sciendo

Digitalization and the Innovation of Artificial Intelligence: A Systematic Review

Georgiana-Alina CRIȘAN
Bucharest University of Economic Studies, Bucharest, Romania
crisangeorgiana18@stud.ase.ro

Andrei-Alexandru SUCIU*
Bucharest University of Economic Studies, Bucharest, Romania
**Corresponding author, suciuandrei24@stud.ase.ro*

Adrian DOMENTEANU
Bucharest University of Economic Studies, Bucharest, Romania
domenteanuadrian18@stud.ase.ro

Mădălina Ecaterina POPESCU
Bucharest University of Economic Studies, Bucharest, Romania
The Romanian National Scientific Research Institute for Labour and Social Protection
madalina.andreica@csie.ase.ro

Abstract. *The implementation of new technologies comes with the use of digitalization and Artificial Intelligence (AI) as core drivers. AI, including machine learning and deep learning, thrives in digitally mature environments with robust infrastructures and vast data availability With respect to AI innovations, digitalization is equally important because it provides the necessary computation power, data frameworks, and even the network systems needed to spearhead innovations. However, global disparities exist, with the United States and China excelling in AI commercialization, while Europe leads in academic research but struggles with industry adoption due to fragmented policies and inconsistent investment in AI-driven enterprises. This study conducts a systematic bibliometric analysis to examine the relationship between digitalization and AI research productivity. Using data from the Web of Science Core Collection, bibliometric techniques such as keyword co-occurrence analysis, citation network mapping, and thematic clustering were applied to assess AI research trends and their connection to digitalization. Responding to the outlining issue: How has digitalization influenced AI research evolution, and what are the key bibliometric trends? Findings confirm that digitally advanced regions lead in AI research output, while Europe faces commercialization challenges due to regulatory constraints and weak industry-academia collaboration. This study offers a novel contribution by integrating bibliometric analysis with policy insights to examine AI commercialization challenges, a dimension that has received limited attention in prior systematic reviews. This analysis points to insufficient academic activity and industrial adoption and calls for collaboration, dedicated policies for AI, and infrastructure investments. This helps policymakers focused on AI innovation as well as those in charge of AI governance and business leaders aiming to improve industry competition and commercialization.*

Keywords: Artificial Intelligence, Digitalization, Bibliometric Analysis, Bibliometrix, Digital Transformation.

DOI: 10.2478/picbe-2025-0211

Introduction

In the last several years, the fields of Artificial Intelligence (AI) and digitalization have both dramatically advanced, transforming industries, economies, and the global landscape of research. The application of AI systems which include algorithms like machine learning, deep learning, and even more sophisticated neural networks, is now prevalent in healthcare, finance, the supply chain, even in public governance. (Russell et al., 2020) (Heaton, 2017). Digitalization, defined as the integration of digital technologies into economic and social processes, has accelerated AI adoption by enabling vast data generation, cloud computing, and enhanced connectivity (Brennen & Kreiss, 2016) (Matt et al., 2015). These two technological paradigms are interdependent, with digitalization serving as the infrastructure and data ecosystem necessary for AI models to thrive (Bughin et al., 2018) (European Commission, 2022).

AI development and adoption remains uneven across the world. The United States and China have positioned themselves as frontrunners in AI advancements due to significant private funding, government created AI policies, and active participation of industries and universities (Stanford AI Index, 2023) (OECD, 2024). Europe suffers from insufficient commercialization of AI technology industrial deployment and venture capital funds in AI due to lack of unified policies as well as complicated regulatory frameworks despite excelling in academic publications on AI (European Investment Bank, 2023) (European Court of Auditors, 2024)

To bridge these gaps, the European Union (EU) has introduced various policy initiatives to strengthen AI development and digital infrastructure, including the (European Commission, 2010), (European Commission, 2020), and the Coordinated Plan on Artificial Intelligence. These strategies emphasize investment in AI, digital education, and public-private partnerships to stimulate AI innovation (European Commission, 2021).

Due to the nature of AI and digitalization as two interlinked, complex fields, a combination of bibliometric and network analysis will best showcase the dimensions of intellectual structure, evolution and trends within these domains. Bibliometric methods allow researchers to map scientific impact, co-authorship networks, and citation patterns, offering insights into the knowledge flow within AI and digitalization research (Zupic & Čater, 2015) (Donthu et al., 2021). This study leverages bibliometric analysis to explore how digitalization has influenced AI innovation over time.

The main research question guiding this study is:

RQ1: how has digitalization influenced the evolution and impact of AI research, and what are the key bibliometric trends in AI and digitalization literature?

To address this, the study conducts a systematic bibliometric analysis of AI and digitalization, examining publication trends, citation networks, and keyword co-occurrence to map the intellectual structure of the field. It assesses the global research landscape by comparing contributions across countries, institutions, and collaborations, highlighting regional disparities in AI research productivity and commercialization.

This paper starts with an introduction that describes the context of the study and provides the objectives. The literature review contains primary gaps and hypotheses in defined studies, while the methodology specifies the bibliometric methods used. Finally, the results and discussion portions analyze the publication trends, citation networks, thematic clusters, and offer insights. The abstract outlines the insights, consequences, and proposed directions for later work.

Literature review

The shift to a digitalized society remains a critical point within research and policy circles. Initiatives aimed at improving digital skills and innovation, entrepreneurship and employment were put forth by the European Commission in 2010 along with other innovations marking an effort towards building a digital economy (European Commission, 2010). A subsequent initiative, (European Commission, 2020), extended these efforts by addressing critical issues such as cybersecurity, sustainability, and investment in emerging technologies like blockchain, digital education, and AI (European Commission, 2021).

Digital transformation has been studied with emphasis on digital maturity frameworks and innovation ecosystems as major enablers of success (Warner & Wäger, 2019). Organizations that effectively integrate AI within their digitalization strategies are more likely to adapt to market changes, optimize workflows, and maintain competitive advantages (Srai & Lorentz, 2019). The adoption of AI in enterprises is further examined by (McKinsey & Company, 2024), which reports that companies with advanced digital systems experience substantially higher productivity benefits from AI than companies with poorly developed digital systems.

McClure (McClure, 2018) explores AI's impact on labor markets, highlighting concerns over automation-driven job displacement and financial insecurity. However, other studies emphasize the economic benefits of AI, particularly in domains such as supply chain resilience and business performance optimization (Belhadi et al., 2021). A systematic review by (Culot et al., 2024) shows that AI-assisted applications such as machine learning algorithms for forecasting demand, optimization models for inventory control, and smart logistics systems greatly enhance the responsiveness of the supply chains. The results are consistent with previous systematic review studies that conclude that application of AI in digitalized supply chains brings considerable advantages in the long run, especially in times of market volatility.

The relationship between digitalization and AI innovation has been widely studied. Several researchers argue that AI development is directly dependent on digital infrastructure (Bughin et al., 2018). Countries with high levels of digital investment—such as broadband expansion, cloud computing, and data analytics—tend to produce more high-impact AI research (OECD, 2024). Digitalization enables AI advancements by providing computational power, large-scale data access, and connectivity (Donthu et al., 2021).

This leads to the first hypothesis:

H1: *Higher levels of digitalization are associated with greater AI research productivity and innovation.*

While Europe excels in AI research, its impact on global AI leadership remains limited. It has been claimed that the main commercialization of AI research is mainly taking up by the US along with China as a result of huge capital investment, national AI policies, and high levels of public private partnership (Zeng, 2021) (Ding, 2020). The US has the advantage of Silicon Valley's well-established AI ecosystem, while China is propelled by the state-led strategy for AI, allowing swift adoption of AI capabilities in diverse sectors (Stanford AI Index, 2023).

In contrast, Europe struggles with fragmented AI policies, inconsistent funding mechanisms, and weak AI collaboration between industry and academic entities (European Investment Bank, 2023). The European Court of Auditors notes that despite significant AI-related research funding, Europe struggles with AI startup creation, AI patent filings, and AI venture capital investment (European Court of Auditors, 2024).

This leads to the second hypothesis:

H2: *Europe produces a high volume of AI research but lags in AI innovation and commercialization compared to the US and China.*

Bibliometric analysis has emerged as a key method for mapping research trends, assessing academic impact, and identifying collaboration networks in various scientific fields. Zupic & Čater (2015) provide a foundational framework for bibliometric studies, outlining techniques such as citation network analysis, keyword co-occurrence mapping, and thematic clustering. Donthu et al. (2021) further expand on these methodologies, emphasizing their application in business and technology research, including AI-related fields. These works confirm the effectiveness of bibliometric analysis for studying research landscapes, but they do not address the impact of digitalization on the AI commercialization, which is the primary focus of our research.

Recent bibliometric studies highlight the use of Artificial Intelligence in the context of Digital Transformation, analyzing the publication trends, thematic structures, and collaboration patterns. Frankowska and Pawlik (Frankowska & Pawlik, 2022) conducted a bibliometric analysis of AI research within the EU, mapping regional research productivity and highlighting disparities in commercialization. Kovač et al. (Kovac et al., 2024) explored the integration of AI and digitalization across various European industries, demonstrating how different sectors are adopting AI technologies in their digital transformation efforts. While these studies provide valuable insights into AI research trends and industry adoption, they do not explicitly examine how digitalization influences AI commercialization trajectories or assess the structural gaps preventing research from being translated into market applications. This study addresses these gaps by integrating bibliometric techniques with policy insights to evaluate how digitalization facilitates AI research evolution and its impact on commercialization across different regions.

Our work builds on the previous research conducted on the topic and adds policy context to the study of how digitalization shifts the trends of AI commercialization, especially in areas with weak industry-academia collaboration. By integrating bibliometric techniques with policy analysis, we provide a novel contribution that bridges the gap between research productivity and economic impact.

Methodology

In order to achieve the paper's purpose, we applied a bibliometric analyses methodology consisting of: (1) extraction of documents in the field; (2) analysis on aspects like dataset analysis, sources, authors, countries and keywords; (3) discussion based on the results; (4) conclusions and limitations. This approach complies with the widely used PRISMA guidelines (Linares-Espinós et al., 2018) (Snyder, 2019).

The steps followed in the data extraction process are presented in Table 1. The data source is Clarivate Analytics' Web of Science Core Collection, also known as Web of Science (WoS), a database that is regarded in the academic community to be highly relevant to bibliometric research due to the wide range of journals and subjects it covers, according to Bakir et al (Bakır et al., 2022). This is further supported by other bibliometric studies in the sphere of technological advancement (Domenteanu et al., 2025; Sandu et al., 2024). The search was performed based on filters related to specific terms. For digitalization, the keywords included "digitaliz*", "digitalis*", "internet_access", "digital_econom*" and "society_index". For artificial intelligence, the search terms were "Artificial_Intelligence", "AI", "Machine_Learning" and "Deep Learning". This filtering was conducted on titles, abstracts, and keywords, therefore after the intersection of the 10 steps that incorporate term-based filtering, the database contained 3,311 papers. Additionally, two

filters were applied to restrict the search based on the English language and the document type as "Article" and not retracted publication, in light of the analysis's consistency and the outcomes' comparability as this prevents any variations that can occur from combining different document typologies. The final result consists of 1,974 articles relevant to the field incorporating digitalization and AI.

The analysis was performed using the R programming language and the "bibliometrix" library. In order to extract useful information about the data, the "biblioshiny()" command generated an interactive graphical interface via the "Shiny" framework for application implementation.

Table 1. Dataset extraction steps

Exploration steps	Questions on Web of Science	Description	Query	Query number	Count
1	Title	Contains one of the Digitalization specific keywords	((((TI=(digitaliz*) OR TI=(digitalis*)) OR TI=(internet_access)) OR TI=(digital_econom*)) OR TI=(society_index))	#1	15,278
2	Title	Contains one of the AI keywords	(((TI=(Artificial_Intelligence) OR TI=(AI)) OR TI=(Machine_Learning)) OR TI=(Deep Learning))	#2	360,190
3	Title	Contains the specific keywords related to digitalization and AI	#1 AND #2	#3	172
4	Abstract	Contains one of the digitalization specific keywords	((((AB=(digitaliz*) OR AB=(digitalis*)) OR AB=(internet_access)) OR AB=(digital_econom*)) OR AB=(society_index))	#4	48,142
5	Abstract	Contains one of the AI keywords	(((AB=(Artificial_Intelligence) OR AB=(AI)) OR AB=(Machine_Learning)) OR AB=(Deep Learning))	#5	817,935
6	Abstract	Contains the specific keywords related to digitalization and AI	#4 AND #5	#6	3,224
7	Keywords	Contains one of the digitalization specific keywords	((((KP=(digitaliz*) OR KP=(digitalis*)) OR KP=(internet_access)) OR KP=(digital_econom*)) OR KP=(society_index))	#7	1,842
8	Keywords	Contains one of the AI keywords	(((KP=(Artificial_Intelligence) OR KP=(AI)) OR KP=(Machine_Learning)) OR KP=(Deep Learning))	#8	18,465
9	Keywords	Contains the specific	#7 AND #8	#9	11

Exploration steps	Questions on Web of Science	Description	Query	Query number	Count
		keywords related to digitalization and AI			
10	Title/Abstract/Keywords	Contains the specific keywords related to digitalization and AI on title or abstract or keywords	#3 OR #6 OR #9	#10	3,311
11	Language	Restrict the results on language	(#10) AND LA=(English)	#10	3,108
12	Document Type	Limit to Article and not retracted publications	((#11) AND DT=(Article)) NOT (DT==("RETRACTED PUBLICATION"))	#11	1,974

Source: Authors' own research.

Results and discussions

Considering the purpose of the paper is to identify the main aspects needed to describe the research conducted in the domain the reunites digitalization and AI the analysis conducted highlights the main aspects as mentioned in the methodology. In consequence, the following illustrations and tables focus on the overview of the extracted dataset highlighting sources, authors, countries, and keywords.

Table 2 presents the main information regarding the dataset, including details about the timestamp, citations and references. The articles were published between 1985 and 2025, thus covering a great number of technological trends and events.

Table 2. Main information about the dataset

Indicator	Value
Timespan	1985:2025
Sources	1131
Documents	1974
Average citations per documents	12.1
Keywords plus	2670
Author's keywords	6470
References	100368

Source: Authors' own research.

Figure 1 encompasses the most relevant ten journals with publications on digitalization and AI. The journal with the most significant impact in the research is *Sustainability* where authors published 72 articles. This journal is being recognized in the specialized literature as one of the most representative publication for mainstream social trends (Tang et al., 2018). On the second place, *IEEE Access* displays 42 articles published during the analyzed period, and it is also regarded as a very significant journal for producing relevant articles in the field of advanced technology

(Qadir et al., 2015) (Kibria et al., 2018). Other notable sources include *Applied Sciences-Basel, Sensors, Electronics, Energies, Baltic Journal of Economic Studies, Journal of Cleaner Production, Plos One* and *Scientific Reports*, with the number of published papers that vary from 12 to 33. The interdisciplinary nature of AI is highlighted by the fact that the journals in this top are not in the field of computer science. Not only do the effects of AI reflect a variety of areas, but it has the potential to have a major impact on the environment, which is why there is an extensive number of articles in "Sustainability" on artificial intelligence. This field's interdisciplinary viewpoint is further supported by the paper of Martini et al (Martini et al., 2024), which views the idea of a multidisciplinary approach as an essential point in the growth of the AI industry.

These findings reinforce that higher levels of digitalization are associated with greater AI research productivity and innovation, as the top journals primarily focus on technological innovation, smart systems, and digital infrastructure.

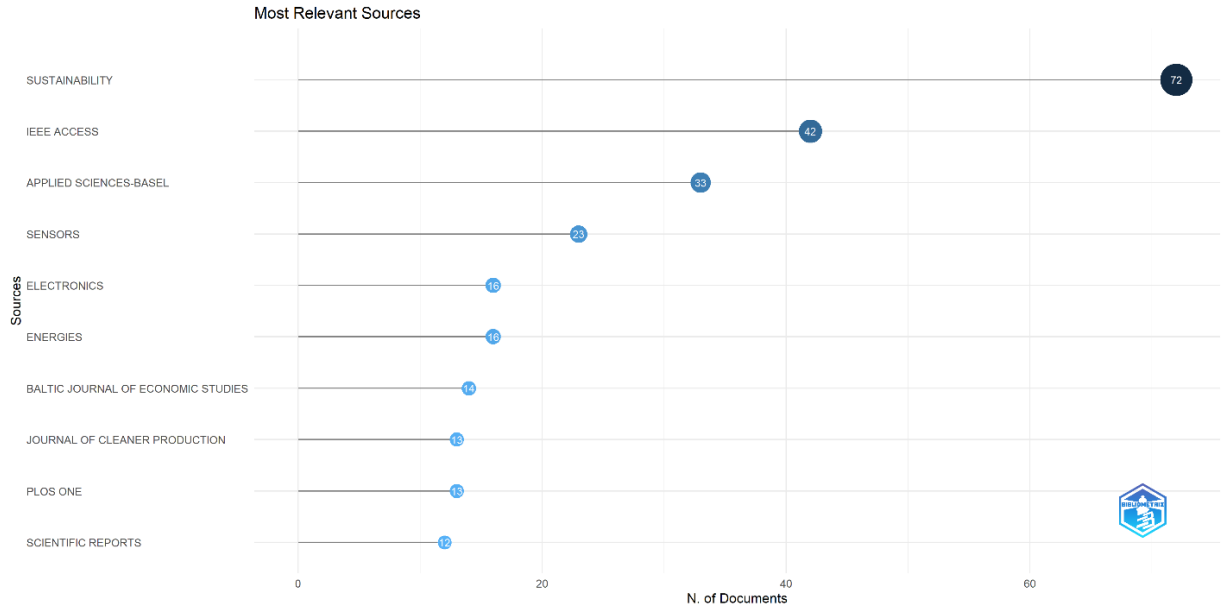


Figure 1. Top 10 most relevant sources

Source: Authors' own research.

Lotka's Law was formulated to predict trends and patterns in the publishing behavior of authors in a studied field (Newby et al., 2003). Accordingly, Figure 2 depicts the author's publishing trend as a relationship of the percentage of authors and the number of published articles. Given that the percentage of authors is decreasing as the number of publications gets higher, it is reasonable to anticipate challenges and barriers towards publishing an extensive number of documents on the research of digital transition and AI implementation. This trend highlights the need for greater institutional and funding support to encourage sustained research output, particularly in Europe, where research commercialization remains limited.

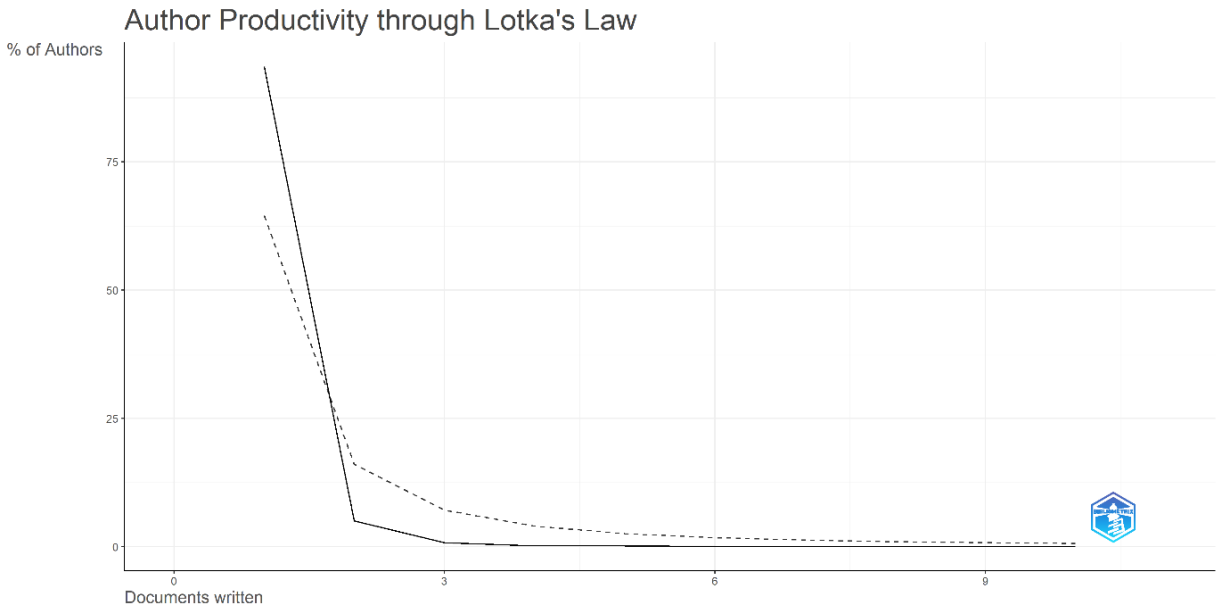


Figure 2. Author Productivity through Lotka's Law

Source: Authors' own research.

Figure 3 presents the most significant corresponding author's countries from two different points of view: the number of Multi-Country Publication (MCP) and the number of Single-Country Publication (SCP). China is in top position, with a significant difference from the rest of the countries. The authors from China published a total of 371 articles, 278 SCP (74.9%) and 93 MCP (25.1%). Chinese papers account for 18.8% of articles published globally in digitalization and AI. Germany is on the second place with 162 publications, and with the same preference to SCP as the German authors produced 124 SCP (76.5%) and 93 MCP (23.5%), representing 8.2% of the global production of articles. The third place is occupied by USA with 128 papers, from which 88 are SCP (68,7%) and 40 are MCP (31.3%), representing 6.5% of the global publication. The next country in the top ten is India with 104 articles, 73 SCP (70.2%) and 31 MCP (29.8%), defining 5.3% of the total number of articles. Russia ranks next in the top with 100 papers (5.1% from the total) with 86 SCP (86%) and 14 MCP (14%). The next countries in the hierarchy each register fewer than 100 articles, indicating reduced relevance in terms of publishing volume. Given that the percentage of MCP publications is only 29.78% and the percentage of papers arising from national collaborations is 70.22%, authors generally have a preference to publish articles in national collaborations, which can have a substantial detrimental effect on the spread of AI knowledge. The preference for SCP, in particular, not only limits the possibilities for harmonizing innovative perspectives that could be found through international collaborations as authors provide innovative ideas from diverse cultural perspectives, but it also reduces the rate of dissemination of research trends.

The World Digital Competitiveness Ranking (WDCR) hierarchy can be used to examine the relationship between research on the advances in technology implied by AI and the level of digitalization. The first places of the hierarchy contain the countries that were evaluated as significant in the analysis (China in 14th place, Germany in 23rd place, the United States in 4th place, and the United Kingdom in 18th place) (IMD World Competitiveness Center, 2022). The WDCR suggests that nations leading in digital competitiveness also demonstrate strong AI research productivity. These findings support both hypotheses by demonstrating that highly digitalized

economies tend to have stronger AI research productivity and innovation. The prominence of China, the USA, and Germany in AI and digitalization research further highlights how digital infrastructure and national investments in technology contribute to the advancement of AI. The data also reinforces that Europe, despite its substantial research output, lags in AI commercialization, further confirming the need for improved collaboration between private enterprises and academic institutions to bridge the gap between research productivity and industrial application.

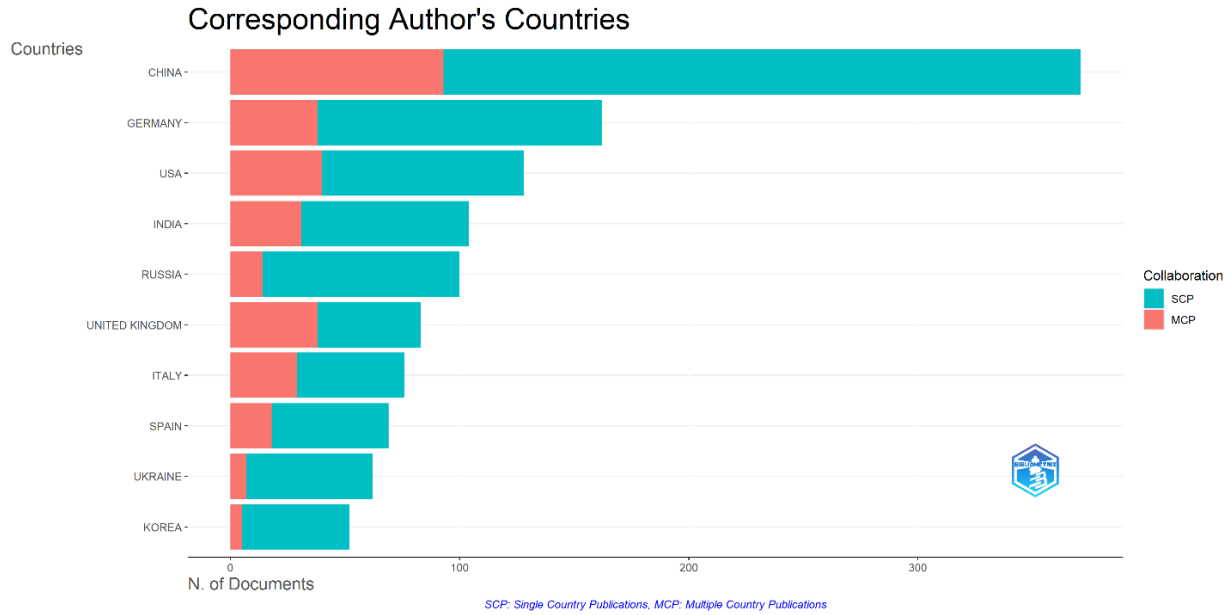


Figure 3. Top 10 most relevant Corresponding Author's Countries

Source: Authors' own research.

Figure number 4 displays two word clouds showcasing the top 50 terms used around AI and digitalization research. Panel A shows the keywords plus which are generated automatically from the references of an article, while panel B shows the keywords provided by the authors which are chosen by the researchers.

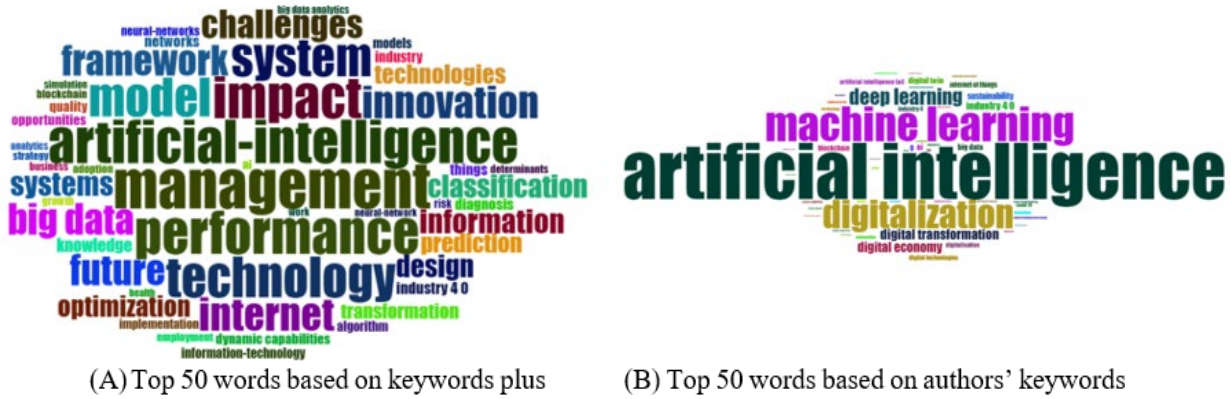
In panel A, the most frequent term is "artificial intelligence," signifying its importance to the research. Other common terms are "machine learning", "big data", "management", "technology", "performance" and "system" which suggest that AI driven research is associated with technological infrastructure, engineering and performance evaluation systems. The occurrence of "framework", "model" and "impact" indicates focus on the architecture and AI's applicability in different field. With terms such as "classification", "prediction" and "optimization", there is clear focus on machine learning and its applications while "internet," "future" and "digitalization" highlight the connection between AI and digital transformation.

In panel B, "artificial intelligence" continues to rank as the most dominant term, with "machine learning" and "digitalization" close behind. Compared to panel A, this demonstrates digitalization as a key driving factor for AI research, thus reinforcing the first hypothesis (higher levels of digitalization are associated with greater AI research productivity and innovation). The presence of "deep learning" and "digital transformation" highlights the impact of advanced computational models and digital infrastructure in shaping AI advancements.

The comparison of panels A and B reveal a distinct observation: while keywords generated automatically focus on the more technical, performance-driven features of AI research (e.g.,

"performance," "optimization," "framework"), the authors' keywords shift this focus to more peripheral and broader applications of AI and digitalization ("digital transformation", "machine learning"). This indicates that researchers highlight AI's relationships toward digitalization and applied research on purpose, strengthening the first hypothesis even more.

The dominance of methodology-related terms (e.g. machine learning, classification, deep learning) with fewer references to commercialization or industry adoption supports the second hypothesis (Europe lags in AI commercialization compared to the US and China).



(A) Top 50 words based on keywords plus (B) Top 50 words based on authors' keywords

Figure 4. WordClouds - keywords plus and authors' keywords

Source: Authors' own research.

The articles were divided into four groups based on the 250 most prevalent keywords using the two indicators on the axes in Figure 5: on the Oy axis, the influence of the papers in the investigated field (impact) is measured and on the Ox axis, the external factors of that field (centrality) are measured. The blue cluster is characterized by low impact and centrality. The articles included in this cluster consider the terms "model" (with a frequency of 69.8%), "performance" (frequency of 29%) and "system" (frequency of 23.7%), thus focusing on basic aspects of any analysis. The articles in the red cluster are more representative due to the size of the illustration and follow themes represented by "impact" (a term that appears in 100% of the articles in this cluster), "performance" (frequency of 66.1%) and "innovation" (frequency of 64.3%). These themes are in the area of high centrality but have low impact. The green cluster also has increased relevance and is characterized by high impact and centrality. The articles in this cluster contain as main terms "management" (73.2% of the total occurrences), "framework" (frequency of 63.4%) and "system" (frequency of 52.6%). The articles with high impact and low centrality are represented by the purple cluster, which by its size suggests low relevance. The terms addressed are "technology" (49% of the occurrences), "artificial-intelligence" (frequency of 37.3%) and "future" (frequency of 16.7%). The articles in this cluster focus on issues related to the innovation scope. The absence of high impact, high centrality clusters in the areas of commercialization and in the applied research of AI demonstrates the challenges faced in the research-to-market translation. This fact supports the second hypothesis which builds the case that while Europe is known to have an extensive output of AI research, it fails to convert such research into widely adopted technologies. The clustering of themes around AI performance, innovation, and management further supports the idea that digitalization is an important indication for AI research trends, providing structural support for technological evolution.

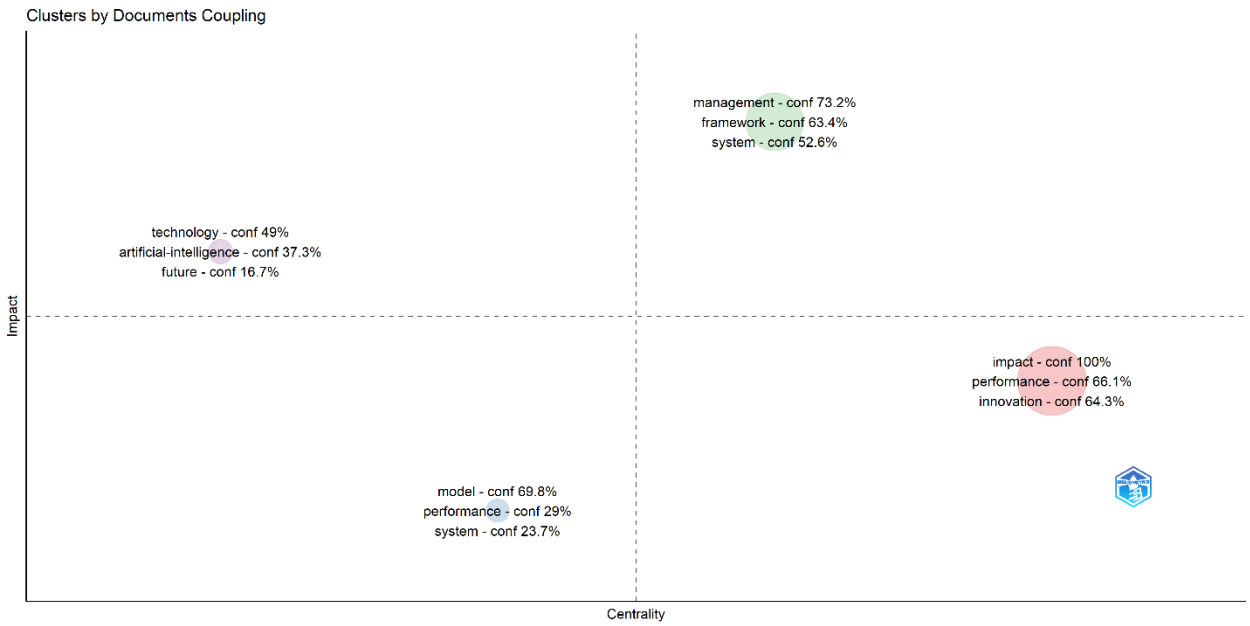


Figure 5. Clusters by Document Coupling

Source: Authors' own research.

Tables 3 and 4 present the most frequently used bigrams and trigrams in research titles and abstracts, highlighting the key thematic areas within digitalization and AI. They also convey the principal areas of concentration in relation to digitalization and AI. Without a doubt, "artificial intelligence" (bigram) occurs with overwhelming frequency in both titles and abstracts. This only reaffirms its overwhelming centrality as the theme of research. Closely following is "machine learning" which attests to its prominence as an important subset to AI research. "Digital economy" and "digital transformation" especially underline the stronger correlation that exists between AI and digitalization in economic and organizational terms. "Deep learning" suggests that advanced forms of AI are researched extensively. Phrases like "supply chain" and "digital twin" express a concern with logistics and industry 4.0. The predominance of theoretical and methodological AI works in the literature studied suggests strong research output but weaker commercialization, this trend emerging clearly from the thematic framework of the literature in question. Our keyword and thematic clustering reveal that a significant portion of AI research focuses on conceptual advancements, such as model optimization and algorithm development, rather than applied or industry-driven implementations. Further supporting this conclusion, bibliometric data displays low coverage of topics related to commercialization of artificial intelligence technologies such as business transformation or industrial AI adoption. Other industry studies also looked at these trends (OECD, 2024; European Investment Bank, 2023), and observed the gap between the output of AI research and its market application. These keyword trends are in direct connection to the first hypothesis demonstrating the relationship between digitalization and AI. The strong presence of terms related to digital transformation further solidifies the claim that digitalization is not only complementary but essential for AI innovation and growth.

Table 3. Top 10 most used bigrams in titles and abstracts

Bigrams Titles	Frequency	Bigrams Abstracts	Frequency
artificial intelligence	251	artificial intelligence	1398
machine learning	128	machine learning	748
digital economy	82	digital economy	474
deep learning	80	digital transformation	383
digital transformation	75	intelligence ai	377
supply chain	36	digital technologies	299
digital twin	30	deep learning	284
digital technologies	24	supply chain	165
learning approach	22	internet access	135
neural networks	22	neural network	127

Source: Authors' own research.

Table 4. Top 10 most used trigrams in titles and abstracts

Trigrams Titles	Frequency	Trigrams Abstracts	Frequency
machine learning approach	11	artificial intelligence ai	373
convolutional neural networks	9	machine learning ml	103
machine learning techniques	8	machine learning algorithms	74
artificial intelligence technologies	7	fourth industrial revolution	53
artificial intelligence technology	7	machine learning techniques	50
convolutional neural network	7	machine learning models	46
deep learning approach	7	natural language processing	35
artificial intelligence ai	6	convolutional neural network	31
deep neural networks	6	artificial intelligence technologies	29
natural language processing	6	deep learning models	29

Source: Authors' own research.

This bibliometric analysis reinforces the fact that digitalization helps innovation productivity and innovation of AI research by providing the necessary infrastructure, processing capabilities, and access to data. Research focused on AI continues to lead in importance in the journals that specialize in digital economy and its transformation, highlighting the impact of digitalization on the advancement of AI. The conclusions from keyword analysis also show how seamlessly AI and machine learning Connect with digital transformation, which strengthens the idea that digitalization drives the growth of AI.

In Europe there is a high amount of activity, however, the region is struggling with the commercialization of AI activities. This is due to regulatory frameworks and inconsistent industrial investment. China has maintained a leading position in business-driven applied AI, while there are industry and venture capital driven initiatives in the US. Thematic clustering shows that European AI research lacks strong commercialization pathways, reinforcing the need for strategic industry-academia partnerships.

Reducing this gap requires enhanced cross-border collaboration, increased private investment, and stronger policy frameworks to accelerate AI innovation and its economic impact (Fosso Wamba et al., 2021). The findings confirm that higher levels of digitalization correlate with greater AI research output and impact, as seen in clusters around AI performance, innovation, and management. Digital infrastructure, computational power, and big data accessibility are very important to AI research.

Conclusion

This study takes a bibliometric approach to examine how digitalization relates to the field of artificial intelligence (AI). By tracking and analyzing publication data, it becomes clear that digital technologies are not just helpful but essential to the development of AI. In particular, elements like digital infrastructure, computing capabilities, and access to large data collections appear to directly support more productive research in this area.

The analysis of keywords and topic clusters further shows that AI is often tied to digital advancements. Countries or regions that invest heavily in digital infrastructure tend to be the same ones producing high volumes of AI research. One of the study's main goals was to determine whether digitalization plays a role in AI's growth and influence. The data suggest that it does — AI research seems to thrive in digital-forward environments. At the same time, the findings highlight clear regional differences. While Europe produces a great deal of AI-related work, it trails behind the U.S. and China when it comes to practical use and adoption.

The first hypothesis (H1) is supported. Places that have moved further along in digital transformation tend to publish more AI work, and their research often has greater impact. The analysis found that many of the themes in AI papers overlap with digital technology topics, pointing to a strong link between the two.

The second hypothesis (H2) is also confirmed. Although Europe performs well in terms of research output, it lags in turning ideas into applied solutions. Several reasons are noted: uneven digital policies, weaker startup funding, and limited partnerships between universities and private companies. Much of the work in Europe remains academic and is not yet making its way into commercial or industrial applications.

Despite these findings, the study has some limitations. The research depends on specific databases, meaning not all relevant work may have been included. In addition, while patterns are identified, the study does not fully explain why certain regions adopt AI more effectively than others. Also, current use of AI in private-sector settings was outside the scope of this analysis, and could be explored in future research using other methods like interviews or case studies.

To conclude, the findings offer a useful starting point for understanding how digitalization and AI development are linked — and why the digital foundation of a region might determine how far it can go in advancing AI.

References

Bakır, M., Özdemir, E., Akan, Ş., & Atalık, Ö. (2022). A bibliometric analysis of airport service quality. *Journal of Air Transport Management*, *104*, 102273. https://doi.org/10.1016/j.jairtraman.2022.102273

Belhadi, A., Mani, V., Kamble, S., Khan, S., & Verma, S. (2021). Artificial intelligence-driven innovation for enhancing supply chain resilience and performance under the effect of supply chain dynamism: An empirical investigation. *Annals of Operations Research*, *333*. https://doi.org/10.1007/s10479-021-03956-x

Brennen, J. S., & Kreiss, D. (2016). Digitalization. In *The International Encyclopedia of Communication Theory and Philosophy* (pp. 1–11). https://doi.org/10.1002/9781118766804.wbiect111

Bughin, J., Seong, J., Manyika, J., Chui, M., & Joshi, R. (2018). *Modeling the global economic impact of AI | McKinsey*. https://www.mckinsey.com/featured-insights/artificial-intelligence/notes-from-the-ai-frontier-modeling-the-impact-of-ai-on-the-world-economy

Culot, G., Podrecca, M., & Nassimbeni, G. (2024). Artificial intelligence in supply chain management: A systematic literature review of empirical studies and research directions. *Computers in Industry*, *162*, 104132. https://doi.org/10.1016/j.compind.2024.104132

Ding, J. (2020). Promoting nationally, acting locally: China's next generation AI approach. *Elliott, H. Ed*, 11–16.

Domenteanu, A., Cotfas, L.-A., Diaconu, P., Tudor, G.-A., & Delcea, C. (2025). AI on Wheels: Bibliometric Approach to Mapping of Research on Machine Learning and Deep Learning in Electric Vehicles. *Electronics*, *14*(2), Article 2. https://doi.org/10.3390/electronics14020378

Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, *133*, 285–296. https://doi.org/10.1016/j.jbusres.2021.04.070

European Commission. (2010). *A Digital Agenda for Europe*. https://eufordigital.eu/library/a-digital-agenda-for-europe/

European Commission. (2020). *A Europe Fit for the Digital Age*. https://commission.europa.eu/strategy-and-policy/ priorities-2019-2024/europe-fit-digital-age_en

European Commission. (2021, April 21). *Coordinated Plan on Artificial Intelligence 2021 Review | Shaping Europe's digital future*. https://digital-strategy.ec.europa.eu/en/library/coordinated-plan-artificial-intelligence-2021-review

European Commission. (2022). *The Digital Economy and Society Index (DESI) | Shaping Europe's digital future*. https://digital-strategy.ec.europa.eu/en/policies/desi

European Court of Auditors. (2024, August). *Special report 08/2024: EU Artificial intelligence ambition*. http://www.eca.europa.eu/en/publications/sr-2024-08

European Investment Bank. (2023). *European Investment Bank Group Activity Report 2022*. European Investment Bank. https://doi.org/10.2867/75965

Fosso Wamba, S., Queiroz, M., Guthrie, C., & Braganza, A. (2021). Industry experiences of artificial intelligence (AI): Benefits and challenges in operations and supply chain management. *Production Planning & Control*, *33*, 1–13. https://doi.org/10.1080/09537287.2021.1882695

Frankowska, A., & Pawlik, B. (2022). A Decade of Artificial Intelligence Research in the European Union: A Bibliometric Analysis. In C. Biele, J. Kacprzyk, W. Kopeć, J. W. Owsiński, A. Romanowski, & M. Sikorski (Eds.), *Digital Interaction and Machine Intelligence* (pp. 52–62). Springer International Publishing. https://doi.org/10.1007/978-3-031-11432-8_5

Heaton, J. (2017). Ian Goodfellow, Yoshua Bengio, and Aaron Courville: Deep learning: The MIT Press, 2016. *Genetic Programming and Evolvable Machines*, *19*. https://doi.org/10.1007/s10710-017-9314-z

IMD World Competitiveness Center. (2022). *The IMD World Digital Competitiveness Ranking*. https://www.imd.org/ centers/wcc/world-competitiveness-center/rankings/world-digital-competitiveness-ranking/

Kibria, M. G., Nguyen, K., Villardi, G. P., Zhao, O., Ishizu, K., & Kojima, F. (2018). Big Data Analytics, Machine Learning, and Artificial Intelligence in Next-Generation Wireless Networks. *IEEE Access*, *6*, 32328–32338. IEEE Access. https://doi.org/10.1109/ACCESS.2018.2837692

Kovac, N., Żmija, K., Roy, J. K., Kusa, R., & Duda, J. (2024). Digital divide and digitalization in Europe: A bibliometric analysis. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, *19*(2), Article 2. https://doi.org/10.24136/eq.2899

Linares-Espinós, E., Hernández, V., Domínguez-Escrig, J. L., Fernández-Pello, S., Hevia, V., Mayor, J., Padilla-Fernández, B., & Ribal, M. J. (2018). Methodology of a systematic review. *Actas Urológicas Españolas (English Edition)*, *42*(8), 499–506. https://doi.org/10.1016/j.acuroe.2018.07.002

Martini, B., Bellisario, D., & Coletti, P. (2024). Human-Centered and Sustainable Artificial Intelligence in Industry 5.0: Challenges and Perspectives. *Sustainability*, *16*(13), 5448. https://doi.org/10.3390/su16135448

Matt, C., Hess, T., & Benlian, A. (2015). Digital Transformation Strategies. *Business & Information Systems Engineering*, *57*(5), 339–343. https://doi.org/10.1007/s12599-015-0401-5

McClure, P. (2018). "You're Fired," Says the Robot: The Rise of Automation in the Workplace, Technophobes, and Fears of Unemployment. *Social Science Computer Review*, *36*, 139–156. https://doi.org/10.1177/0894439317698637

McKinsey & Company. (2024). *The state of AI in early 2024 | McKinsey*. https://www.mckinsey.com/capabilities/quantumblack/our-insights/the-state-of-ai

Newby, G. B., Greenberg, J., & Jones, P. (2003). Open source software development and Lotka's Law: Bibliometric patterns in programming. *Journal of the American Society for Information Science and Technology*, *54*(2), 169–178. https://doi.org/10.1002/asi.10177

OECD. (2024, May 14). *OECD Digital Economy Outlook 2024 (Volume 1)*. https://www.oecd.org/en/publications/oecd-digital-economy-outlook-2024-volume-1_a1689dc5-en.html

Qadir, J., Yau, K.-L. A., Imran, M. A., Ni, Q., & Vasilakos, A. V. (2015). IEEE ACCESS SPECIAL SECTION EDITORIAL: ARTIFICIAL INTELLIGENCE ENABLED NETWORKING. *IEEE Access*, *3*, 3079–3082. IEEE Access. https://doi.org/10.1109/ACCESS.2015.2507798

Russell, S. J., Russell, S., & Norvig, P. (2020). *Artificial Intelligence: A Modern Approach*. Pearson.

Sandu, A., Cotfas, L.-A., Delcea, C., Ioanăş, C., Florescu, M.-S., & Orzan, M. (2024). Machine Learning and Deep Learning Applications in Disinformation Detection: A Bibliometric Assessment. *Electronics*, *13*(22), Article 22. https://doi.org/10.3390/electronics13224352

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, *104*, 333–339. https://doi.org/10.1016/j.jbusres.2019.07.039

Srai, J. S., & Lorentz, H. (2019). Developing design principles for the digitalisation of purchasing and supply management. *Journal of Purchasing and Supply Management*, *25*(1), 78–98. https://doi.org/10.1016/j.pursup.2018.07.001

Stanford AI Index. (2023). *AI Index Report 2023 – Artificial Intelligence Index*. https://aiindex.stanford.edu/ai-index-report-2023/

Tang, M., Liao, H., Wan, Z., Herrera-Viedma, E., & Rosen, M. A. (2018). Ten Years of Sustainability (2009 to 2018): A Bibliometric Overview. *Sustainability*, *10*(5), Article 5. https://doi.org/10.3390/su10051655

Warner, K. S. R., & Wäger, M. (2019). Building dynamic capabilities for digital transformation: An ongoing process of strategic renewal. *Long Range Planning*, *52*(3), 326–349. https://doi.org/10.1016/j.lrp.2018.12.001

Zeng, J. (2021). Securitization of Artificial Intelligence in China. *The Chinese Journal of International Politics*, *14*(3), 417–445. https://doi.org/10.1093/cjip/poab005

Zupic, I., & Čater, T. (2015). Bibliometric Methods in Management and Organization. *Organizational Research Methods*, *18*, 429–472. https://doi.org/10.1177/1094428114562629