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Artificial Intelligence in Journalism: A Ten-Year Retrospective of Scientific Articles (2014–2023)

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Abstract: Academic interest in AI in journalism has been growing since 2018. Through a systematic review of the literature from 2014 to 2023, this study discusses the evolution of research in the field and how AI has changed journalism. The aim is to understand the impact of AI on journalism, based on a review of academic papers and a qualitative analysis of the most cited articles. This study combines: a systematic review of scientific articles extracted from Web of Science and Scopus (n = 699) and a qualitative approach with categorical content analysis of those with more than 50 citations (n = 59). The results (n = 699) highlight the prominence of authors from the Universities of Amsterdam and Santiago de Compostela. The United States has the largest number of authorships: 261 distributed across 99 institutions. The categorical content analysis (n = 59) shows a focus on issues like the work of the journalist, because AI is replacing journalists with repetitive and monotonous tasks, raising several questions about the role of the journalist. The findings show the rise of computational methods, highlighting the pervasiveness of AI in research, which has not been explored in previous work. Ethics, regulation, and journalism education remain under-discussed in research.

Keywords: artificial intelligence; automated journalism; news production; GenAI; NLP; systematic review

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1. Introduction

The history of AI took its first steps in the 1950s, marked by pioneering scientists such as John McCarthy, who coined the term artificial intelligence (AI). However, it was not until the launch of ChatGPT in November 2022 that AI gained significant visibility, registering new developments in society. With financial investments exceeding USD 90 billion in 2021 and 2022 (Thormundsson 2023), AI has become ubiquitous in people's daily lives (Minh et al. 2022), especially in communication processes (Diakopoulos 2019; García-Orosa et al. 2023).

AI, virtual reality, augmented reality, big data, robotics, and Internet of Things (IoT) technologies are part of Industry 4.0, which is characterised by the constant exchange of information over networks (Shrivastava et al. 2023). The widespread use of these tools is contributing to a revolution in society, industry, and journalism, which has attracted academic interest. In 2021, there were 500,000 scientific articles registered on AI, a significant increase compared to the 200,000 papers published in 2010 (Maslej et al. 2023). These data show that AI is increasingly prominent in all areas of society, raising questions, issues, and transformations that have been discussed in scientific work.

Regarding AI in journalism, other systematic review studies, such as those by Calvo-Rubio and Ufarte-Ruiz (2021), Parratt-Fernández et al. (2021); Ioscote (2021), and García-Orosa et al. (2023), have shown the prospect of increasing publications in academia, especially since 2018. Other studies have also carried out similar systematic reviews in different time periods (Pinto and Barbosa 2024; Peña-Fernández et al. 2023). Between 2008 and 2019, Calvo-Rubio and Ufarte-Ruiz (2021) identified a variety of topics in information production, such as data journalism, information verification, social media applications, and big data. Between 2015 and 2020, Parratt-Fernández et al. (2021) found that topics

such as the reformulation of the role of the journalist, the personalisation of content, and the integration of AI in journalism education were missing from the bibliography studied. This suggests a gap in journalism studies, perhaps due to a reluctance to assume that this new tool is reshaping the journalism industry.

In a study covering the period from 2010 to 2020, both globally and in the Brazilian context, Ioscote (2021) found that articles in journals focus mainly on tools and applied research, with an emphasis on data and news, while conferences focus on discussing algorithms and their impact on journalism, including the replacement of the human journalist. García-Orosa et al. (2023), covering the period from 2017 to 2021, identified a predominance of issues related to the use of AI in journalism (production, profession, and audience), its impact on the public sphere, democracy and public communication, and the role of algorithms on digital platforms. In general, these systematic review articles demonstrate how AI studies in journalism have evolved and raised new questions. For instance, the questioning of the journalist's role, the future of work, and the influence of algorithms on the values and ethics of journalism are emerging themes, yet still relatively underexplored in the literature. These and other issues require more in-depth theoretical discussions that seek to understand how AI is challenging the traditional assumptions of journalism.

Based on the assumption that AI can be understood as a tool and ally in journalistic work (Beckett 2019; Marconi 2020), the questions that mobilises this study are: What are the main topics studied about AI in journalism in scientific articles between 2014 and 2023? How does AI impact journalism? Other aspects surrounding the research question have the following specific objectives: (a) to highlight the evolution of the publication of articles on AI in journalism over a ten-year period (2014–2023), emphasising authors, affiliations, and journals; and (b) to identify the main topics covered and the methods used by the authors. All these characteristics will allow us to identify more precisely the authors, universities, and journals that have dedicated themselves to the study of AI in journalism, in order to later understand the main concerns of these researchers in relation to the subject under study. Qualified production on AI in journalism must be mapped and subjected to critical analysis to advance studies. Our hypothesis is that artificial intelligence, a field of research in computer science that is pervasive in society, is depicted in journalism as a tool. A simplified view of AI as a mere tool can hinder understanding of implications such as bias, ethics, and transparency.

1.1. The 4 Waves of AI

A pertinent question for communication and journalism researchers is: What do we mean when we talk about artificial intelligence in this field of study? To be clear, AI is a field of research within computer science. From the research of the 1950s, initiated by the computer scientist John McCarthy, to the current stage of technological progress, there has been a remarkable acceleration with the Internet in the mid-1990s. The four waves of AI (Lee 2019) contribute to understanding the role of AI in the digital sphere. The AI waves are organised in chronological order: (1) internet AI, (2) business AI, (3) perception AI, and (4) autonomous AI.

The first wave, from 1998, applied deep learning to online content personalisation and recommendation systems. The second, starting in 2004, focused on improving business processes, such as credit scoring by banks and decision support. The third wave, under development since 2011, uses IoT (Internet of Things) sensors to understand the physical world. Examples include speech-to-text software, translators, facial recognition systems, and more natural and intuitive human–machine interaction. The fourth wave, which began in 2015, aims to create autonomous systems capable of making decisions without constant human intervention (Lee 2019). These waves represent the continuous evolution of AI, each bringing new applications and challenges. However, this is not a strict timeline, and sometimes the waves overlap. At the intersection of the timeline of digital journalism and the evolution of AI, the third wave, which began around 2011, stands out as the most aligned with innovation in the newsroom. This phase saw the emergence of advances such

as IoT sensors, voice assistants, automated translation, and transcription systems. Notable examples include the launch of Google Glass in 2013, Alexa in 2014, and the virtual and augmented reality game Pokémon Go in 2016, among other key milestones. The theoretical foundations for ChatGPT, and similar programs based on the Transformer architecture[1], trace back to a seminal paper titled Attention is All You Need, published by Vaswani et al. (2017), a team from Google Research.

Another important point to clarify is the difference between analytical AI and generative AI (GenAI). Analytical AI is more related to the first and second waves of AI, focused on business, able to classify and analyse data, make predictions, and support decision-making processes. Generative AI is the third wave, perceptive, creating new images, videos, and texts useful for the design and personalisation of content. GenAI gains prominence starting in 2022 with the launch of programs like ChatGPT, MidJourney, and Stable Diffusion, among others. Some of these tools were made available for free with limited-use functionalities. Therefore, there was no democratisation of GenAI usage. The intention was to create a necessity for their use, and users were indeed able to integrate them into daily tasks. Since the inception of GenAI, significant changes have been recorded in various fields, such as programming and journalism.

As has happened throughout the history of journalism, many emerging technologies have been integrated and adopted by journalists to facilitate their work. The same applies to analytical and generative AI, which are being applied at different levels in the field of journalism (Beckett 2019; Beckett and Yaseen 2023), as will be discussed further.

1.2. The Impact of AI on Journalism

AI has an impact throughout the news ecosystem, which can be understood in three stages: (1) newsgathering, which includes searching for topics, events, and obtaining information; (2) production, which includes creating texts, images, sounds, or videos; and (3) distribution, which includes news delivery processes, strategies for interacting with the public, personalising content, or techniques for attracting subscribers (Diakopoulos 2019; Beckett 2019; Marconi 2020). These systems have been incorporated into routine, monotonous, and error-prone tasks that do not generate financial value, such as translating content and transcribing interviews, but also in more relevant functions such as news writing or fact-checking (Beckett and Yaseen 2023; Newman et al. 2023; Cardoso et al. 2021; Lindén 2017). This is changing the way journalists work and raising various concerns, particularly about the possible replacement of journalists by machines (Gonçalves et al. 2024).

This expansion of the use of AI in journalism comes at a time when the news industry is going through a structural crisis. This crisis is the result of social, economic, political, and cultural factors. The acceleration of technological development and the ubiquity of smartphones and the Internet in people's lives are triggering new processes of information consumption and the failure of the traditional model of funding journalism, based on advertising revenue. The news industry has been profoundly affected by the logics of platformisation: business models, advances in computing infrastructures, and socio-technical and cultural issues (Poell et al. 2020). Thus, access to information has become predominantly mediated by smartphones, digital platforms, and algorithms. As a result, accessing news on a smartphone has become a recurrent practice, giving rise to mobile journalism and forcing the journalistic field to adapt (Westlund 2013; Nelson 2020; Canavilhas 2021). All these changes are being driven by three factors: the Fourth Industrial Revolution, the global economic recession, and the emergence of digital platforms as the preferred way to access and share information (Jukes 2013). Combined with this situation, significant progress in the research and application of AI in different sectors (Lee 2019), highlights a chapter of changes in everyday life, possibilities, and implications, such as time optimisation, innovation, reduction in production costs, and, on the other hand, the reduction of jobs and the ethical challenges related to the use of AI.

Survival in this capitalist era means the ability to innovate and reinvent, and AI strategy needs to be both "informed and imaginative—not just in terms of monetisation"

(Deuze and Beckett 2022). Thus, news organisations have adopted smart technologies to be more productive, innovative, and competitive as a strategy to overcome the shortage of human resources and to maintain an economically sustainable activity (Simon 2024). The integration of high technologies in journalism has become increasingly important since 2014, the year in which an increase in experiences with chatbots, voice assistants, virtual reality, 360° videos, and AI systems was registered (Pérez-Seijo and Vicente 2022). As a result, new formats and different ways of doing journalism are emerging, causing concern and uncertainty for journalists.

In this sense, we believe that a news organisation that refuses to use AI will struggle to remain competitive. On the other hand, it is important to consider that the use of AI in journalism may not be useful where there is not an abundance of data—a vital condition for machine learning. Furthermore, the use of AI must be combined with the journalistic values of transparency, objectivity, and truthfulness. The media must therefore develop strategies to harness the potential of AI without compromising the role of journalism as a public service and to allow journalists to continue to do their job of gathering information, interpreting facts, and putting them into context—something machines cannot yet do because they do not have a "nose for news" (Thurman et al. 2017).

Different tensions in the field of journalism arise when AI is applied in all three stages of news production. The first one, newsgathering, selection, and filtering, has always been one of the most important functions of journalists, who follow the knowledge of their profession to choose the most relevant information to report. For decades, this process was based on news values and was the origin of the gatekeeping theory, dedicated to explaining the selection and control procedures of journalists over the topics reported. So how does AI recognise these values and norms in order to select a newsworthy issue? How can the machine have this human instinct in its code? If only machines decide which stories to cover, what will journalism look like?

However, with the ubiquity of social platforms, search engines, and websites in communicative processes, gatekeeping also began to be performed by algorithms whose performance criteria did not follow journalistic standards (Wallace 2018). Thus, many of the steps inherent to newsgathering began to be subjected to new filtering logics, guided by the acquisition of profits for technology companies such as Google, Meta, Microsoft, and Apple (Diakopoulos 2019; Simon 2022). Even at this stage of newsgathering, media organisations are using AI systems to filter large amounts of data, whether on social media or search engines. It is only with these technologies that it has become possible to access and analyse vast amounts of data on the internet, resulting in new journalistic stories (Diakopoulos 2019).

The second stage, news production, is the one that has been most affected by the arrival of generative AI, in 2022. This technology allows the creation of text, sound, audiovisual, graphic, and infographic content using deep learning techniques that emulate human learning (Franganillo 2023). These models process large amounts of complex and unstructured data and use it to produce new content in the same format (Franganillo 2023).

In this sense, generative AI differs from news automation, the latter described as automated journalism (Graefe 2016) or algorithmic journalism (Dörr 2016). The first experiences with the automation of journalistic writing (analytical AI) were registered in 2010, with a diversification of automated topics between 2014 and 2018, and a consolidation of the use of this technology between 2018 and 2022 (Canavilhas 2023). Automation works on predictable themes with low variability and a wealth of statistical data, such as the economy, sports, earthquake warnings, or weather forecasting (Sirén-Heikel et al. 2019). However, it was not until the end of 2022, with the launch of ChatGPT, that generative AI became a possibility in newsrooms, sparking new discussions and controversies (Pavlik 2023). While automation works with templates set by programmers and only with structured data, generative AI can create entirely new content by correlating the vast amounts of data it is given. Nevertheless, its use in the production of journalistic content opens space for questioning the values of the profession, including public service, commitment to truth, strictness, and transparency. The quality and credibility of news are another area of tension

with the use of AI, particularly in news writing. Journalists and researchers have been concerned about the loss of news quality and the risk that the public will see journalism as less credible because of the use of AI. However, on certain topics with a lot of statistical data, for example, sports, automated news has been well received by audiences, who even see it as more objective because it has a lot of numbers (Murcia Verdú et al. 2022). This does not mean that all news can be written by software, especially long stories, where creativity and human interpretation are essential.

In the distribution stage, AI systems have contributed to accelerating the diffusion of content to the public, which is increasingly fragmented and distributed across different online platforms. Through algorithmic operations, the distribution of news has become increasingly personalised and interactive, through sharing and commenting between users, alerts, and recommendations (Carlson 2018). AI is also used in content moderation on social media and newspaper websites to exclude explicitly violent, racist, extremist, hateful, or sexual content, which could lead to the rejection of offended users (Diakopoulos 2019). In addition, analytical AI is being applied to marketing and sales strategies, such as paywalls and analysis of audience metrics (Simon 2024).

As media organisations explore more applications of algorithmic systems and AI, it becomes urgent to discuss the ethical, economic, and professional challenges. At the newsgathering stage, the problems are more complex, as journalists need to have knowledge of computational methods for handling big data, from extraction to data cleaning. In the production stage, analytical AI and generative AI help journalists without the need for programming skills, as tools are available for text transcription, text correction, and summarisation. However, they raise many questions about the authorship of the work and the transparency of this process. In the final stage, analytical AI allows us to extract insights and create recommendation systems, but the biggest constraint is the filtering done by the platforms, which affects all stages. This raises several questions: What are the main changes in the work, skills, and authority of journalists (Carlson 2014; Hermida and Young 2017; Lewis et al. 2019)? How does the use of AI affect the credibility of news (Waddell 2018; Graefe et al. 2018; Wölker and Powell 2021)? What are the ethical risks associated with the use of these tools (Dörr and Hollnbuchner 2017; Diakopoulos and Koliska 2017)? What are the main implications of AI for the public sphere and democracy (Powers 2017; Entman and Usher 2018; Helberger 2019; Nechushtai and Lewis 2019)? These questions have motivated several scientific articles in the social sciences, but also in the field of computer sciences.

2. Materials and Methods

The methodological procedure includes a systematic review (n = 699) and a qualitative approach with categorical content analysis (n = 59). It was structured based on a previously validated protocol and consisted of the following steps: (a) definition of the central research question; (b) search strategy; (c) selection of studies with eligibility criteria; (d) analysis of the results; and (e) discussion and presentation of the findings.

Based on the results of previous studies (Calvo-Rubio and Ufarte-Ruiz 2021; Ioscote 2021), this research started with these questions: RQ1: What are the main topics studied about AI in journalism in scientific articles between 2014 and 2023? RQ2: How does AI impact journalism? To answer this question, we turned to the Web of Science (WoS) and Scopus databases. These platforms stand out as the most widely used in academic research (Quevedo-Silva et al. 2016) and were also used in the studies by Calvo-Rubio and Ufarte-Ruiz (2021); Ioscote (2021), and García-Orosa et al. (2023), which allows comparisons to be made.

The search used the Boolean operators AND and OR to combine relevant keywords with the term "journalism" in the titles, abstracts, and/or keywords of the articles (Table 1). The keywords were chosen based on literature studies on this topic (Carlson 2014; Beckett 2019; Diakopoulos 2019; Thurman et al. 2019). Thus, the inclusion criteria for the articles in the sample were strictly based on the presence of the terms, requiring their occurrence in at least one of the following places: title, abstract, and/or keywords. This resulted in 979 articles in Scopus and 908 in WoS. It should be noted that no filters were applied in

terms of fields of knowledge. After cleaning[2] to remove coincidences and false hits in each database and cross-referencing between databases, the corpus of analysis resulted in 699 articles (n = 699) (Table 1).

Table 1. Search results.

Keywords	Number of Articles	
	Scopus	WoS
Journalism AND Artificial Intelligence	212	166
Journalism AND Algorithm OR Algorithmic	344	344
Journalism AND Automated OR Automation	348	325
Journalism AND Robot OR Robotic	75	73
Total on each base	979	908
Coincidences	396	652
Total number of coincidences in each base	583	256
Total articles	839	
Coincidences in each base	140	
Total	699	

In order to identify the evolution of the publication of articles on AI in journalism, the journals and authors with the most publications, simple statistical operations, such as average, sum, and counting of numerical values, were used in Microsoft Excel on the database (n = 699). In addition, the Python programming language was used, using the spaCy library for Natural Language Processing (NLP) and the support of Jupyter Notebook to create clouds of the most frequent terms in the keywords of the articles. The journals have also been classified according to the SCImago Journal and Country Rank (SJR) areas. We also used SPSS software to visualise the prominent areas of the journals. To analyse specific quantitative data where a cut-off was necessary for the presentation of the data, such as authors and journals with the highest number of publications, the statistical cut-off method was applied in a frequency distribution table (Battisti and Battisti 2008).

In a second stage, a qualitative approach with categorical content analysis was conducted for 59 articles, aligned with the proposal of Sampaio and Lycarião (2018). For scientific validation, content analysis must be based on three fundamental epistemological principles of scientific development: replicability, reliability, and validity. In this regard, an approach using tests to validate coding indices, as well as the use of a codebook, can reduce the subjectivity present in qualitative investigations. In this regard, an approach using tests to validate coding indices, as well as the use of a codebook, can reduce the subjectivity present in qualitative investigations. Therefore, a codebook was created to handle the reading of the 59 articles. According to Sampaio and Lycarião (2018, 2021), codes can derive from existing theories or practices, as well as from previous experiences and research.

The categorical content analysis was carried out on articles with at least 50 citations (n = 59), based on the abstracts, and if the abstract did not answer the questions, the article was read in full. Thus, the abstracts were read with the aim of categorising them based on the common elements identified. For this purpose, a codebook (Table 2) was created, inspired by previous results (García-Orosa et al. 2023) and adapted for the purposes of this research.

In the categorical content analysis, we looked at: (A) phase of the journalistic process; (B) the main themes of the articles; (C) focus, whether theoretical or empirical/experimental; (D) approach, whether quantitative, qualitative, or mixed; and (E) collection techniques. In item (E) collection techniques, we chose to distinguish between digital and computational methods, as we understand digital methods as part of a research design (Rogers 2017), whereas computational methods require the use of machine learning techniques, natural

language processing (NLP), a subfield of artificial intelligence, and even the development of algorithms in specific research cases.

Table 2. Variables and categories.

Variable	Category
(A) Phase of the journalistic process	1—Gathering 2—Production 3—Distribution ND (not defined/does not fit)[3]
(B) Themes	1—Disinformation 2—Ethics and regulation 3—GenAI 4—Journalist's work 5—Tools/framework 6—Public sphere, democracy and political communication 7—Business models, startups and organisation management 8—Fact-checking 9—Audience 10—Journalism research and education 11—Platforms 12—Others
(C) Focus	1—Theoretical 2—Empirical/experimental
(D) Approach	1—Quantitative 2—Qualitative 3—Mixed
(E) Collection techniques	1—Interview 2—Ethnographic method 3—Questionnaire 4—Digital methods 5—Focus group 6—Framing 7—Others 8—ND (not defined)

To guarantee the validity and replicability of the categorisation procedure adopted, 16% of the qualitative sample (n = 59) was subjected to a reliability test, assessed using Krippendorff's alpha coefficient with SPSS software. In general, the results of the test achieved reliability indices above 0.779. Variables A and C reached an index of 1.00, while variables B, C, and E reached indices of 0.882, 0.795, and 0.779, respectively. According to Sampaio and Lycarião (2018), Krippendorff's alpha coefficient values above 0.8 are considered sufficiently reliable, while values between 0.667 and 0.8 are considered sufficient for experimental variables (in improvement).

3. Results and Discussion

3.1. Journalism and AI Research in Numbers

The first variable examined was the number of articles published in each year of analysis. The results show growth, indicating a progressive increase in interest in the topic of AI and journalism. The annual graphic shows a consistent growth pattern, 2000% when comparing the period from 2014 to 2023, with a significant jump from 2018 (Figure 1).

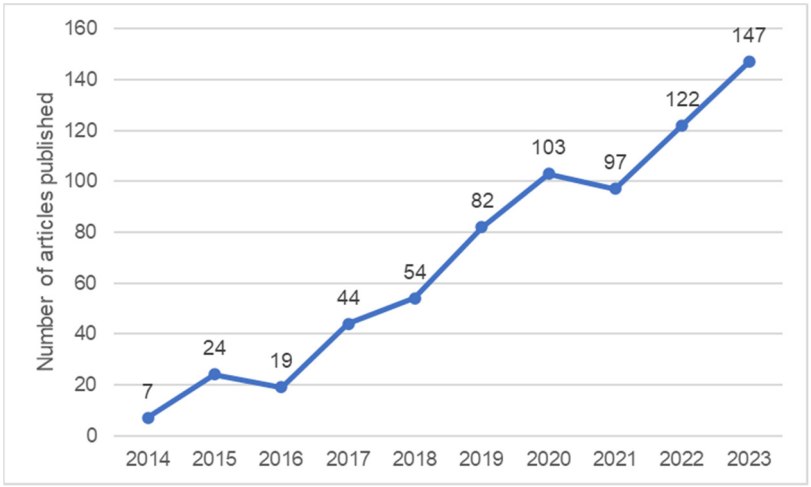


Figure 1. Annual growth in articles.

The observed growth can be understood as a reflection of the growing interest in academic studies in the face of the journalism industry's need to incorporate innovative technologies. This need stems largely from the current challenges posed by platformisation, covering aspects such as audience retention, the fight against disinformation, and the search for monetisation strategies, among others (Carlson 2018; Diakopoulos 2019; Marconi 2020). Above all, the period analysed coincides with significant advances in processing capacity, machine learning, and AI software (Lee 2019), providing a more robust technological base that can be implemented in journalism.

Two hundred and eighty-three journals were identified, of which the British journals Digital Journalism (103 articles), Journalism Studies (31 articles), Journalism (28 articles), and Journalism Practice (28 articles) stand out for their significant concentration of publications, together with the Spanish journal Profesional de La Información[4] (24 articles), for a total of 214 articles, or 30.6% of the base (n = 699). In part, these results are similar to those described by Calvo-Rubio and Ufarte-Ruiz (2021); Ioscote (2021), and García-Orosa et al. (2023), who noted the predominance of these same journals. In addition, the Portuguese Media and Communication (20 articles) and the British New Media and Society (17 articles) should be mentioned. García-Orosa et al. (2023) found 12 and 18 articles, respectively, published in these two journals.

The results show the evolution of publications over the period considered, taking into account the five journals with the highest number of publications (Figure 2).

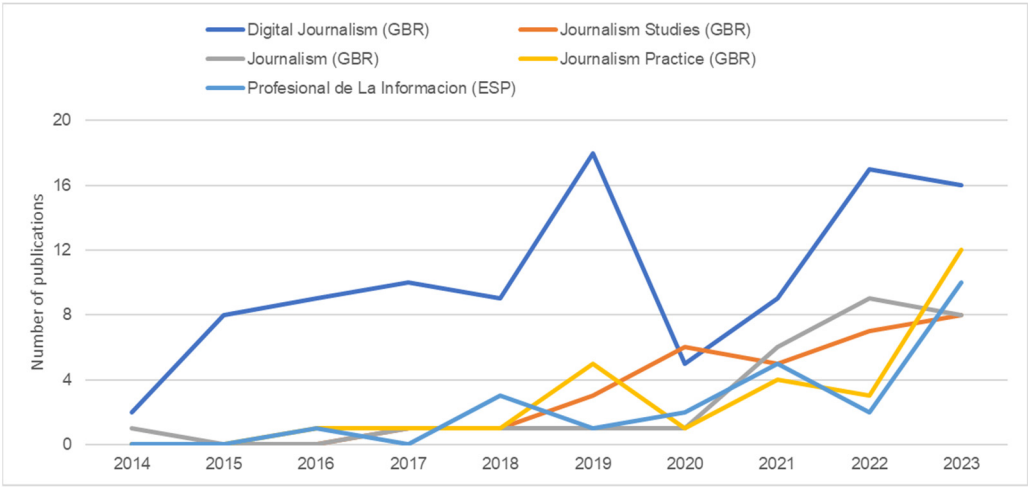


Figure 2. Annual growth of articles in the five journals with the highest number of publications.

The journals were distributed according to the parameters established by SCImago Journal and Country Rank (SJR) in relation to the different fields of knowledge. This distribution was used because no filters were applied to the fields at the time of collection. Of the 283 journals analysed, the field of social sciences predominates with 59.7% of the total. This is followed by computer sciences with 15.7% of the journals evaluated. It should be noted that some journals were classified in more than one field, reflecting the multidisciplinary and interrelated nature of the knowledge represented in the publications.

It is worth considering that seeking publication in computer sciences journals may reflect the need to link communication research to specific technological advances. These journals can attract a specific audience interested in technical developments and algorithms to improve efficiency, personalisation and automation, thus giving greater visibility to research on the integration of AI in journalism. In addition, computer science journals can provide a propitious environment for developing and sharing specific methodologies related to the implementation of AI in the journalism context. An example is the article FactRank: Developing automated claim detection for Dutch-language fact-checkers by Berendt et al. (2021), which addresses the importance of fact-checking in journalism and highlights the need to support human fact-checkers with semi-automated methods due to the increasing volume and speed of news, as well as the increase in disinformation. Another study, An exploratory approach to the computational quantification of journalistic values, authored by Choi (2019), explored how news algorithms shape the presentation of information and influence public discourse. The study sought to quantify journalistic values in an algorithmically readable way, combining natural language processing (NLP) with automated content analysis and a survey of journalism students.

Further detail of the database (n = 699) reveals the distribution of article authorship, reflecting the diversity of the scholarly collaboration mode. It can be observed that 31.9% of the articles have a single author, while 27.5% have two authors. Articles with three authors represent 23.2% of the sample, those with four authors 8.7%, and those with five or more authors 8.7%. In line with the findings of García-Orosa et al. (2023), the majority of articles in this sample (68.2%) are the result of research between two or more authors, as opposed to 31.9% with a single author, indicating a strong collaboration between researchers (Table 3).

Table 3. Distribution of article authorship.

Authorship	Number of Articles	Percentage (%)
1 (author)	223	31.9%
2 (authors)	192	27.5%
3 (authors)	162	23.2%
4 (authors)	61	8.7%
5 (authors or more)	61	8.7%
Total	699	100.0%

Among the most prominent researchers, a group of 29 authors stand out who have signed at least five articles (Table S1), either as main author or co-author. The author with the most articles is Nicholas Diakopoulos from Northwestern University (USA), with a total of 10 articles. His topics of research interest include: computational journalism, algorithmic accountability and transparency, automation, and algorithms in news production. We identified Seth C. Lewis from the University of Oregon (USA), Xosé Lopéz-García from the Complutense University of Madrid (ESP), and María José Ufarte-Ruiz from the University of Castilla-La Mancha (ESP) with nine articles each. Seth C. Lewis has dedicated his research to the social implications of emerging technologies, with an emphasis on the digital transformation of journalism. Xosé Lopéz-García's research focuses on the study of digital and printed media. He analyses the implications of technology for mediated communications, examining the performance and financing of the cultural industries and exploring the history of communication. María José Ufarte Ruiz investigates the influence of technology on journalistic genres and the relationship between genres on the border

between journalism and literature. Her research has also focused on how the precariousness of journalists' work affects the quality of news information.

These data do not establish the level of success of the researchers based on the number of articles; they simply show which authors have dedicated themselves to the study of this topic based on our selection. As the research is conducted in English, papers in other languages are not covered, which introduces a bias, so it is to be expected that researchers with papers in other languages are not included in the sample.

Regarding the affiliation[5] of the authors, the analysis showed that some authors are signed by more than one institution, resulting in 1.705 authorships. According to the analysis, the University of Amsterdam stands out with 59 authorships, followed by the University of Santiago de Compostela (Table 4). These data help us better understand which centres and universities have been most active in publishing articles in English on AI in journalism, many of them in countries where the use of AI in newsrooms is more advanced, such as the Netherlands or Germany (Bäck et al. 2019).

Table 4. Distribution according to affiliation.

#	Affiliation	Country	Authorships	Authors	Articles
1	University of Amsterdam	NED	59	35	33
2	University of Santiago de Compostela	ESP	51	16	24
3	University of Zurich	SUI	40	20	18
4	Lomonosov Moscow State University	RUS	23	16	10
5	University of Vienna	AUT	22	17	11
6	University of Castilla-La Mancha	ESP	21	5	10
7	University of Ljubljana	SLO	21	8	11
8	Ludwig Maximilians University Munich	GER	20	11	14
9	Nanyang Technological University	SGP	20	10	9
10	University of Münster	GER	20	11	8
11	Others		1.408	1.149	551
	Total	69	1.705	1.298	699

Examining the 1.705 authorships by country, the United States has the highest quantity. There are 261 authorships distributed across 99 institutions, with Northwestern University (18 authorships; 10 authors) and The University of Texas at Austin (15 authorships; 11 authors) standing out. A further analysis of the data shows that 671 (96.0%) of the articles were written by authors from universities, institutes, and academic research centres. On the other hand, 28 (4.0%) of these articles were written by authors from partnerships between universities, companies, non-governmental organisations, and government agencies. We recognise that collaboration between academia and industry is uncommon in scientific publications. Nevertheless, we argue that collaboration between researchers, technology companies, and the media can make better use of the knowledge of different professionals and provide contexts for experimentation and improvement of AI systems governed by journalistic criteria.

Regarding the keywords extracted from the database (n = 699), a word cloud was created highlighting the 50 most frequent terms (Figure 3). The first highlights the scenario of digital journalism, where terms such as "journalism", "news", "medium", "social", and "digital" indicate a concentration of efforts and discussions focused on journalistic issues, especially in the online environment. Furthermore, the presence of terms such as "artificial" and "intelligence" reflects the growing influence of AI in the field, suggesting the possible integration of advanced technologies into journalistic practices.



Figure 3. Top 50 keywords (n = 699).

This phenomenon opens the way to thinking about the implications (job replacement, erosion of journalistic authority, expansion of disinformation) and opportunities (countering disinformation, increasing transparency and trust, greater efficiency in production routines) that AI offers contemporary journalism, as shown in studies by Diakopoulos (2019), Thurman et al. (2019), and Marconi (2020).

The analysis of word frequency also reveals a tendency towards data analysis and the use of algorithms in the production of journalistic content. Terms such as "analysis", "algorithm", "computational", "algorithmic", and "machine learning" indicate an orientation towards strategies based on a deep understanding of data and the implementation of algorithms. Studies such as those by Stavelin (2013), Caswell and Dörr (2017), Milosavljević and Vobič (2019) discuss how computational methods, the use of algorithms, and automation through natural language processing (NLP) can be useful in journalistic tasks. Furthermore, the keywords also indicate that little attention is paid to ethical challenges and maintaining credibility in the digital journalistic environment, as evidenced by the low frequency of terms such as "ethics" and "credibility". These elements point to a gap in studies on awareness of ethical issues and journalistic values, as identified in previous systematic reviews such as Calvo-Rubio and Ufarte-Ruiz (2021) and García-Orosa et al. (2023).

Moreover, the prominence of terms related to AI technologies suggests a growing acceptance and integration of these tools in newsrooms. This raises important questions about the role of journalists and the potential need for new skill sets to work alongside AI systems. However, it also opens questions about which AI we are referring to when we mention it in journalism studies. Some clues to answering this question are in the next section.

3.2. Themes, Approaches, and Methods

In the qualitative analysis, the most cited articles (n = 59) are published in journals from different areas, but predominantly in the social sciences (69.2%). Other areas such as computer science and arts and humanities follow with 10.3% each. As will be seen in this section, although topics related to an interface with computer science were identified in the sample (n = 59), the discussion between journalism and AI is not necessarily concentrated in journals in the exact sciences. We understand that this represents an effort by the scientific community in the area of communication to discuss emerging technology topics.

In the analysis of the phases of the journalistic process—newsgathering, production, and distribution—which are discussed in the 59 articles, the production phase represents 33.9% of the total sample (Table 4). These data show that researchers have emphasised the use of automation and generative AI in the production of news, as this is one of the applications that has grown the most in recent years and has stimulated changes in news production (Pavlik 2023; Wölker and Powell 2021; Dörr 2016). In this variable, another

33.9% of articles did not clearly attribute their research to a specific phase or did not fit into any of the phases mentioned (ND), such as theoretical articles discussing epistemological issues (Parasie 2015; Primo and Zago 2015; Lewis and Westlund 2015). These articles are from before 2021, which may justify an inclination towards a more epistemological discussion about the consequences of platformisation for journalism or journalistic practices. In addition, it was noted that the term AI appears only once in the titles. This gives us clues to the idea that the use of analytical AI in the first and second waves attracted the attention of researchers for other terms such as big data, algorithms, machines, and automation.

Articles dedicated to the distribution phase (25.4%) explore the advantages and disadvantages of using AI at this moment. Moreover, it is important to mention that in this set of articles there was also a predominant discussion of the role of social media in the distribution of news, especially Twitter and Facebook. There was no discussion of how the implementation of AI could solve problems related to the filtering or hierarchy of content.

As advantages, the works highlight the reduction in costs and the amplification of news distribution (Blankespoor et al. 2018). As disadvantages, several problems with algorithmic filtering are recognised, such as the excessive personalisation of content (Bakir and McStay 2018), the hierarchy of news according to algorithmic criteria, and the risk of confusing the editorial, algorithmic, and social filters that coexist in the online environment (Boczkowski et al. 2018). These factors can reduce the diversity of content to which readers are exposed, creating filter bubbles that undermine democratic values and critical thinking. It is therefore necessary for researchers to assess the impact of these technologies on the quality, diversity, and plurality of ideas (Nechushtai and Lewis 2019).

Finally, the newsgathering represents only 6.8% of the sample, suggesting that the first stage of the news process has not received as much attention from academics. One possible reason for this is that some procedures in the newsgathering require more specific computer skills, such as data extraction and manipulation, depending on the type and size of the database. Another hypothesis could be related to the strong presence of traditional journalistic assumptions, where the journalist is the main gatekeeper of information, due to his knowledge of news values and newsworthiness criteria. In this sense, researchers may consider that AI does not have as much influence at this stage.

In the variable themes, the journalist's work (10 articles) and tools/framework (10) stood out (Table 4). These themes had already been identified by Ioscote (2021). However, the author considers that the articulation of the journalist's work in the face of algorithms was a first movement. The articles that discussed the work of journalists, especially those presented at conferences, considered the implications of the algorithm for the profession, which included risks such as the replacement of human journalists (Ioscote 2021). As shown in previous studies, such as Ioscote's (2021), the tools/frameworks try to show the possibilities of automation for journalism.

The articles in the journalist's work highlight the centrality of AI, automation, algorithms, and big data in journalism, and the ways in which these tools challenge the functions of the journalist. Automated journalism is seen by researchers as a disruptive practice that strains journalistic authority (Carlson 2014) and raises questions about algorithmic authorship and judgement (Montal and Reich 2017; Carlson 2018). In this sense, some articles discuss hybrid practices and the challenges of human–machine communication (Hermida and Young 2017; Lewis et al. 2019). This evolving scenario suggests a future in which the role of the journalist will not be diminished, but transformed, just as the incorporation of other technological innovations has done to journalism throughout history. The challenge lies in integrating these technologies in a way that increases the journalist's integrity and trust.

Regarding the theme of tools/framework, the findings point to the rise of computational methods as a methodological resource in social sciences studies, especially the use of topic modelling, application inventory, and natural language processing (NLP). Here, the use of such methods results in tools that support journalism in the data extraction and processing stages. Sometimes, depending on the type of data, whether structured or unstructured, it is

also necessary to test different algorithms to help deal with the data. In addition, computational methods are presented in different approaches, from dictionaries to machine learning techniques[6], which can be useful in new tests. These data confirm the growing use of AI in newsrooms, with around 75% of media outlets surveyed using AI in at least one of the areas—newsgathering, production, or distribution (Beckett and Yaseen 2023). However, a pertinent question, which has not been addressed in this article, is whether the implementation of computational methods is the responsibility of journalists or computer specialists. This opens a gap to reflect on to what extent the values intrinsic to journalism are applied to the use of these experiments with algorithms and AI. This also makes us consider that transdisciplinary studies can be a useful strategy for integrating journalism and computer science and for developing AI systems adapted to the needs of journalism.

The third most relevant theme was audience (8 papers), which included research on the impact of AI and algorithms on information consumption and news quality (Table 4). Most studies investigated readers' perceptions when reading news written by machines compared to news written by human journalists (Wölker and Powell 2021; Graefe et al. 2018; Jung et al. 2017). Another systematic review identified 18 articles published in Scopus and WoS between 2014 and 2022 that analysed the quality of automated news (Sandoval-Martín and Barrolleta 2023). This is an important point because the quality of journalism is a characteristic that could be compromised by the automation of journalistic writing. The use of AI puts a strain on several points of journalistic quality and credibility, firstly by raising the question of how machines follow the news values and ethical principles to which journalists are committed.

Text quality and credibility were two of the characteristics measured in these articles. "In summary, the available evidence suggests that the quality of computer-written news is competitive with that of human journalists for routine tasks for which well-structured, machine-readable and reliable data exist" (Graefe et al. 2018, p. 605). Similarly, in terms of credibility indices, news stories written by software performed similarly to those written by humans and performed better in the case of sports articles (Wölker and Powell 2021). These studies show that automated writing is often imperceptible to readers, proving that this technology can be an asset in content production. On the other hand, incidental news consumption and news personalisation mechanisms have also been addressed as two consequences of the use of algorithms in journalism and digital platforms (Boczkowski et al. 2018; Powers 2017).

Other themes emerged from the sample, reflecting the diversity of approaches and challenges posed by AI in the information ecosystem. These papers discussed issues related to the use and functioning of digital platforms, generative AI, disinformation scenarios, consequences for the public sphere, democracy and political communication, and the need to promote ethical values by regulating the use of AI, among others (Table 5). It is important to mention that the sample (n = 699) included five articles on ChatGPT published in 2023. Only one article was included in the sample (n = 59) because it met the minimum criterion of at least 50 citations. In general, these articles discuss the possibilities and limitations of using ChatGPT in journalistic routines.

The variable article focus also showed that 69.5% of the articles had an empirical/experimental focus, while 30.5% of the articles had a theoretical focus. With regard to the variable approach, 78.0% of the articles followed a qualitative approach, 16.9% followed a mixed approach, and 5.1% followed a quantitative approach. These results show that the preference for qualitative methods is a constant in studies on AI and journalism (Parratt-Fernández et al. 2021).

Finally, in relation to the variable collection techniques, a predominance of digital methods (36.6%), interviews (24.4%), and questionnaires (17.1%) was observed. On this parameter, this study represents a novelty in relation to previous ones, as it shows the rise of digital and computational methods for the study of this topic. Of the 15 articles (36.6%), at least 5 used techniques of topic modelling, NLP, and supervised machine learning to extract data and perform automated text analysis. These five articles were published in

2016, which may indicate a movement of interest in using computational methods to solve journalistic problems, given the abundance of data in a digital environment.

Table 5. Results of variable B "Themes".

Themes	Quantify	%
1—Disinformation	3	5.1%
2—Ethics and regulation	3	5.1%
3—GenAI	5	8.5%
4—Journalist's work	10	16.9%
5—Tools/framework	10	16.9%
6—Public sphere, democracy and political communication	3	5.1%
7—Business models, startups and organisation management	2	3.4%
8—Fact-checking	2	3.4%
9—Audience	8	13.6%
10—Journalism research and education	1	1.7%
11—Platforms	5	8.5%
12—Others	7	11.9%
Total	59	100.0%

At this point, we see the possibility of applying AI to digital journalism with NLP, a sub-area of AI. It is worth mentioning that natural language processing is gaining more notoriety with advances in large language models (LLMs), which are available to the public in a more simplified way, like ChatGPT, since 2022. However, creating an LLM for journalistic purposes is a challenge for most of the world's media sectors. Although initiatives such as Bloomberg's already exist (Bloomberg 2023), there are financial and purpose challenges.

This also highlights the importance of integrating a transdisciplinary approach, where computational methods are applied to meet the needs of journalism. To implement such an approach, it is necessary to empower journalists to make use of these software tools and foster critical debate around ethics, authorship, and credibility.

4. Conclusions

The analysis of scientific articles published over a decade allowed us to take a broad and, at the same time, detailed look at the evolution of studies on AI and journalism. Firstly, the exponential increase in articles published in WoS and Scopus stands out (7 works in 2014 and 147 in 2023). The year in which the collection started, 2014, marks the beginning of the diversification of topics in the field of automated journalism (Canavilhas 2023). The period between 2018 and 2022 is seen as the consolidation of automated journalism (Canavilhas 2023), which coincides with the increase in the number of scientific articles, mainly published in British Q1 magazines. Among the five journals with the most articles on this topic, the only non-British one is the Spanish journal Profesional de La Información (Q1 in Scopus), which has a permanent open call on AI.

The growth in interest in the subject of AI in journalism addresses other questions: which AI is being studied by researchers? Although this investigation was limited to examining a decade of studies up to the year 2023, we identified five articles that explored the possibilities of using ChatGPT in journalistic routines. Consequently, with the growing trend of discussing tools based on large language models (LLMs), it is crucial to consider the intersection of this technology with journalistic values. This raises another question: Is AI in journalism studies synonymous with automation, algorithms, or tools? If there is evidence of a consolidation of automation in newsrooms, it is necessary to specify the uses, methods, and relevance of AI in journalism.

Given the importance of British journals, it might be expected that the most frequent affiliations would be to British institutions, but this hypothesis did not hold. The results showed that the three institutions with the highest number of affiliations were the Univer-

sity of Amsterdam (Netherlands), the University of Santiago de Compostela (Spain), and the University of Zurich (Switzerland). The presence of research centres dedicated to the intersection of AI and journalism, such as the AI, Media, and Democracy Lab (University of Amsterdam) and New Media (Trends, Cybermedia, and Printed Media) (University of Santiago de Compostela), can be seen as the driving force behind these universities. It is relevant to mention that the United States holds the highest quantity of authorships; however, they are distributed across different universities.

To answer the research question RQ1: "What are the main topics studied about AI in journalism in scientific articles between 2014 and 2023?" and RQ2: "How does AI impact journalism?", the categorical content analysis (n = 59) showed that the most cited works problematise the work of the journalist, use AI as a tool or framework, and bring the audience's perceptions about the use of AI in journalism. In relation to AI in journalists' work, pertinent points such as authorship and human judgement are articulated in the sample (n = 59). However, we also noticed a dystopian view of AI in articles that, in a way, try to compare the human–machine relationship. We understand that this discussion is productive, but nevertheless, predicting when, how, and if a robot will take the place of a human journalist does not depend solely on technology.

The main novelty in relation to previous systematic reviews is the predominance of AI as a journalistic tool, as evidenced by studies that propose the use of digital and/or computational methods. We also argue that this is a new point in relation to previous systematic reviews, but that the need for digital and/or computer methods is yet another consequence of platformisation. Nevertheless, it is at this point that the use of AI becomes more relevant and journalistic values can be confronted.

On the other hand, issues related to ethics, regulation, and journalism education are poorly represented in the sample of most cited articles. This can be seen as a gap in academic work, which may also be related to the lack of clear strategies for using AI in newsrooms (Beckett and Yaseen 2023). However, a more targeted search using a string containing the terms "ethics", "regulation", or "education" may give different results.

It is also worth noting that the platformisation of information plays a significant role in the intersection of AI and journalism. However, this issue was underemphasised in the sample (n = 59). We observed this as well in the larger sample (n = 699) from the 50 most frequent terms in a word cloud, where platformisation does not appear. This leads us to consider that the advancement of AI might be interpreted by the researchers as a phenomenon dissociated from platformisation. We understand that AI represents a new chapter in the transformative landscape imposed by the logics of platformisation. Consequently, journalism jobs may be transformed, but they are also at risk of extinction. Above all, the dependence on digital platforms for the different stages of news production could also have an impact on the quality of information, especially due to advances in GenAI.

Research involves choices that allow us to achieve or not achieve our objectives. The methodological procedures used in this study allowed us to identify important trends and gaps in research on artificial intelligence in journalism. Nevertheless, we acknowledge that there are limitations related to the methodological procedures. For example, the choice of strings can be a limiting factor in the collection of articles. The selection was necessary. This does not prevent new research from being conducted with new selections and intentions. The experimental categories can also be a limitation, but they serve as a basis for future research. Additionally, researchers can review and improve the code used. There are also articles from the field of computer sciences among the investigated articles, which is why many computational methods are present in the topics. However, we decided to keep them because we understand that this is a transdisciplinary topic that benefits from various disciplines and different fields of knowledge. By selecting articles with more than 50 citations, we also considered that more recent articles would be excluded, especially those that include research on generative AI, a topic that becomes more prominent from

2022 with the launch of ChatGPT. On the other hand, the most cited articles help us understand the foundation for the discussion of AI in contemporary times.

For future research, a more in-depth analysis of the research centres and laboratories involved in studying the intersection between AI and journalism can provide a more complete understanding of the direction of scientific knowledge in this field. Understanding the dynamics of these centres and the collaborations between researchers can provide important insights into the trends and future directions of research in this constantly evolving field.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/journalmedia5030056/s1, Table S1: Authors with at least five articles (author or co-author).

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Notes

1 The Transformer architecture is a type of machine learning model used for tasks involving natural language processing (NLP).

2 Database cleansing is performed in Microsoft Excel using duplicate filter functions.

3 We created the ND (not defined) category for articles that do not mention the collection technique in the abstract and at the same time are not available in the full version for consultation.

4 From January 2024, Profesional de La Información is being published by Oxbridge, UK.

5 Affiliation includes universities, research institutes and centres, companies and non-governmental organisations.

6 Dictionaries provide static definitions of terms. Machine learning is a dynamic technique that allows computers to learn from data and make predictions or decisions without being explicitly programmed.

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