Journal of Innovation & Knowledge 9 (2024) 100465

Journal of Innovation & Knowledge

https://www.journals.elsevier.com/journal-of-innovation-and-knowledge

Mapping the conceptual structure of innovation in artificial intelligence research: A bibliometric analysis and systematic literature review

Dragoș M. Obreja[a,*], Răzvan Rughiniș[b,c], Daniel Rosner[b]

[a] Faculty of Sociology and Social Work, University of Bucharest, 90-92 Panduri Road, 5th Sector, Bucharest 050663, Romania
[b] National University of Science and Technology Politehnica Bucharest, Romania
[c] The Romanian Academy of Scientists, Romania

ARTICLE INFO

Article History:
Received 25 September 2023
Accepted 25 January 2024
Available online 29 January 2024

Keywords:
Bibliometrics
AI innovation
Conceptual structure
Artificial intelligence
Big data

JEL classification:
A14
O30
O35

ABSTRACT

This study uses bibliometric analysis and a systematic literature review to map the conceptual structure of artificial intelligence innovations (AI-I) in the social sciences between 2000 and 2023. It explicitly focuses on non-economic aspects conducive to AI-I, namely social, technological, cultural, sustainable, personal, moral, and ethical. Our analysis reveals that 1225 articles and proceeding papers have been published, and terms such as "technology," "big data," "management," "performance," "future," and "impact" are the most frequently used when discussing innovation and AI. According to our time-zone analysis, the last two years have shown a significant emphasis on concepts such as "transformation," "corporate social responsibility," and "resource-based view." In terms of citations, the countries that receive the highest number of references in the AI-I field are the United Kingdom, the United States, Germany, Australia, and China. The most prolific authors in terms of publications are David Teece, Erik Brynjolfsson, and Anjan Chatterjee. Given that most studies highlight the economic side of AI-I, we selected the most prolific 163 articles from all social science research areas. These studies legitimize the main non-economic aspects that highlight both certainties and uncertainties conducive to such innovations. Although the technological component is the most popular in our analysis of the non-economic aspects of the AI-I subfield, we find an important emphasis on ethical/moral dimensions conducive to slow innovation principles. We also observe a growing interest in the cultural dimension, specifically exploring potential factors that can lead to better human acceptance of these innovations.

Introduction

Artificial intelligence allows businesses and multiple social groups to perform effectively in the digital age, influencing various innovations (Verganti et al., 2020; Wamba et al., 2021). Thus, there is growing academic interest in the interdisciplinary implications of AI-I, as evidenced by the variety of fields highlighting the social, economic, and cultural implications of this type of innovation.

This article mainly investigates aspects of knowledge centered around the non-economic factors related to AI-I. Specifically, this article investigates the heterogeneous context of AI-I, including social, sustainable, technological, personal/personalizing, ethical/moral, and cultural factors. By investigating these recurrent non-economic factors in the study of innovations, we plan to map this emerging topic coherently, encompassing all research areas specific to the social sciences and humanities. This approach is necessary since it highlights research areas less addressed in relation to AI-I, such as social issues, educational research, sociology, geography, and others. These will be explored in the systematic literature review.

Thus, this study maps the conceptual structure of AI and innovation research articles, review articles, and proceeding papers published between January 2000 and July 2023. This study addresses multiple gaps in existing research focused on bibliometric analysis by providing quantitative evaluations in the AI-I field through a variety of analyses based on authorship, journals, countries, and "hot topics," thereby contributing to the extensive mapping process (Faraji et al., 2022) on a particular topic. We also use bibliometrics to trace the AI-I field longitudinally, observing not only the main trends but also the existing potential trends in this knowledge field based on grouping keyword clustering. This mapping process allows for an overlay visualization, which can inform AI-I scholars about new and emerging topics as well as topics that are no longer generating intense attention.

* Corresponding author.
E-mail address: dragos.obreja@s.unibuc.ro (D.M. Obreja).

https://doi.org/10.1016/j.jik.2024.100465

The study of AI for innovation purposes is of visible interest, given that this conceptual direction systematically differs from previous applications of AI (Chui et al., 2018; Lu, 2019). Although AI applications represent a prevalent topic in research areas such as business and management (Adner et al., 2019; Bettis & Hu, 2018; Haefner et al., 2021), the wider and interdisciplinary implications of the AI-I field remain understudied within the social sciences. Therefore, this systematic qualitative literature review explores research areas that have begun integrating publications from the AI-I sphere, such as sociology, social issues, urban studies, the arts, and the humanities. We propose to answer the following research questions:

RQ1. What is the current status of AI-I research?

RQ1a. What are the most relevant keywords in relation to AI-I research?

RQ1b. What are the most relevant journals in relation to AI-I research?

RQ1c. Which authors, countries, and organizations are most significant in relation to AI-I research?

RQ2. What prominent topics are closely related to AI-I publications? How do they group together?

RQ3. What does the conceptual structure of AI-I research look like in such a heterogeneous field as the social sciences and humanities?

The discourse surrounding the potential innovative role of AI is a widely debated subject despite the concept itself not being novel. For instance, Haefner et al. (2021) highlighted that the idea of AI-based computers dates back to the mid-1950s when management scholars began investigating the implications of increasingly autonomous computers for firms and organizations. Although the knowledge field of AI-I research is not evenly distributed across research areas, a substantial increase in the number of publications on AI-I has been observed in the last ten years.

Material and methods

Given the growing popularity of bibliometric analysis as a coherent framework for mapping a particular knowledge field (Snyder, 2019; Zupic and Čater, 2015), our study uses bibliometric techniques to map the conceptual structure of innovation in AI. Previous studies have used similar methodologies in the innovation field spectrum (Li et al., 2019; Sun & Grimes, 2016), thus supporting the idea that bibliometrics effectively emphasizes pivotal points in a knowledge field (Cheng et al., 2023).

Search strategy

We used bibliometrics to assess the present condition of the field of AI-I as well as its potential and emerging trends. Bibliometrics is a valuable tool as it scrutinizes research progress, including important journals, authors, papers, countries, and other relevant factors (Hood & Wilson, 2001). Thus, through effective processes of sorting, mapping, and visual analysis, bibliometrics highlights the overall structure of particular themes or fields. The present study employed the five-step methodology proposed by Fahimnia et al. (2015) for comprehensive data collection and analysis within a specific field: mentioning the database used, screening the initial results, refining the obtained results, developing particular data statistics, and examining the dataset with some bibliometric techniques. Fig. 2 presents our methodological framework for conducting searches, screening relevant information, and refining our strategies.

In line with a previous approach for identifying relevant keywords (Cheng, 2023), we have reviewed the recurrent interdisciplinary aspects related to AI-I. Subsequently, we sought input from researchers in both the fields of science and technology and social science to identify the most relevant components in the relationship with which AI-I is scored. Finally, we used the search string to encompass not only the keywords “artificial intelligence” and “innovation” but also at least one of the components identified by the researchers, such as social, technological, sustainable/sustainability, personal, cultural, moral, and ethical. All these components will be further developed in our qualitative systematic review, given that these recurring components contribute to shaping different types of knowledge regarding AI-I.

The Web of Science (WoS) database was utilized to comprehensively search for research articles, review articles, and proceeding papers containing the following terms: “artificial intelligence” AND “innovation” AND (social OR technological OR sustainab* OR person* OR cultural OR moral OR ethical). Given the explicit focus on the economic side of previous studies centered on the AI-I field (Mariani et al., 2023; Truong & Papagiannidis, 2022), we mainly focused on the non-economic aspects of this field to highlight less popular research areas associated with AI-I. We have included all entries published between January 2000 and October 2023. The WoS database was chosen because of its comprehensiveness and frequent use in bibliometric analyses and systematic literature reviews (Benavides-Velasco et al., 2013; Khan & Wood, 2015; Köseoglu et al., 2019; Uyar et al., 2020).

Result screening and refinement

Previous studies have primarily focused on screening processes within well-established research areas such as business, economics, and management (Mariani et al., 2023). In contrast, the present study expands the scope by incorporating less prominent areas within the social sciences and related fields. First, our analysis focused exclusively on articles, reviews, and procedural papers published between January 1, 2000, and October 31, 2023. Subsequently, we carefully examined all research areas on the WoS database, including all specific subfields of the social sciences and humanities. The most popular subdomains that match our search strategy are as follows: Business Economics (565 entries), Science Technology Other Topics (235 entries), Social Sciences Other Topics (128 entries), Educational Research (107 entries), Public Administration (88 entries), and others. In addition, this broader inclusion encompasses less popular entries related to AI-I research, such as information science (95 entries), sociology (26 entries), communication (21 entries), psychology (43 entries), and international relations (20 entries). Fig. 2 presents the complete range of research areas included in the analysis.

Following topic refinement, we identified 1225 publications worth investigating. As mentioned in the introduction, including less popular areas of AI-I research in our qualitative analysis for the systematic review is advantageous. This approach allows us to highlight the various levels of analysis related to AI-I. Upon gathering the 1259 publications, all three authors examined their abstracts and titles to identify the elements that were not relevant to the topic of our inquiry. The subsequent grouping of these publications is based on two criteria: 1) the nature of the innovation discussed concerning AI, and 2) the research area of which the publication is a part. After screening for potential abstract unavailability or content irrelevance, we eliminated 24 entries, resulting in a total of 1225 publications included in our analysis.[1]

Data description

Fig. 1 shows the distribution of the 1225 publications discussing innovation and AI in various related fields in the social sciences. The first publication related to the AI-I field in the analyzed period is that

[1] Although not directly part of social sciences, we also maintained the Science and Technology area, given the fact that it is a field adjacent to the social sciences, through multiple elements specific to the knowledge process, such as ethical considerations of adopting new technologies, the interdisciplinary impact of technology on society, as well as important valences related to policy regulation.

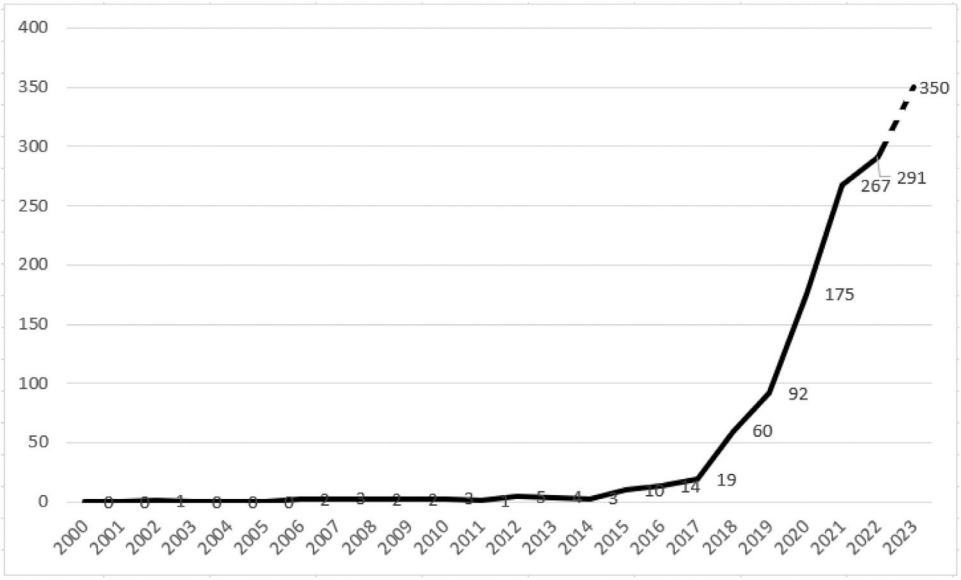

Fig. 1. Number of WoS publications on AI and innovation
Note. For 2023, we estimated that if the number of publications is maintained, a further upward trend is expected compared to 2022.

of Schulz-Schaeffer (2002), which was published in a German sociological journal and has the title "Innovation by means of concept transfer: Recourse to established knowledge in the production of technological innovations exemplified by multiagent research," as well as the keyword "artificial intelligence" in the *Keywords Plus* category. The upward trend of publications in the AI-I field is evident. However, the number of publications per year declined to less than ten by 2014. A significant "leap" was observed in 2018, with 60 publications, compared to only 19 in the preceding year. This was followed by 92 publications in 2019, 175 in 2020, 291 in 2022, and 350 potentially related publications by the end of 2023.

Co-word analysis and social network analysis

In order to perform the bibliometric techniques and meaningfully visualize the results obtained, we conducted a co-word analysis using *VOSviewer* (Waltman et al., 2010), a well-known tool in this field. Co-word analysis is one of the most popular bibliometric techniques, as proposed by Callon et al. (1986). This analysis examines the intensity with which two nodes, such as keywords, authors, journals, or countries, are used together, thereby reflecting the underlying structure of a particular knowledge field and the outline of some thematic clusters formed by these nodes. Thus, a high co-occurrence between two or more nodes highlights their strong relationship (An & Wu, 2011; Hâncean et al., 2021; Hu & Zhang, 2015; Ravikumar et al., 2015). Co-word analysis is already frequently used in a variety of bibliometric analyses, such as those related to intellectual capital (Faraji et al., 2022), corporate entrepreneurship (Funko et al., 2023), creativity (Zhang et al., 2015), auditing (Uyar et al., 2020), and others.

One notable observation derived from the WoS database is that author-selected words (author keywords) are accompanied by the words automatically rendered by the WoS (Keywords Plus) algorithm. Therefore, co-word analysis is useful due to its multifaceted capacity to identify thematic connections (Khasseh et al., 2017) and domains and trending topics (Dai et al., 2020; Faraji et al., 2022).

To explore the latent content of these publications, we used bibliometric social network analysis (SNA). In the context of SNA, nodes are represented by individuals (in our case, prominent researchers) or keywords, while ties represent the relationships between these nodes (Köseoglu et al., 2019; Yang et al., 2012). In our analysis, SNA demonstrates its utility by elucidating the conceptual map for a particular field or topic (Uyar et al., 2020). By applying SNA in our research on AI-I, we precisely investigate the main thematic clusters for this new and emerging field.

Results

Co-occurrence of keyword analysis: network and overlay visualization

The 1225 articles included in our analysis provide a total of 5543 keywords. However, we included only keywords with at least ten occurrences, reducing the number to 162 that met the threshold. Fig. 3 illustrates the grouping of these words into relevant clusters. The most important words from AI-I research are presented in Table 1, with their relevance determined by both occurrences (*oc*) and total link strength (*ls*). Thus, the most important words, in addition to AI (*oc* = 538; *ls* = 2063) and innovation (*oc* = 358; *ls* = 1831), are technology (*oc* = 163; *ls* = 866), big data (*oc* = 125; *ls* = 742), management (*oc* = 99; *ls* = 627), future (*oc* = 96; *ls* = 577), performance (*oc* = 98; *ls* = 575), and impact (*oc* = 92; *ls* = 551).

Fig. 3 depicts AI as part of the green cluster, while innovation is part of the purple cluster. In general, the red cluster evaluates AI-I in relation to its related technological and sustainable implications, as well as other intra-cluster words such as *sustainability, technologies, big data,* and *smart cities*. Additionally, it examines the effects of AI operating independently, focusing on keywords such as *industry 4.0, digital innovation,* and *smart*. Similar to the green cluster, the red cluster contains 33 keywords, and those with the highest level in terms of *oc* and *ls* centrality are words from the business and management sphere, such as *technology, adoption,* and *social media*. The cluster also contains keywords such as *machine learning, trust,* and *satisfaction*. The third cluster (*n* = 27), denoted by the color blue, mainly includes themes related to consequences and implications regarding management, as well as the potential acceptability regarding the AI-I field through words such as *impact, information, management, strategies,* and *perspective,* among others. The fourth cluster (*n* = 22 items) is also popular and mainly discusses the nature of innovation regarding AI. Thus, noticeable words in this cluster are *technological innovation, open innovation, emerging technologies*, and *creativity*. Cluster 5 (*n* = 21), denoted by the color purple, contains terms related to policymaking and ethical implications through keywords such as *education, challenges,* and *governance*. It also contains terms related to the

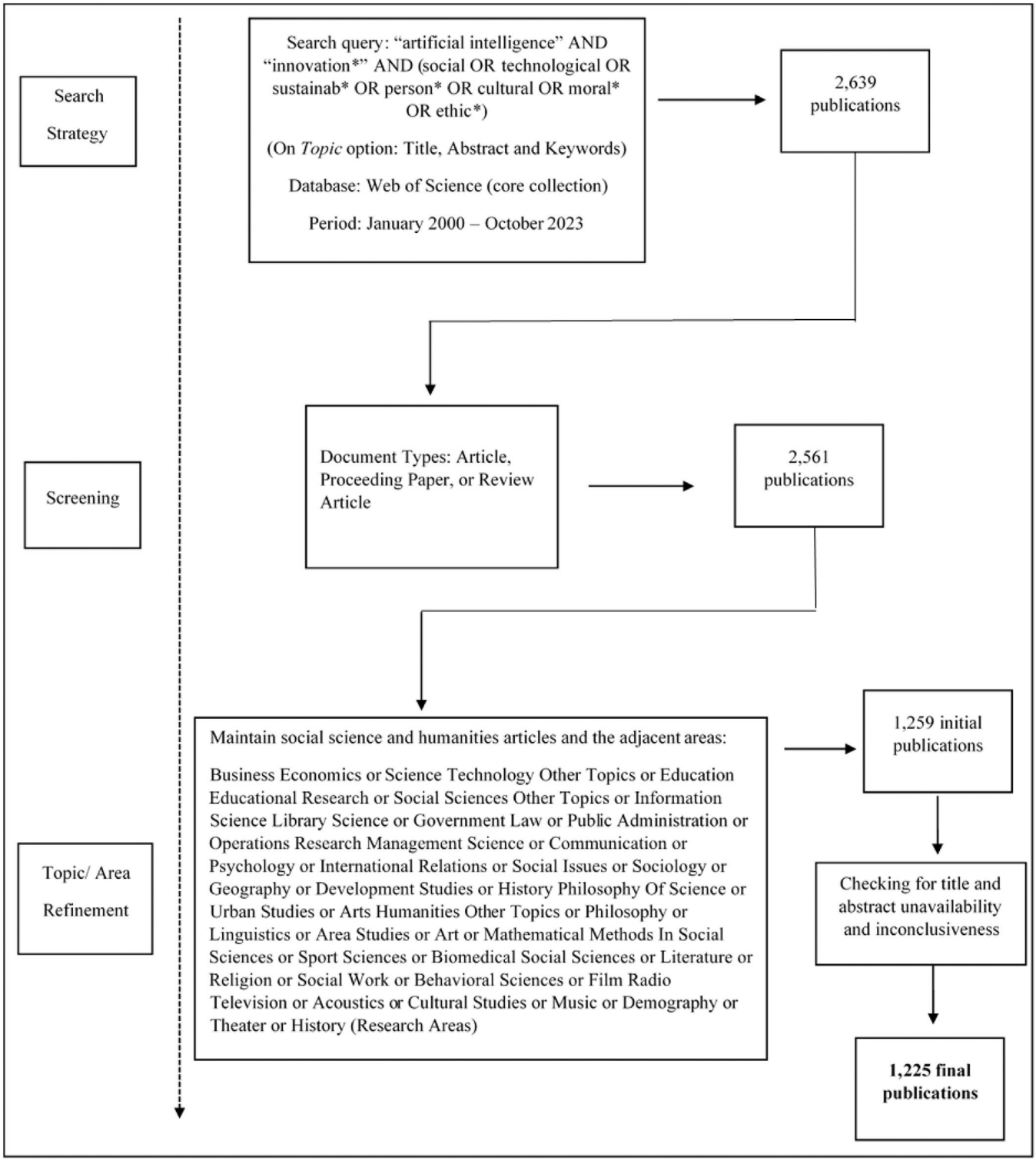

Fig. 2. The research protocol applied in this study.

preservation of the environment: *responsible innovation, health,* and *regulation*. Finally, cluster 6, denoted by the turquoise color, contains sixteen keywords related to the digital side of AI conducive to innovations: *digital transformation, digitalization, entrepreneurship,* and *value creation.*

Fig. 4 presents a visual representation of the "time-zone" view related to the AI-I field, illustrating the evolution of knowledge within specific temporal frameworks. However, given the significantly low frequency of publications within our reference interval, specifically the first 100 publications out of 1225 published between 2000 and 2016, we were compelled to reduce the threshold from 10 to 5 occurrences of a keyword. In addition, given the scarcity of relevant words prior to 2018, our time-zone analysis in Fig. 4 included 2016 – 2023 as a reference interval. The "oldest" word in the overlay visualization includes *technology diffusion,* with 2016 being its average publication year. In 2017, we noticed knowledge trends like *neural networks, sociology,* and *uncertainty*, while in 2018, we noticed the emergence of keywords such as *e-learning* and *information*

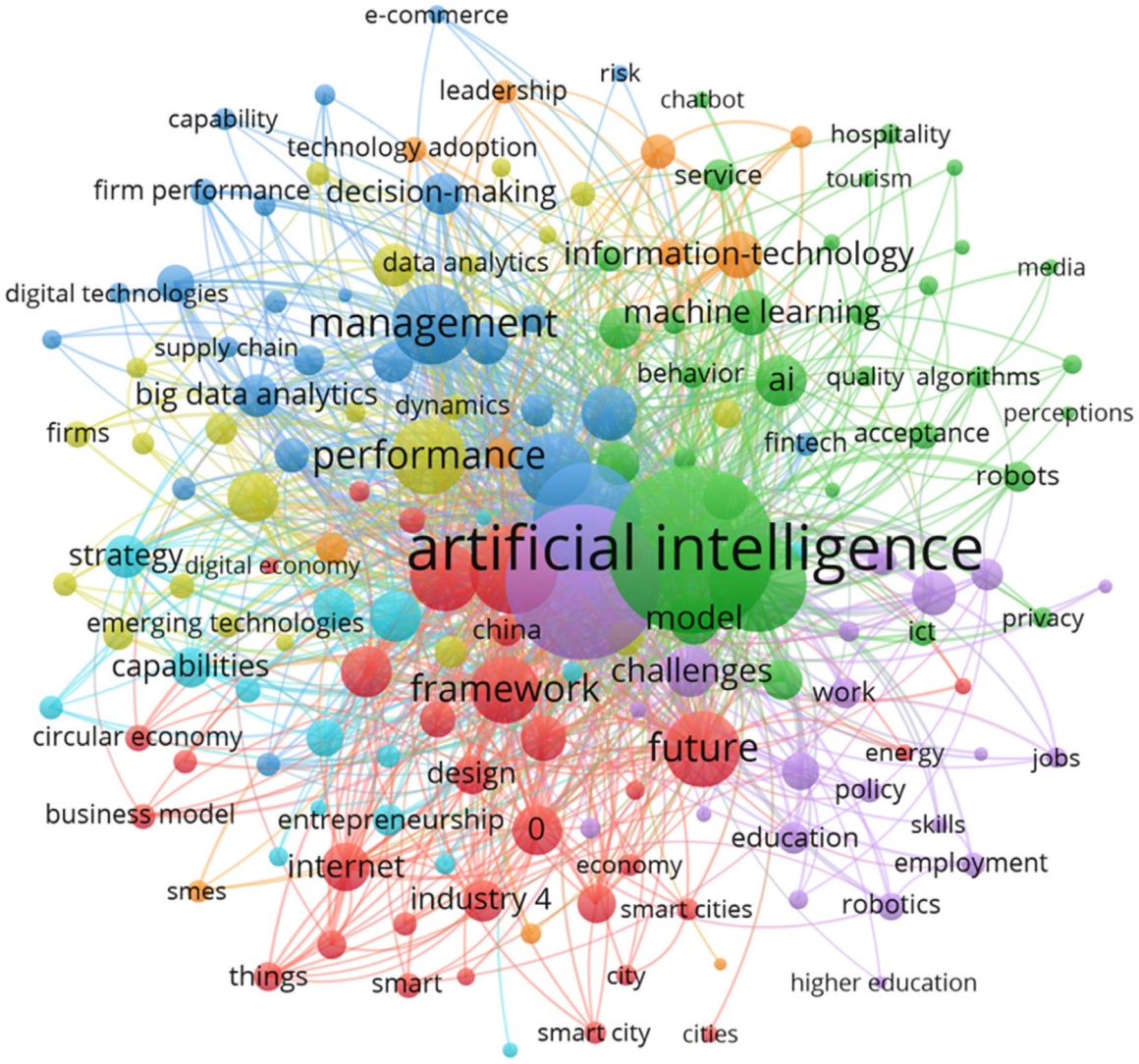

Fig. 3. Keywords co-occurrences (min. 10 keywords threshold).

Table 1
Main 20 keywords based on co-occurrence analysis (ranked by link strength).

Rank	Keyword	Cluster	Occurrences	Total link strength
1	artificial intelligence	2	538	2063
2	innovation	5	358	1831
3	artificial-intelligence	3	178	1025
4	technology	2	163	866
5	big data	1	125	742
6	management	3	99	627
7	future	1	96	577
8	performance	4	98	575
9	impact	3	92	551
10	sustainability	1	94	504
11	framework	1	75	479
12	information	3	59	345
13	model	2	61	314
14	ai	2	60	313
15	challenges	5	46	312
16	Industry 4.0	1	59	309
17	knowledge	4	59	308
18	Digital transformation	6	58	307
19	0	1	41	290
20	internet	1	43	287

Note. Cluster 1 is the red one, cluster 2 is the green one, cluster 3 is the blue one, cluster 4 is the yellow one, cluster 5 is the purple one, and cluster 6 is the turquoise one.

technology. In 2019, many new relevant keywords emerged, introducing different fields in which AI-I can be effective: *triple-helix, robotics*, and *university*. There were also some structural causes and processes regarding the AI-I performances: *inequality, competencies,* and dynamics. The year 2020 drew public attention to important keywords such as *model, internet of things,* and *networks*, alongside the potential ethical, moral, environmental, and legal implications through keywords such as *ethics, responsible innovation,* and *diffusion.* In the year 2021, new technological opportunities emerged in the AI-I field, such as *technological innovation, the future,* and *sustainability*. These opportunities were seen in diverse contexts where AI adoption could enhance innovative processes, such as *industry 4.0, fintech, blockchain,* and *digitalization*. There were also adjacent frameworks that explain the contexts in which users adopt different AI implementations leading to innovation, such as the *technology acceptance model*. By around 2022, there was evidence of isolated nodes that possessed the capacity to bring about potential social, technological, and organizational implications, taking more into account the climate crisis, such as *transformation, corporate social responsibility, resource-based view, firms, business-model innovation, perceived risk*, and so on. Thus, there is a growing interest in ecological and sustainable concerns related to the AI-I field, although these concerns may differ according to certain organizational

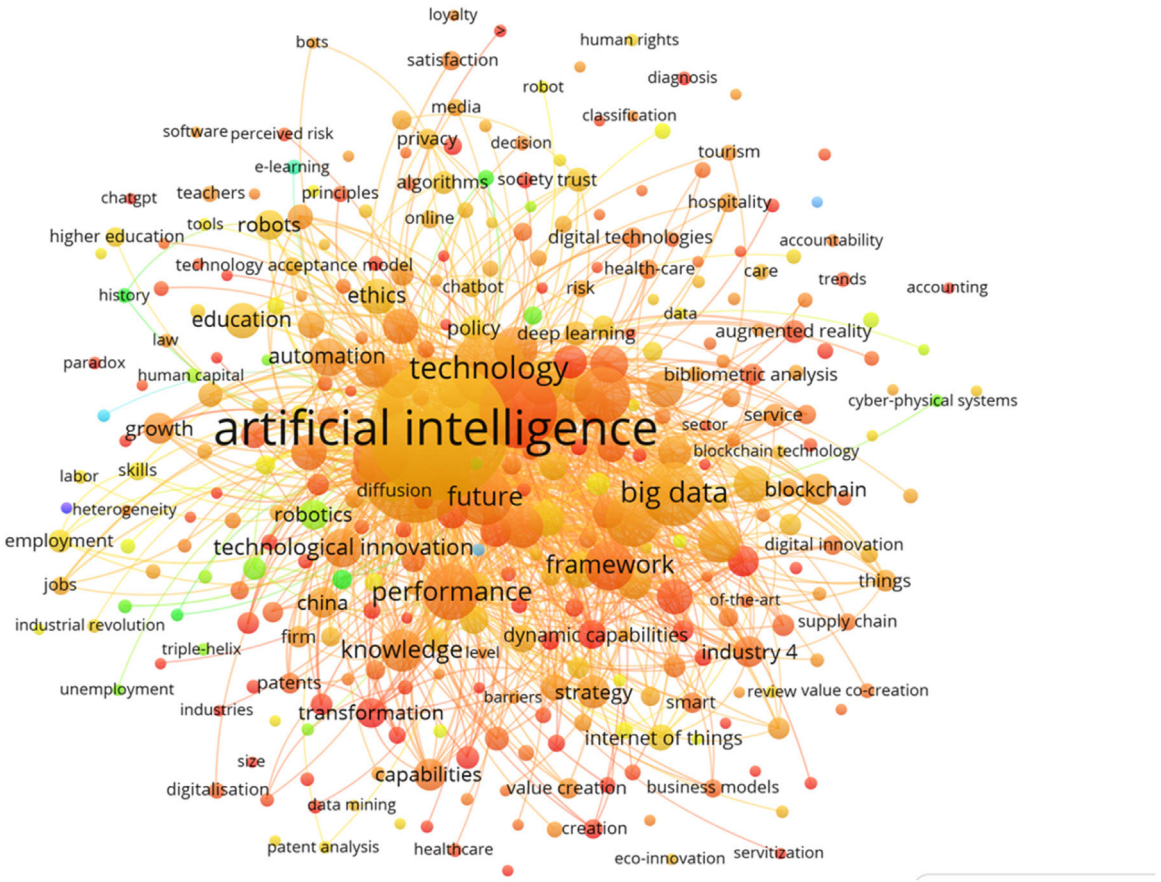

Fig. 4. Keywords heatmap (5 keywords threshold).

characteristics, such as company size, category, and age (Cripps et al., 2020; Mariani et al., 2023).

Author and journal (Co-) citation networks

A co-citation analysis was utilized in this study, which involves a situation when a third document cites two or more documents together. Co-citation analysis retains its technical flexibility specific to bibliometrics since its networks might include references from authors, journals, and articles (Cobo et al., 2011). Table 2 and Fig. 5 present the most co-cited journals. For Fig. 5, we included a minimum number of 30 citations for a source, thereby keeping the 353 most co-cited sources out of a total of 29,765. Thus, in terms of total *ls*, we note that the most co-cited sources regarding AI-I are

Table 2
Main 20 academic outlets based on co-citation analysis (ranked by link strength).

Rank	Academic Outlet	Cluster	Citations	Link strength
1	Technological Forecasting and Social Change	5	1408	77,522
2	Journal of Business Research	2	1102	71,062
3	Sustainability	1	1044	52,864
4	Journal of Cleaner Production	5	804	47,618
5	International Journal of Information Management	3	609	40,318
6	Research Policy	4	773	36,949
7	Industrial Marketing Management	2	437	29,031
8	Strategic Management Journal	3	472	28,219
9	MIS Quarterly	2	478	27,972
10	International Journal of Production Economics	5	313	21,646
11	Harvard Business Review	3	385	21,270
12	Computers in Human Behavior	2	366	20,214
13	International Journal of Production Research	5	294	19,410
14	Technovation	3	289	17,743
15	Organization Science	3	323	17,723
16	Academy of Management Review	3	301	17,009
17	Journal of Marketing	2	243	15,394
18	Business Horizons	3	274	15,290
19	Journal of the Academy of Marketing Science	2	234	15,277
20	Journal of Product Innovation Management	3	226	14,753

Note. Cluster 1 is the red one, cluster 2 is the green one, cluster 3 is the blue one, cluster 4 is the yellow one, and cluster 5 is the purple one.

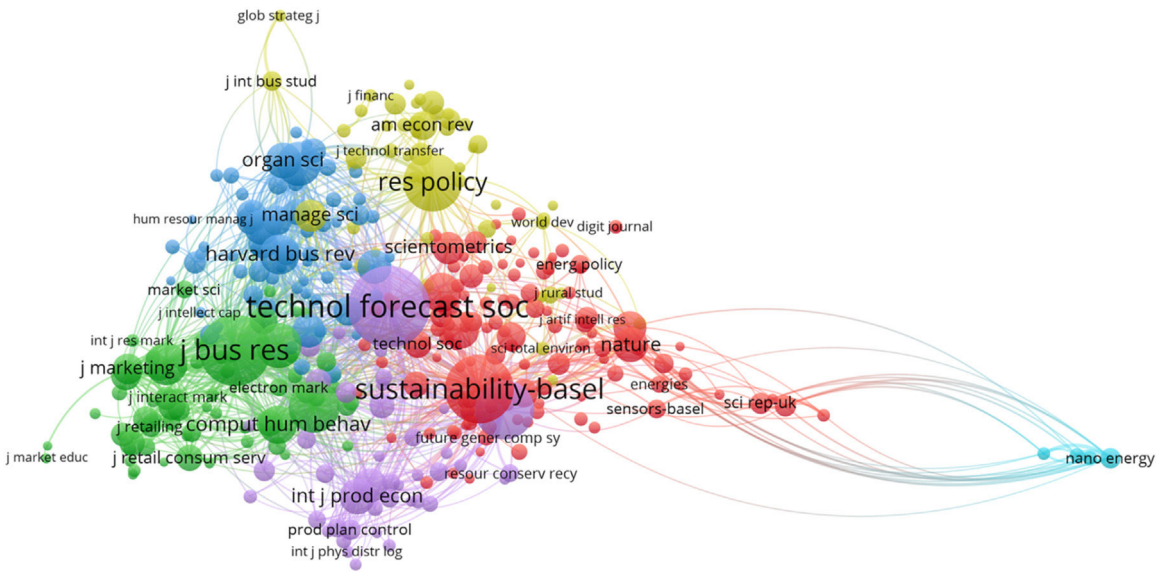

Fig. 5. Co-citation of sources map (30 citations threshold).

Technological Forecasting and Social Change (*ls* = 77,522), Journal of Business Research (*ls* = 71,062), Sustainability (*ls* = 52,864), and Journal of Cleaner Production (*ls* = 47,618). The Journal of Innovation and Knowledge is also included in this ranking, having 73 citations and a link strength of 3686. In terms of author co-citations, we observe that the most central authors in the co-citation network (Fig. 6) are Erik Brynjolfsson (*ls* = 1869), David Teece (*ls* = 1857), and Anjan Chatterjee (*ls* = 1694).

In terms of citations, the most cited studies regarding the multiple implications of AI-I are as follows: "Brave new world: service robots in the frontline" (Wirtz et al., 2018), "Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy" (Dwiveldi et al., 2021), and "Applied artificial intelligence and trust—The case of autonomous vehicles and medical assistance devices" (Hengstler et al., 2016). Tables 3 and 4 and Fig. 7 present a visual representation of the most important studies, journals, and authors in the field. In terms of citations, the most relevant journals are Sustainability (n_c = 1359), Technological Forecasting and Social Change (n_c = 1295), International Journal of Information Management (n_c = 927), Journal of Business Research (n_c = 667), and Journal of Cleaner Production (n_c = 353). Concerning documents related to the diverse aspects of AI-I, the most prominent journals are Sustainability (n_d = 120), followed by Technological Forecasting and Social Change (n_d = 35), IEEE Transactions and Engineering Management (n_d = 25), and Journal of Business Research (n_d = 16).

Table 5 and Fig. 8 present the most important countries in AI-I research. Table 5 demonstrates significant differences between countries regarding classification by citations and classification by documents; however, the United Kingdom ranks first in terms of citations (n_c = 6007). The next countries in terms of citations are the United States (n_c = 3795), Germany (n_c = 2091), India (n_c = 1811), and Australia (n_c = 1729). In terms of documents, the most visible countries are China (n_d = 192), the United States (n_d = 189), the United

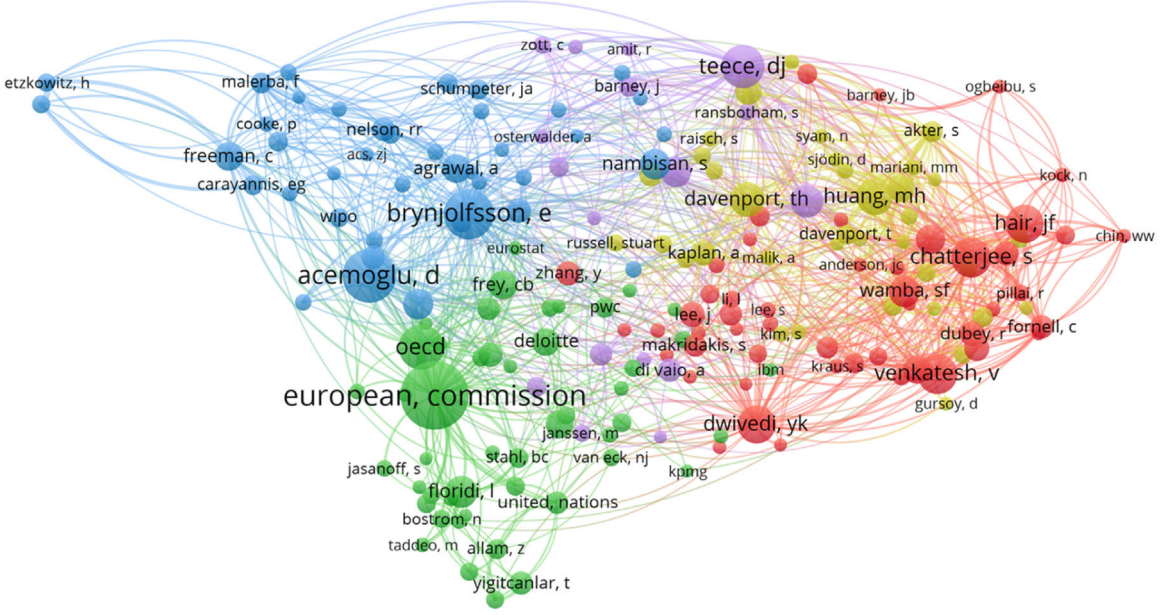

Fig. 6. Co-citation of authors.

Table 3
Top 10 most cited interdisciplinary publications in the field of AI innovations (20 citations threshold).

Rank	Title	Authors (year)	Google Scholar citations as of October 2023	Links with other publications on the map
1	Brave new world: service robots in the frontline	Wirtz et al. (2018)	1427	8
2	Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy	Dwiveldi et al. (2021)	1342	13
3	Applied artificial intelligence and trust—The case of autonomous vehicles and medical assistance devices	Hengstler et al. (2016)	612	4
4	Accelerating the discovery of materials for clean energy in the era of smart automation	Tabor et al. (2018)	574	0
5	Influences of the industry 4.0 revolution on the human capital development and consumer behavior: A systematic review	Sima et al. (2020)	535	0
6	Artificial intelligence and business models in the sustainable development goals perspective: A systematic literature review	Di Vaio et al. (2020)	469	6
7	Smart Factory Implementation and Process Innovation	Sjödin et al. (2018)	450	2
8	A review of research into automation in tourism: Launching the Annals of Tourism Research Curated Collection on Artificial Intelligence and Robotics in Tourism	Tussyadiah et al. (2020)	444	2
9	Service robot implementation: a theoretical framework and research agenda	Belanche et al. (2020)	405	3
10	An agile co-creation process for digital servitization: A micro-service innovation approach	Sjödin et al. (2020)	383	1

Table 4
Top 15 most relevant journals in the field of AI-I, by citations and documents (as of October 2023).

Panel A			Panel B		
No.	Journal name	Citations	No.	Journal name	Documents
1	Sustainability	1359	1	Sustainability	120
2	Technological forecasting and social change	1295	2	Technological forecasting and social change	35
3	International Journal of Information Management	927	3	IEEE Transactions on Engineering Management	25
4	Journal of Business Research	667	4	Journal of Business Research	16
5	Journal of Cleaner Production	353	5	Frontiers in Psychology	16
6	Technology in Society	268	6	Technology in Society	15
7	IEEE Transactions on Engineering Management	225	7	Journal of Cleaner Production	14
8	Government Information Quarterly	203	8	Technovation	12
9	Telecommunications Policy	145	9	PLOS one	9
10	Technovation	134	10	International Journal of Information Management	8
11	Business Strategy and the Environment	134	11	Government Information Quarterly	8
12	Frontiers in Psychology	124	12	Research Policy	8
13	Industrial Marketing Management	120	13	International Journal of Technology Management	8
14	Industrial and Corporate Change	96	14	Industrial Marketing Management	7
15	Research Policy	70	15	Futures	7

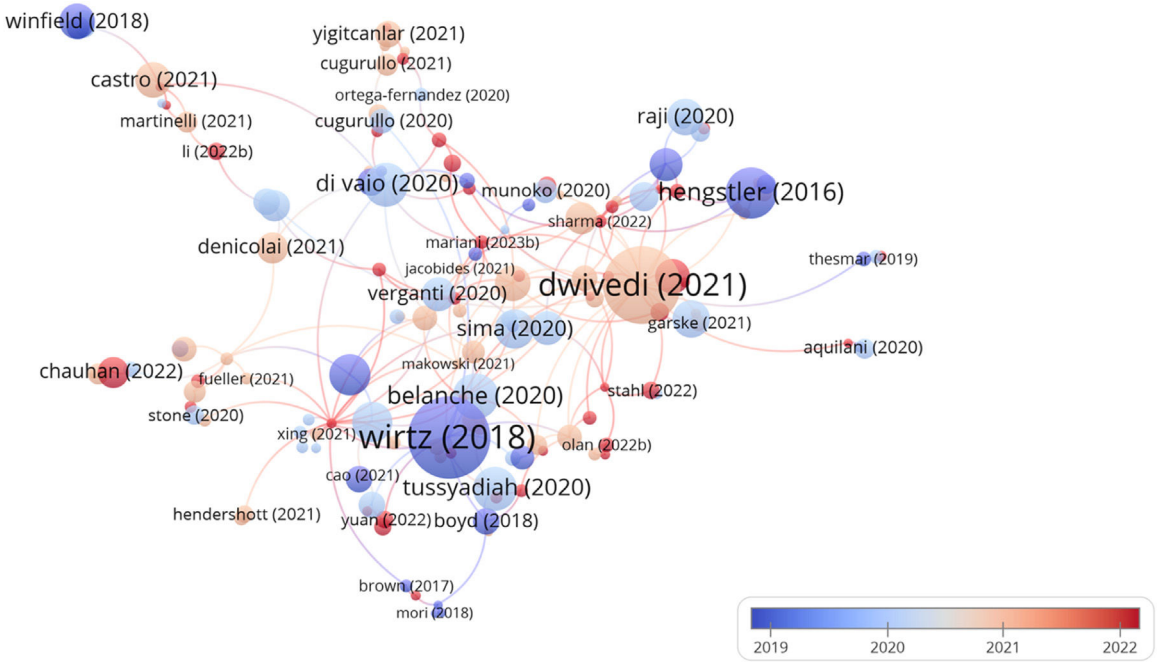

Fig. 7. Authors' citations heat map (10 citations threshold).

Table 5
Top 15 most relevant countries in the field of AI-I, by citations and documents (as of October 2023).

Panel A			Panel B		
No.	Country	Citations	No.	Country	Documents
1	United Kingdom	6007	1	China	192
2	United States	3795	2	United States	189
3	Germany	2091	3	United Kingdom	161
4	India	1811	4	Spain	95
5	Australia	1729	5	Italy	94
6	Italy	1601	6	Germany	85
7	China	1588	7	India	79
8	Netherland	1287	8	Australia	73
9	France	1241	9	France	72
10	Spain	1230	10	Russia	65
11	Finland	1224	11	Canada	39
12	Singapore	1091	12	South Korea	39
13	Sweden	1052	13	Netherlands	38
14	Denmark	961	14	Sweden	36
15	Switzerland	711	15	Finland	34

Note. We applied the criteria of keeping the countries with at least 5 documents and 5 citations per document, leading us to the final 57 entries.

Kingdom (n_d = 161), Spain (n_d = 95), and Italy (n_d = 94). While previous studies (Faraji et al., 2023) identified significant discrepancies between research in the United States and other countries regarding the study of intellectual capital, our observation indicates that these disparities are less pronounced in the study of AI-I. This finding suggests a significant degree of academic competition within the field of knowledge pertaining to this subject matter.

Table 6 and Fig. 9 present the most prominent organizations in this knowledge field; however, there are some notable differences in terms of citations and documents. The most important universities in terms of citations are Loughborough University, UK (n_c = 1450); Swansea University, UK (n_c = 885); the National University of Singapore (n_c = 815); the University of the West of England, UK (n_c = 812); and the Indian Institute of Technology (n_c = 796). In terms of documents published in this knowledge field, the most important universities are Bucharest University of Economic Studies, Romania (n_d = 14); Oxford University, UK (n_d = 12); University of Queensland, Australia (n_d = 12); Tsinghua University of China (n_d= 11); and University of Nicosia, Cyprus (n_d = 10).

A typological framework for AI-I research

As mentioned previously, we conducted a qualitative systematic review comprising the most influential articles from each research area included in the analysis. Depending on the relevant scientometric details (Zhu et al., 2019), we assigned a weight to each research area, such as the number of articles in each field discussing the most relevant aspects, including social, technological, cultural, and moral, related to AI-I.

Thus, adhering to the syntax used in the previous bibliometric analysis, we selected the most influential articles from each research area while simultaneously applying the rule of a frequency >5 per research area as the screening criterion (Cheng et al., 2023). While recent studies have discussed technological, social, and economic criteria as important antecedents in AI adoption for innovation purposes (Mariani et al., 2023), our study specifically addresses aspects that are often neglected outside the business economics field, such as personal, cultural, moral, and ethical aspects. Subsequently, it was necessary to assign a weight to the most influential articles in each area relative to the total number of published articles. Thus, we divided the number of articles in areas with more than 50 articles by ten, after which we divided this number by five for areas with less than 50 articles. Afterward, each co-author investigated the abstract, introduction, discussion, and conclusion for these items. Finally, we investigated the 57 most cited articles in business economics, 23 in science and technology, 13 in the social

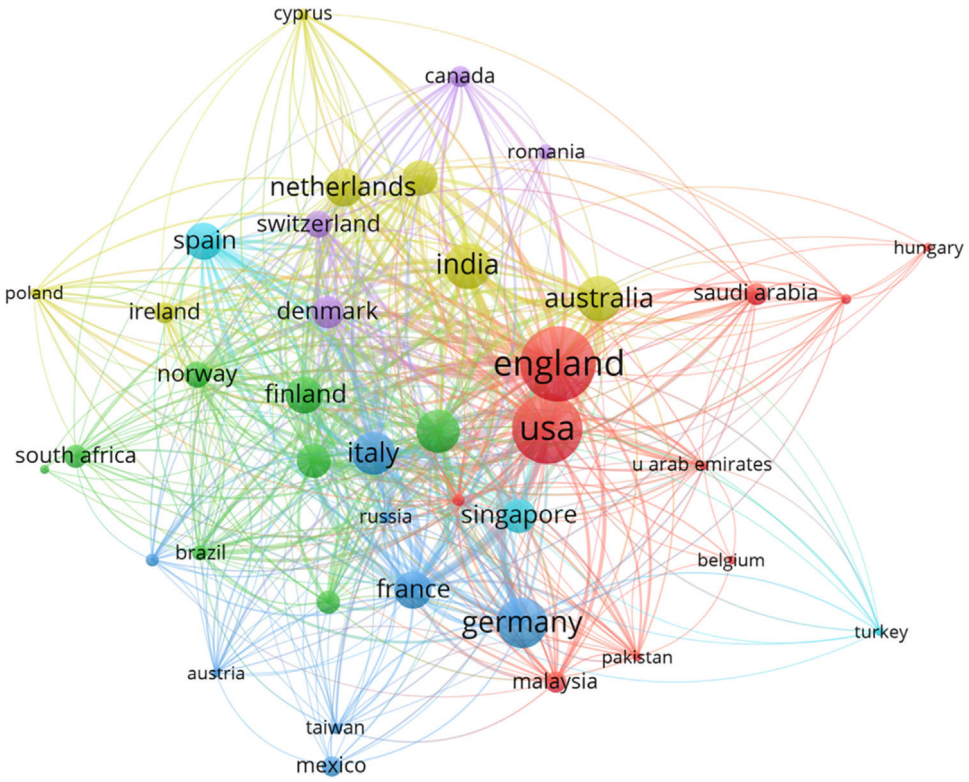

Fig. 8. Main countries in the AI-I field, weighted by citations (minimum 10 documents and 10 citations threshold)
Note. If we count for the United Kingdom, it reaches the first place in terms of citations (with 6007) and 161 documents.

Table 6
Top 15 most relevant organizations in the field of AI-I, by citations and documents (as of October 2023).

Panel A			Panel B		
No.	University (Country)	Citations	No.	University (Country)	Documents
1	Loughborough University (UK)	1450	1	The Bucharest University of Economic Studies (Romania)	14
2	Swansea University (UK)	885	2	Oxford University (UK)	12
3	National University of Singapore (Singapore)	815	3	University of Queensland (Australia)	12
4	University of the West of England (UK)	812	4	Tsinghua University (China)	11
5	Indian Institute of Technology (India)	796	5	University of Nicosia (Cyprus)	10
6	University of Queensland (Australia)	767	6	Swansea University (UK)	9
7	Delft University of Technology (The Netherlands)	745	7	National University of Singapore (Singapore)	8
8	Lulea University of Technology (Sweden)	695	8	Copenhagen Business School (Denmark)	8
9	Copenhagen Business School (Denmark)	662	9	Harvard University (USA)	8
10	Harvard University (USA)	639	10	University of Vaasa (Finland)	8
11	University of Vaasa (Finland)	586	11	University of Naples Parthenope (Italy)	8
12	University of California Berkeley (USA)	500	12	University of Reading (UK)	8
13	Oxford University (UK)	494	13	Polytechnic University of Milan (Italy)	8
14	University of Naples Parthenope (Italy)	322	14	Huazhong University of Science & Technology (China)	8
15	University of Surrey (UK)	260	15	Sydney University of Technology (Australia)	8

Note. We applied the criteria of keeping the countries with at least 5 documents and 5 citations per document, leading us to the final 68 entries.

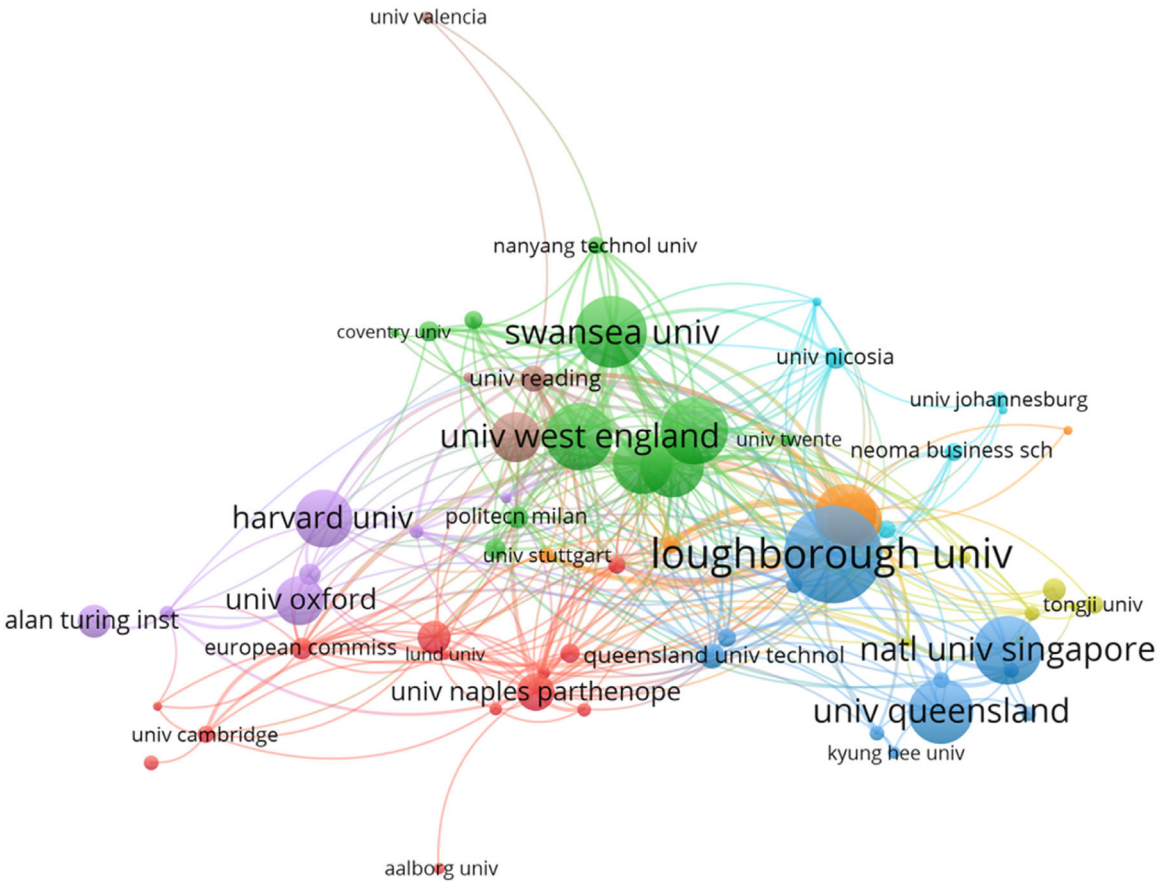

Fig. 9. Main organizations in the AI-I field, weighted by citations (minimum 5 documents and 5 citations threshold).

sciences, 11 in educational research, 9 in information science, 9 in public administration, and a maximum of 5 articles in areas such as social issues, sociology, geography, history philosophy of science, communication, development studies, 4 in philosophy, arts and humanities, 2 in art, and 1 in religion, totaling 163 influential articles for our systematic literature review. Given that certain journal articles fell into overlapping areas, we refrained from duplicating their classification to avoid potential redundancy of the main findings.

Such a systematic review is useful since it brings two major advantages: 1) it changes the focus that is explicitly centered on economic factors that generate innovations through AI; and implicitly, 2) it brings into discussion social science areas other than business/economics, thus highlighting complementary forms of knowledge associated with AI-I. Thus, we find that all these essential non-economic aspects in the field of AI highlight the multidimensional character of innovations, along with their potential implications at the societal level. Our review focuses on both certainties and uncertainties involving the previously mentioned aspects. Fig. 10 examines the multidimensional valences of knowledge in this study.

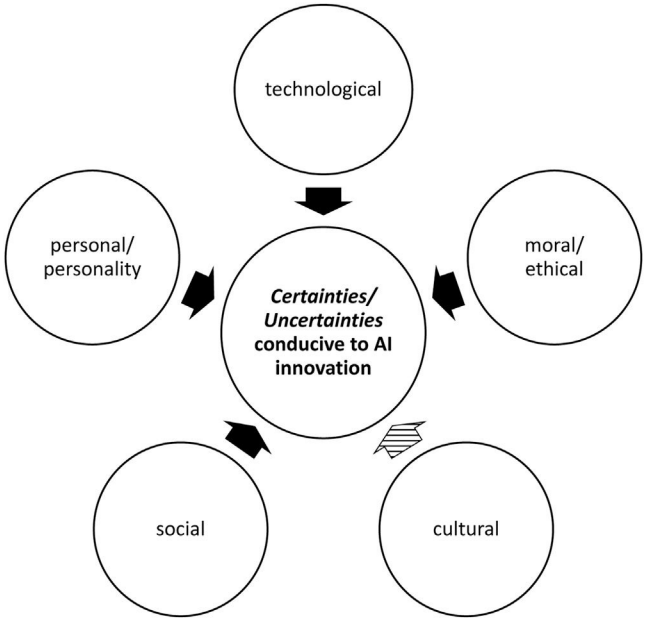

Fig. 10. Conceptual framework to study the multidimensional aspects regarding certainties/ uncertainties on innovations in AI

Note. The arrow with horizontal stripes represents a research field where additional studies would be needed.

Social dimension

The social dimension is popular in the study of AI-I as it examines the heterogeneous human responses that occur with the planning or implementation of these innovations. Thus, through this dimension of knowledge, the antithesis between certainties and uncertainties reflects exactly the aspects through which individuals go through the processes related to AI-related knowledge and, implicitly, the potential innovations in the field of AI. In this sense, Hengstler et al. (2016) highlight the recurring skepticism in relation to AI-I automation while also offering certain ways in which individuals can overcome potential AI-related uncertainties. For example, trust can be gained through increased knowledge of the assembly itself and by assimilating how firms communicate about these innovations. Another relevant article in this field is Tussyadiah's (2020) review on automation in tourism. The author emphasizes the significance of understanding AI automation as a social phenomenon. Thus, the obvious priorities in terms of the social dimension relate to designing a useful AI, along with highlighting the main risks and benefits associated with tourism automation. However, there are some areas in which the social dimension associated with AI-I is rather paved with uncertainties, particularly when it comes to the use of AI in performing criminal acts. King et al. (2020) show that AI in crime is such a new subfield that its social consequences are difficult to predict in the near future.

Other sociologically oriented studies examine AI-I as an important precursor to realizing a social transformation. Boyd and Holton (2018) argue that innovations that facilitate the advancement of AI contribute to knowledge processes maintained by symbolic and discursive forms of power. Consequently, the adjacent historical dynamics are centered on the epistemological and empirical problems through which individuals come into contact with the specific uncertainties related to AI-I.

Sustainable dimension

While the social dimension is popular in research areas such as social sciences, social issues, sociology, and public administration, the sustainable dimension is frequently addressed in fields such as business economics, social issues, and geography. Each area allocates different knowledge processes that involve certainties and uncertainties associated with AI-I.

In business-related contributions, Di Vaio et al. (2020) investigate the primary models through which AI can be trained to encourage the principles of sustainable development. Thus, the authors observe that the systematic implementation of the UN's Sustainable Development Goals is contingent upon the particular uncertainties associated with individuals' mentalities while also influencing production and consumption standards. Denicolai et al. (2021) find that the relationship between sustainability, internationalization, and digitalization among small and medium-sized enterprises is not linear but depends on the company's expansion outside the nation; as the company internationalizes, digitalization and sustainability start to compete. According to Chauhan et al. (2022), digital technologies benefit from the principles of the circular economy; this allows the Internet of Things and AI to work together to solve potential uncertainties, such as policy-related issues, information vulnerabilities, and predictability deficiencies.

From an urban geography perspective, Cugurullo et al. (2021) demonstrate how the transition to autonomous vehicles also changes the design of the road infrastructure. At the same time, this transition gives rise to certain urban politics that go beyond the urban homogeneity specific to the former socialist regions (Chelcea et al., 2021). In addition, the experimental principles related to global cities constitute important sites of uncertainty (Macrorie et al., 2021) such that processes related to responsible urban innovation continue to represent a challenge in the context of the most heterogeneous social infrastructures.

Technological dimension

Among the non-economic dimensions addressed in this systematic review, the technological dimension is the most frequently addressed, being found in most research areas within the social sciences and humanities. Thus, within the science and technology domain, several estimates are made regarding automation in the energy sector in the next five to ten years. Tabor et al. (2018) estimate the emergence of certain tools, such as virtual screening or automation-based synthesis planning, aim to reduce emissions from the energy sector. Lin et al. (2022) propose a technological model centered on machine learning to create high-performance classification systems within supply chain management.

In the educational field, Tamayo et al. (2020) discuss a case study of EconBot focused on making distance learning accessible to students enrolled in the microeconomics class. Krouska et al. (2019) discuss the emergence of social networking-based learning, a technological innovation centered on e-learning where students' social networks play a key role. The authors highlight the potential uncertainties associated with social networking-based learning, as it currently lacks alternatives tailored to the needs of each student. Thus, the emergence of the technological dimension in the educational sector legitimizes the need for a convergence between creative design and a focus on technological automation but also grants an increased role for social media affordances in the educational process (Al Hashimi et al., 2019; Hosszu & Rughiniș, 2020). In this technological context, Garcia-Peñalvo (2023) examines the implications and consequences of ChatGPT adoption in the educational sector, highlighting the nature of the tsunami effect that can easily lead to disruptive innovations, particularly in the absence of coherent regulations that explicitly address the certainties and uncertainties related to language models in education.

In the geography area, Acemoglu and Restrepo (2020) examined the uncertainties surrounding AI-I, finding that the human workforce is in a systematic regression due to the automation processes that

have taken place in a manner that prevents the design of new tasks where human employees can prove productive. Pink et al. (2018) argue that the convergence of mobile phones and cars, both of which have become highly digitized in recent years, can create favorable conditions for autonomous driving while facilitating the interaction between completely different technologies. Armour and Sako (2020) highlight the sociological implications of the technological dimension surrounding AI innovations, demonstrating that AI can still not replace human activity in the legal sector. Given the social and legal implications of improperly automated decisions, it is noted that the legal sector is still one where AI evaluations must be treated with caution.

Technological innovations are also examined in the communication area, investigating how certain ads can generate human reactions when AI techniques are involved. Campbell et al. (2022) examine the emergence of synthetic ads, which refer to content created based on data modification through AI. For instance, in the context of an increasingly accelerated presence of deepfakes, it can be seen how future uncertainties generated by AI-based content will significantly affect consumer activity. In addition, García-Orosa (2021) identifies the recurrent technological innovations in the sphere of e-democracy, identifying a trajectory that starts from 1990, when political actors began their activity online, to 2016, when the Cambridge Analytica scandal highlighted the rise of AI in the production of fake digital contents intended to increase disinformation in a political context.

Personal/personalising dimension

The personal dimension is a relevant form of knowledge regarding AI-I since it sheds light on both the heterogeneous nature of innovations and the personalization component that some innovations make available via AI. However, only a few studies discuss this dimension, and they are found mainly in research areas such as psychology and social issues.

For example, Samuel et al. (2021) discuss the dilemma surrounding automated personalization in the advertising sector. They found that while organizations offering personalized assets may appeal to consumers in many ways, these advanced personalizations are made by obtaining detailed information about their activity, which creates feelings of fear and destruction. Therefore, fully understanding the fears evoked by consumers could enable a deeper understanding of the main barriers to AI-based personalization.

Furthermore, when social issues are involved, different personal valences of AI-I are discussed. For example, Steen (2021) offers some reflections focused on the latest advances in the field of AI, emphasizing the adoption of slow innovation and aiming to create a framework of knowledge that emphasizes the main uncertainties surrounding these innovations. Thus, elements such as uneasy questions and vulnerable experiences must be considered to encourage responsible innovations that contribute to a more human-centric version of AI.

Ethical/moral dimensions

This dimension is debated in multiple research areas involving AI-I, such as science and technology, sociology, educational research, public administration, and philosophy. In science and technology, Winfield and Jirotka (2018) investigate the need for ethical governance for AI systems. Their aim is to establish public trust in AI and promote social solidarity regarding potential innovations based on automation. By shifting the interest from an information-centric approach to a data-centric one, Floridi and Taddeo (2016) highlight data ethics as a relevant epistemological branch, whereby the interest in the ethical dimension of AI-I becomes holistic and inclusive. Floridi (2018) distinguishes between *hard ethics*, which creates the technological premises for the implementation of legislation in the field of AI, and *soft ethics*, which takes place after legislation is established and legal compliance is achieved.

In the educational sciences, Grunhut et al. (2022) demonstrate the ethical implications of doctors adopting AI in the medical education curriculum. Moreover, conservative principles prevent the incorporation of AI innovations in the educational sector due to uncertainties that revolve around the lack of technical expertise among physicians and the lack of interest of medical students in learning about AI.

Kravchenko and Kyzymenko (2019) introduce a philosophical approach centered on ethical issues related to the Fourth Industrial Revolution. Thus, various theories from the sphere of the socio-humanitarian paradigm overlap with the empirical concerns surrounding automation, encouraging the adoption of "responsible innovations" as a relevant form of knowledge involving AI-I to address recurring social problems such as technological unemployment.

Cultural dimension

The cultural dimension is the least prevalent among AI-I from a quantitative perspective; however, we encounter cultural aspects of knowledge in various research areas, such as business economics, information science/library science, public administration, and sociology. Within business economics, several studies (Fountaine et al., 2019) argue that the technological factor is not the biggest obstacle to an organization adopting AI innovations but rather the cultural factor. Specifically, when adopting automation-centric innovations, it is important to consider the cultural barriers of traditional mindsets, along with the constant concern of job loss.

From another point of view, Feijóo et al. (2020) believe that adopting AI on a large scale can be achieved through international policy coordination that considers cultural variations in certainties and uncertainties, which broadly revolve around principles related to efficiency, surveillance, and privacy protection. From the sphere of public administration, Lazzeretti (2022) notes that the cultural aspect is at the confluence of digital transformation and social change, indicating that both the certainties and uncertainties in the sphere of AI-I relate to the preservation of cultural elements. When innovations lack an emotional component, people can no longer fulfill their expectations of cultural proximity (Tubadji et al., 2021). From a sociological standpoint, Brooks et al. (2020) also demonstrate how cultural pressure prevents the rapid adoption of automation and AI transformations, and such resistance systematically challenges different business models. Therefore, the discourse around the cultural dimension confirms the relevance of establishing connections with other components, such as social, technological, and sustainable aspects. Furthermore, we observe that each dimension contributes to shaping particular types of knowledge, with their own certainties and uncertainties regarding the adoption of AI-I. Thus, it is imperative to examine these dimensions collectively.

Discussion

By combining bibliometric analyses and a typological review of the AI-I field in the social sciences until July 2023, we highlighted the main research topics and adjacent keywords most frequently connected with innovation and AI. We also demonstrated the emergence of new topics in this field, indicating a shift in scholarly interest from purely technological or engineering interests toward interests related to large-impact implementations, such as the blockchain-centered approach and sustainability interests. This shift is reflected in the incorporation of concepts such as *corporate social responsibility, resource-based view*, and *ecosystems*. In addition, we demonstrated the tendency of these keywords to form coherent clusters, thereby drawing upon the broader field of AI innovations to supplement existing methodologies, such as the method employed by Mariani et al. (2023), which involves the exclusion of specific innovation types.

There are a variety of implications for such a study. First, it maps the existing knowledge field for innovation and AI scholars through the convergence of the two increasingly popular concepts. Therefore, mapping the AI-I field using bibliometric techniques revealed the main thematic clusters in which these studies are grouped, as well as a time-zone approach analysis that highlights the "hot topics" in the AI-I field and topics that are no longer of intense interest. Second, our systematic review of the relevant typologies reveals practical implications in the AI-I field. For example, while previous studies have mainly highlighted the organizational and economic implications of firms in different sectors adopting AI in order to innovate (Cui et al., 2023; Lin et al., 2022; Mariani et al., 2023), our study extends this approach by focusing on non-economic factors conducive to AI-I. Thus, we mainly focused on the social, technological, cultural, personal/personalizing, and moral/ethical forms of knowledge by including a plethora of research areas that are part of the social sciences and humanities field.

The findings from our analysis emphasize the non-economic criteria of knowledge associated with AI-I, highlighting at the same time the promising dimensions and the areas lacking in terms of knowledge. For example, our bibliometric analysis and further systematic review demonstrate an increasing focus on the ethical dimension associated with AI-I. This form of knowledge proves relevant as it highlights the bottom-up side of such a field, generating at the same time forms of soft ethics (Floridi, 2018) that encourage knowledge centered on slow innovation (Steen, 2021). Our analysis also demonstrates the heterogeneous nature of technological certainties and uncertainties. We observe that each research area investigates different technological aspects when it comes to AI-I, from the accessibility of the e-learning process (Krouska et al., 2019) to the improvement of organizational performance (Wamba et al., 2021) or the outline of the infrastructure related to smart cities (Cugurullo et al., 2021).

The results obtained within the social, cultural, and personal dimensions are useful for researchers, journalists, and policymakers as they discuss the main societal directions generated by AI-I. The analysis related to the social, technological, and sustainable aspects proves to be highly valuable within the organizational context as it explores the primary sectors that are progressively incorporating innovative practices and technologies in the AI field. Such an analysis can highlight both the success of such measures in terms of efficiency and productivity as well as the social and cultural factors involved in the organizational environment, such as employee acceptance of these innovations. Furthermore, the concept of sustainability is a frequently approached topic due to its significant role in the advancement of businesses (Denicolai et al., 2021; Verganti et al., 2020). Finally, the personal/personalizing, as well as moral/ethical and cultural dimensions in the AI-I field are useful not only for experts but also for authors who have encountered AI-I in different circumstances. Such discourse is important at the citizen level, given that these rapid innovations have been seen as dehumanizing (Liu, 2021). For this reason, concepts such as "slow innovation" (Steen, 2021) have become increasingly popular concerning AI.

As shown in Fig. 10, there are certain research gaps regarding AI-I that could be addressed by future studies to bridge existing gaps. First, future studies could examine precise cultural contexts in relation to these innovations, such as the relationships between certain religions and ethnicities and the automation that comes along with the large-scale adoption of AI. Second, certain interdisciplinary perspectives could investigate the confluence of factors such as social – cultural, ethical – sustainable, and technological – personal in ways that highlight the heterogeneous nature of uncertainties about AI-I.

Limitations and implications

Our analysis has certain limitations, specifically in regard to the selection of relevant spheres in the study of AI-I. While attempts are made to mitigate this bias by investigating recurrent factors visible in comparable studies (Cheng et al., 2023; Mariani et al., 2023), every search strategy has an evident impact on the main findings obtained. This is the first study to explicitly discuss the non-economic aspects related to AI-I in the social sciences. It places emphasis on the knowledge components centered on *certainties* and *uncertainties*, thus highlighting the complex nature of the factors involved in human decisions concerning AI.

This study has specific implications for researchers and practitioners in the field of AI. At the epistemological level, we highlighted the heterogeneous nature of the debate surrounding innovations, demonstrating how each non-economic factor comes with its own certainties and uncertainties in the context of AI automation. Additionally, these findings offer implications for policymakers. They demonstrate that AI should adopt principles related to responsible and slow innovation, taking into account both cultural and ethical factors. By doing so, these innovations can benefit from a level of greater social acceptance.

Conclusion

This study utilized a bibliometric analysis and systematic literature review to demonstrate that the topic of AI-I presents a heterogeneous orientation in the field of social sciences, and such heterogeneity goes beyond the economic implications associated with these approaches. We identified the recurrent non-economic dimensions in the study of these innovations, specifically the social, sustainable, technological, personal/personalizing, ethical/moral, and cultural dimensions. Through our bibliometric time-zone analysis, we identified recently emerged nodes that present visible scholarly potential, such as *transformation, corporate social responsibility, resource-based view, firms, business-model innovation, and perceived risk*. Through integrating bibliometric techniques and a systematic literature review of the influential studies in each research area, we have provided an integrated framework that maps the evolution of this field from 2000 to the present. In addition, we have identified an estimation of potential future directions that highlight the importance and diversity of innovations in the field of AI.

References

Acemoglu, D., & Restrepo, P. (2020). The wrong kind of AI? Artificial intelligence and the future of labour demand. *Cambridge Journal of Regions, Economy and Society, 13* (1), 25–35. doi:10.1093/cjres/rsz022.

Adner, R., Puranam, P., & Zhu, F. (2019). What is different about digital strategy? From quantitative to qualitative change. *Strategy Science, 4*(4), 253–261. doi:10.1287/stsc.2019.0099.

Al Hashimi, S. A., Al Muwali, A. A., Zaki, Y. E., & Mahdi, N. A (2019). The effectiveness of social media and multimedia-based pedagogy in enhancing creativity among art, design, and digital media students. *International Journal of Emerging Technologies in Learning (IJET), 14*(21), 176–190. doi:10.3991/ijet.v14i21.10596.

An, X. Y., & Wu, Q. Q. (2011). Co-word analysis of the trends in stem cells field based on subject heading weighting. *Scientometrics, 88*(1), 133–144. doi:10.1007/s11192-011-0374-1.

Armour, J., & Sako, M. (2020). AI-enabled business models in legal services: From traditional law firms to next-generation law companies? *Journal of Professions and Organization, 7*(1), 27–46. doi:10.1093/jpo/joaa001.

Belanche, D., Casaló, L. V., Flavián, C., & Schepers, J. (2020). Service robot implementation: A theoretical framework and research agenda. *The Service Industries Journal, 40*(3–4), 203–225. doi:10.1080/02642069.2019.1672666.

Benavides-Velasco, C. A., Quintana-García, C., & Guzmán-Parra, V. F. (2013). Trends in family business research. *Small Business Economics, 40*(1), 41–57. doi:10.1007/s11187-011-9362-3.

Bettis, R. A., & Hu, S. (2018). Bounded rationality, heuristics, computational complexity, and artificial intelligence. *Advances in Strategic Management,* 139–150. doi:10.1108/s0742-332220180000039010.

Boyd, R., & Holton, R. J. (2018). Technology, innovation, employment and power: Does robotics and artificial intelligence really mean social transformation? *Journal of Sociology, 54*(3), 331–345. doi:10.1177/1440783317726591.

Brooks, C., Gherhes, C., & Vorley, T. (2020). Artificial intelligence in the legal sector: Pressures and challenges of transformation. *Cambridge Journal of Regions, Economy and Society, 13*(1), 135–152. doi:10.1093/cjres/rsz026.

Callon, M., Rip, A., & Law, J. (1986). *Mapping the dynamics of science and technology.* Springer.

Campbell, C., Plangger, K., Sands, S., & Kietzmann, J. (2022). Preparing for an era of deepfakes and ai-generated ads: A framework for understanding responses to manipulated advertising. *Journal of Advertising, 51*(1), 22–38. doi:10.1080/00913367.2021.1909515.

Chauhan, C., Parida, V., & Dhir, A. (2022). Linking circular economy and digitalisation technologies: A systematic literature review of past achievements and future promises. *Technological Forecasting and Social Change, 177*, 121508. doi:10.1016/j.techfore.2022.121508.

Chelcea, L., Ferenčuhová, S., & Bădescu, G. (2021). Globalizing postsocialist urbanism. M. Lancione & C. McFarlane, *Global urbanism: Knowledge, power and the city* M. Lancione & C. McFarlane. (pp. 71–79). Routledge.

Cheng, C., Wang, L., Xie, H., & Yan, L. (2023). Mapping digital innovation: A bibliometric analysis and systematic literature review. *Technological Forecasting and Social Change, 194*. doi:10.1016/j.techfore.2023.122706 122706–122706.

Chui, M., Henke, N., & Miremadi, M. (2018). Most of AI's business uses will be in two areas. *Harvard Business Review, 20*, 3–7.

Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2011). Science mapping software tools: Review, analysis, and cooperative study among tools. *Journal of the American Society for Information Science and Technology, 62*(7), 1382–1402. doi:10.1002/asi.21525.

Cripps, H., Singh, A., Mejtoft, T., & Salo, J. (2020). The use of Twitter for innovation in business markets. *Marketing Intelligence & Planning, 38*(5), 587–601. doi:10.1108/mip-06-2019-0349 Emerald.

Cugurullo, F., Acheampong, R. A., Gueriau, M., & Dusparic, I. (2021). The transition to autonomous cars, the redesign of cities and the future of urban sustainability. *Urban Geography, 42*(6), 833–859. doi:10.1080/02723638.2020.1746096.

Cui, Y., Ma, Z., Wang, L., Yang, A., Liu, Q., Kong, S., et al. (2023). A survey on big data-enabled innovative online education systems during the COVID-19 pandemic. *Journal of Innovation & Knowledge, 8*,(1) 100295. doi:10.1016/j.jik.2022.100295.

Dai, S., Duan, X., & Zhang, W. (2020). Knowledge map of environmental crisis management based on keywords network and co-word analysis, 2005–2018. *Journal of Cleaner Production, 262*, 121168. doi:10.1016/j.jclepro.2020.121168.

Denicolai, S., Zucchella, A., & Magnani, G. (2021). Internationalization, digitalization, and sustainability: Are SMEs ready? A survey on synergies and substituting effects among growth paths. *Technological Forecasting and Social Change, 166*, 120650. doi:10.1016/j.techfore.2021.120650.

Di Vaio, A., Palladino, R., Hassan, R., & Escobar, O. (2020). Artificial intelligence and business models in the sustainable development goals perspective: A systematic literature review. *Journal of Business Research, 121*(1), 283–314. doi:10.1016/j.jbusres.2020.08.019.

Dwivedi, Y. K., Hughes, L., Ismagilova, E., Aarts, G., Coombs, C., Crick, T., et al. (2021). Artificial intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Management, 57*(101994). doi:10.1016/j.ijinfomgt.2019.08.002.

Fahimnia, B., Sarkis, J., & Davarzani, H. (2015). Green supply chain management: A review and bibliometric analysis. *International Journal of Production Economics, 162*, 101–114. doi:10.1016/j.ijpe.2015.01.003.

Faraji, O., Asiaei, K., Rezaee, Z., Bontis, N., & Dolatzarei, E. (2022). Mapping the conceptual structure of intellectual capital research: A co-word analysis. *Journal of Innovation & Knowledge, 7*,(3) 100202. doi:10.1016/j.jik.2022.100202.

Feijóo, C., Kwon, Y., Bauer, J. M., Bohlin, E., Howell, B., Jain, R., et al. (2020). Harnessing artificial intelligence (AI) to increase wellbeing for all: The case for a new technology diplomacy. *Telecommunications Policy, 44*,(6) 101988. doi:10.1016/j.telpol.2020.101988.

Floridi, L. (2018). Soft ethics, the governance of the digital and the general data protection regulation. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 376*,(2133) 20180081. doi:10.1098/rsta.2018.0081.

Floridi, L., & Taddeo, M. (2016). What is data ethics? *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 374*,(2083) 20160360. doi:10.1098/rsta.2016.0360.

Fountaine, T., McCarthy, B., & Saleh, T. (2019). *Building the ai-powered organization*. June 18, Harvard Business Review. https://hbr.org/2019/07/building-the-ai-powered-organization.

Funko, I. S., Vlačić, B., & Dabić, M. (2023). Corporate entrepreneurship in public sector: A systematic literature review and research agenda. *Journal of Innovation & Knowledge, 8*,(2) 100343. doi:10.1016/j.jik.2023.100343.

García-Orosa, B. (2021). Disinformation, social media, bots, and astroturfing: The fourth wave of digital democracy. *El Profesional de La Información, 30*(6). doi:10.3145/epi.2021.nov.03.

García-Peñalvo, F. J. (2023). La percepción de la inteligencia artificial en contextos educativos tras el lanzamiento de chatgpt: Disrupción o pánico. *Education in the Knowledge Society (EKS), 24*, 1–9. doi:10.14201/eks.31279.

Grunhut, J., Marques, O., & Wyatt, A. T. M. (2022). Needs, challenges, and applications of artificial intelligence in medical education curriculum. *JMIR Medical Education, 8* (2), e35587. doi:10.2196/35587.

Haefner, N., Wincent, J., Parida, V., & Gassmann, O. (2021). Artificial intelligence and innovation management: A review, framework, and research agenda. *Technological Forecasting and Social Change, 162*(120392). doi:10.1016/j.techfore.2020.120392 sciencedirect.

Hâncean, M. G., Perc, M., & Lerner, J. (2021). The coauthorship networks of the most productive European researchers. *Scientometrics, 126*(1), 201–224. doi:10.1007/s11192-020-03746-5.

Hengstler, M., Enkel, E., & Duelli, S. (2016). Applied artificial intelligence and trust—The case of autonomous vehicles and medical assistance devices. *Technological Forecasting and Social Change, 105*, 105–120. doi:10.1016/j.techfore.2015.12.014.

Hood, W. W., & Wilson, C. S. (2001). The literature of bibliometrics, scientometrics, and informetrics. *Scientometrics, 52*, 291–314. doi:10.1023/a:1017919924342.

Hosszu, A., & Rughiniș, C. (2020). Digital divides in education. An analysis of the Romanian public discourse on distance and online education during the COVID-19 pandemic. *Sociologie Românească, 18*(2), 11–39. doi:10.33788/sr.18.2.1.

Hu, J., & Zhang, Y. (2015). Research patterns and trends of recommendation system in China using co-word analysis. *Information Processing & Management, 51*(4), 329–339. doi:10.1016/j.ipm.2015.02.002.

Khan, G. F., & Wood, J. (2015). Information technology management domain: Emerging themes and keyword analysis. *Scientometrics, 105*(2), 959–972. doi:10.1007/s11192-015-1712-5.

Khasseh, A. A., Soheili, F., Moghaddam, H. S., & Chelak, A. M. (2017). Intellectual structure of knowledge in iMetrics: A co-word analysis. *Information Processing & Management, 53*(3), 705–720. doi:10.1016/j.ipm.2017.02.001.

King, T. C., Aggarwal, N., Taddeo, M., & Floridi, L. (2020). Artificial intelligence crime: An interdisciplinary analysis of foreseeable threats and solutions. *Science and Engineering Ethics, 26*, 89–120. doi:10.1007/s11948-018-00081-0.

Köseoglu, M. A., Okumus, F., Putra, E. D., Yildiz, M., & Dogan, I. C. (2019). Conceptual structure of lodging-context studies: 1990-2016. *Journal of Hospitality & Tourism Research, 43*(4), 573–594. doi:10.1177/1096348018823912.

Kravchenko, A., & Kyzymenko, I. (2019). The forth industrial revolution: New paradigm of society development or posthumanist manifesto. *Philosophy and Cosmology, 22*, 120–128. doi:10.29202/phil-cosm/22/10.

Krouska, A., Troussas, C., & Virvou, M. (2019). SN-Learning: An exploratory study beyond e-learning and evaluation of its applications using EV-SNL framework. *Journal of Computer Assisted Learning, 35*(2), 168–177. doi:10.1111/jcal.12330.

Lazzeretti, L. (2022). What is the role of culture facing the digital revolution challenge? Some reflections for a research agenda. *European Planning Studies, 30*(9), 1617–1637. doi:10.1080/09654313.2020.1836133.

Lin, H., Lin, J., & Wang, F. (2022). An innovative machine learning model for supply chain management. *Journal of Innovation & Knowledge, 7*,(4) 100276. doi:10.1016/j.jik.2022.100276.

Liu, Z. (2021). Sociological perspectives on artificial intelligence: A typological reading. *Sociology Compass, 15*(3). doi:10.1111/soc4.12851.

Lu, Y. (2019). Artificial intelligence: A survey on evolution, models, applications and future trends. *Journal of Management Analytics, 6*, 1–29. doi:10.1080/23270012.2019.1570365.

Macrorie, R., Marvin, S., & While, A. (2021). Robotics and automation in the city: A research agenda. *Urban Geography, 42*(2), 197–217. doi:10.1080/02723638.2019.1698868.

Mariani, M. M., Machado, I., & Nambisan, S. (2023). Types of innovation and artificial intelligence: A systematic quantitative literature review and research agenda. *Journal of Business Research, 155*, 113364. doi:10.1016/j.jbusres.2022.113364.

Pink, S., Fors, V., & Glöss, M. (2018). The contingent futures of the mobile present: Automation as possibility. *Mobilities, 13*(5), 615–631. doi:10.1080/17450101.2018.1436672.

Ravikumar, S., Agrahari, A., & Singh, S. N. (2015). Mapping the intellectual structure of scientometrics: A co-word analysis of the journal Scientometrics (2005–2010). *Scientometrics, 102*(1), 929–955. doi:10.1007/s11192-014-1402-8.

Samuel, A., White, G. R. T., Thomas, R., & Jones, P. (2021). Programmatic advertising: An exegesis of consumer concerns. *Computers in Human Behavior, 116*, 106657. doi:10.1016/j.chb.2020.106657.

Schulz-Schaeffer, I. (2002). Innovation by means of concept transfer: Recourse to established knowledge in the production of technological innovations exemplified by multiagent research. *Zeitschrift Für Soziologie, 31*(3), 232–251. doi:10.1515/zfsoz-2002-0304.

Sjödin, D. R., Parida, V., Leksell, M., & Petrovic, A. (2018). Smart factory implementation and process innovation: A preliminary maturity model for leveraging digitalization in manufacturing moving to smart factories presents specific challenges that can be addressed through a structured approach focused on people, processes, and technologies. *Research-Technology Management, 61*(5), 22–31. doi:10.1080/08956308.2018.1471277.

Sjödin, D., Parida, V., Kohtamäki, M., & Wincent, J. (2020). An agile co-creation process for digital servitization: A micro-service innovation approach. *Journal of Business Research, 112*(1), 478–491. doi:10.1016/j.jbusres.2020.01.009.

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

Steen, M. (2021). Slow innovation: The need for reflexivity in responsible innovation (RI). *Journal of Responsible Innovation, 8*(2), 254–260. doi:10.1080/23299460.2021.1904346.

Sun, Y., & Grimes, S. (2016). The emerging dynamic structure of national innovation studies: A bibliometric analysis. *Scientometrics, 106*, 17–40. doi:10.1007/s11192-015-1778-0.

Tabor, D. P., Roch, L. M., Saikin, S. K., Kreisbeck, C., Sheberla, D., Montoya, J. H., et al. (2018). Accelerating the discovery of materials for clean energy in the era of smart automation. *Nature Reviews Materials, 3*(5), 5–20. doi:10.1038/s41578-018-0005-z.

Tamayo, P. A., Herrero, A., Martín, J., Navarro, C., & Tránchez, J. M. (2020). Design of a chatbot as a distance learning assistant. *Open Praxis, 12*(1), 145–153. doi:10.5944/openpraxis.12.1.1063.

Truong, Y., & Papagiannidis, S. (2022). Artificial intelligence as an enabler for innovation: A review and future research agenda. *Technological Forecasting and Social Change, 183*, 121852. doi:10.1016/j.techfore.2022.121852.

Tubadji, A., Huang, H., & Webber, D. J. (2021). Cultural proximity bias in AI-acceptability: The importance of being human. *Technological Forecasting and Social Change, 173*, 121100. doi:10.1016/j.techfore.2021.121100.

Tussyadiah, I. (2020). A review of research into automation in tourism: Launching the annals of tourism research curated collection on artificial intelligence and robotics in tourism. *Annals of Tourism Research, 81*, 102883. doi:10.1016/j.annals.2020.102883.

Uyar, A., Kılıç, M., & Koseoglu, M. A. (2020). Exploring the conceptual structure of the auditing discipline through co-word analysis: An international perspective. *International Journal of Auditing, 24*(1), 53–72. doi:10.1111/ijau.12178.

Verganti, R., Vendraminelli, L., & Iansiti, M. (2020). Innovation and design in the age of artificial intelligence. *Journal of Product Innovation Management, 37*(3), 212–227. https://onlinelibrary.wiley.com/doi/full/10.1111/jpim.12523.

Waltman, L., van Eck, N. J., & Noyons, E. C. M. (2010). A unified approach to mapping and clustering of bibliometric networks. *Journal of Informetrics, 4*(4), 629–635. doi:10.1016/j.joi.2010.07.002.

Wamba, S. F., Bawack, R. E., Guthrie, C., Queiroz, M. M., & Carillo, K. D. A. (2021). Are we preparing for a good AI society? A bibliometric review and research agenda. *Technological Forecasting and Social Change, 164*, 120482. doi:10.1016/j.techfore.2020.120482.

Winfield, A. F. T., & Jirotka, M. (2018). Ethical governance is essential to building trust in robotics and artificial intelligence systems. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 376*,(2133) 20180085. doi:10.1098/rsta.2018.0085.

Wirtz, J., Patterson, P. G., Kunz, W. H., Gruber, T., Lu, V. N., Paluch, S., et al. (2018). Brave new world: Service robots in the frontline. *Journal of Service Management, 29*(5), 907–931. doi:10.1108/josm-04-2018-0119.

Yang, Y., Wu, M., & Cui, L. (2012). Integration of three visualization methods based on co-word analysis. *Scientometrics, 90*(2), 659–673. doi:10.1007/s11192-011-0541-4.

Zhang, W., Zhang, Q., Yu, B., & Zhao, L. (2015). Knowledge map of creativity research based on keywords network and co-word analysis, 1992–2011. *Quality & Quantity, 49*(3), 1023–1038. doi:10.1007/s11135-014-0032-9.

Zhu, J., Song, L. J., Zhu, L., & Johnson, R. E. (2019). Visualizing the landscape and evolution of leadership research. *The Leadership Quarterly, 30*(2), 215–232. doi:10.1016/j.leaqua.2018.06.003.

Zupic, I., & Čater, T. (2015). Bibliometric methods in management and organization. *Organizational Research Methods, 18*(3), 429–472. doi:10.1177/1094428114562629.