contexts. The findings suggest the potential for more equitable global collaboration and the opportunity to learn from the strengths of related fields, fostering innovation in AI applications for organizational decision-making and societal impact[19].

4. CONCLUSION

The present article makes a distinct contribution to the existing body of knowledge in the fields of artificial intelligence and information systems. It is well recognized that simply applying a concept does not yield substantial results unless its performance is thoroughly and systematically evaluated. Technology inherently drives change, and change is, by nature, in a state of flux. Therefore, it becomes essential to explore, comprehend, and deliberate upon the current state of artificial intelligence and its future prospects.

This bibliometric analysis of artificial intelligence (AI) within information systems (IS) provides a comprehensive overview of the trends, influential publications, key authors, and research themes shaping the landscape of AI in IS research. Over the last few decades, AI integration into information systems has profoundly revolutionized both domains, promoting innovation across enterprises and academic disciplines. The findings show that there is a growing interest in AI-driven solutions, as seen by an exponential increase in publications in fields such as machine learning, data analytics, and decision support systems. AI in information systems can guide funding by highlighting emerging trends and research gaps, helping funders prioritize impactful areas. It informs policy by identifying AI ethics, privacy, and governance concerns, aiding in the creation of effective regulations. The analysis also fosters interdisciplinary collaborations, linking AI with fields like computer science, economics, and management. Expanding the analysis to include healthcare and education applications would offer further insights, guiding funding and policy in these rapidly growing sectors.

5. LIMITATIONS AND FUTURE RESEARCH DIRECTIONS

This bibliometric analysis on artificial intelligence (AI) in information systems (IS) has several limitations like dependency on a single database (Scopus). This has also faces language bias as well as the reliance on citation-based metrics, which may not able to provide the dynamic nature of AI, also may not capture qualitative insights. The analysis's period can possibly leave out important advancements in the field. Future study should broaden the scope to address these issues by combining several databases and carrying out longitudinal studies to track patterns over time. Future bibliometric research should address language bias and reduce reliance on citation-based metrics by promoting inclusivity, diversifying evaluation criteria, and incorporating more comprehensive and equitable methodologies. Furthermore, integrating thematic techniques with bibliometric analysis may provide deeper understanding of developing subfields and useful applications. Understanding can be further improved by investigating international research collaborations, ethical issues, and creating real-time updates for bibliometric analysis. Future bibliometric research could be enhanced by AI tools themselves by utilizing machine learning and natural language processing to provide more thorough and accurate analysis.

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