Artificial Intelligence in the public sector: linking research and practice

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Abstract

The adoption of artificial intelligence (AI) in the public sector can potentially provide many benefits and public value to citizens. Scholars have highlighted the potential value of AI for public service delivery and internal operations while also addressing possible challenges and risks. On the other hand, AI is already being implemented and used in the public sector, supporting different tasks with several techniques and contributing to improvements. Surprisingly, certain scholars pointed out that the usage of AI by the public sector might be outrunning the scientific community. The public sector is said to be using AI with insufficient support. The research on AI, which is mainly theoretical, is leaving a gap in supporting public officials with empirical evidence.

Accordingly, this ongoing study aims to fill the research gap by examining both (1) the literature so far concerning AI (potential) applications within the public sector context and (2) the AI applications from practice. The bibliometric analysis was used for the first part to identify research trends from the existing scientific literature. The second part of the analysis is based on the European Commission survey of 686 AI use cases in the public sector across EU Member States. This ongoing study aims to present initial research towards an overview of AI research – its focus, AI applications in the public sector and the comparison between the two.

The initial results of the analysis reveal a discrepancy between the research community and the practical applications of AI in public administration. For example, the search of scientific papers yielded 526 documents, but only 161 focused explicitly on a particular AI discipline. This indicates that most research on AI in public administration is still quite broad and exploratory rather than focused on specific AI technologies.

Keywords: artificial intelligence, public sector, bibliometric analysis, AI research, AI use cases

Introduction

Artificial intelligence (AI) has a long history, originating in the 1950s when Alan Turing contemplated the possibility of thinking machines (Turing & Haugeland, 1950). Subsequently, John McCarthy, a Dartmouth math professor, introduced the term "artificial intelligence" as a neutral term to characterise this nascent domain in 1955 (Siebel, 2019). Nonetheless, early AI endeavours encountered impediments such as insufficient computing power and undeveloped mathematical concepts, resulting in a decline in interest and funding for AI research during the 1970s, referred to as the "AI winter" (OECD, 2019; Siebel, 2019). However, AI research experienced a resurgence in the 2000s, primarily due to the exponential growth of computational power, the rise of the Internet, and the voluminous amounts of data, as well as significant progress in the mathematical foundations of AI, specifically in machine learning (Siebel, 2019). Due to these advancements, governments have renewed their interest in AI, endeavouring to invest in and regulate its development and application (Kuziemski & Misuraca, 2020).

Artificial intelligence (AI) is a big field encompassing logic, probability, and continuous mathematics; perception, reasoning, learning, and action (Russell & Norvig, 2021). With first-generation AI, the objective was to build systems that attempt to maximise expected utility, with the precise objective being provided by human system designers. It is no longer assumed that the AI system's objective is

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predetermined and known by the AI system; instead, the system is unsure of the real objectives of the human designers. When uncertain about the goal, it must learn what to maximise and still perform effectively (Russell & Norvig, 2021). There are several disciplines composing AI, such as artificial neural networks, natural language processing, machine learning, computer vision, deep learning, etc.

Recently, there has been a growing interest in applying AI to the public sector for the purpose of re-designing internal service delivery procedures and policymaking (Misuraca & Van Noordt, 2020). The public sector holds much potential for AI applications since it generates large amounts of data. If used securely and ethically, AI can potentially improve the public sector's operations by taking over repetitive tasks and freeing up employees for higher-value tasks. AI holds promise for augmenting public service quality, building citizens' trust, increasing efficiency and effectiveness, and impacting competitiveness and public value creation. Furthermore, it can potentially minimise time and costs, assist with resource allocation, and address intricate tasks (Zuiderwijk et al., 2021; Criado & Gil-Garcia, 2019; Kankanhalli et al., 2019).

On the other hand, AI is already being implemented and used in the public sector, according to the findings of a comprehensive survey by the European Commission (Tangi et al., 2022). AI is already supporting different tasks through different disciplines and causing various improvements. Surprisingly, the public sector is said to be using AI with insufficient support, as the usage of AI by the public sector might be outrunning the scientific community (Kankanhalli et al., 2019; Sun & Medaglia, 2019).

A couple of research agendas have focused on the use of AI in public administration (e.g., Dwivedi et al., 2019; de Sousa et al., 2019; Kankanhalli et al., 2019), however with specific foci and studies did not include bibliometric approaches. Hence, the present ongoing study is motivated by a theoretical gap in the literature regarding the bibliometric research approach to study artificial intelligence in public administration and specifically focus on applications of AI in PA and, additionally, to compare the scientific body of knowledge with already implemented AI use cases. Hence, the present paper aims to present an overview of the early results of the research. The remainder of the paper is structured as follows. The next section describes the materials and methods applied. Section 3 presents the initial results of the analysis with a discussion. The last chapter concludes the paper by summarising the main early findings.

2 Materials and methods

In January 2023, bibliometric data about artificial intelligence in public administration research was gathered from Scopus, one of the top academic literature collections worldwide. Various keywords related to AI techniques (machine learning, computer vision, deep learning, etc.) and PA levels (public administration, public organisation, municipality, etc.), identified through a literature review, were employed to ensure a comprehensive search scope. The search was not restricted to any specific time frame or subject area but was limited to articles, conference papers, book chapters and books, and the initial query yielded 652 documents. Manual screening of the titles and abstracts resulted in excluding 125 documents that did not address AI in PA research. Additionally, studies limited to the technical aspects of AI, such as an algorithm to optimise ANN, were excluded. The final number of relevant documents identified for AI in PA research was 526.

Additionally, a secondary source from the European Commission was used, a survey published in 2022, which represents an inventory of 686 use cases of AI across the European Union and characterises them with different features and qualities (Tangi et al., 2022).

Once the data on AI in PA research were collected from Scopus, different bibliometric methods and software applications were utilised, and the research is still in progress. For the descriptive overview, the Biblioshiny application (Aria et al., 2017) was used to extract and calculate descriptive statistics, while frequency analysis was performed through Python Data Analysis Library Pandas (McKinney, 2012) and visualised via Python's visualisation library Matplotlib (Hunter, 2007). To examine keyword co-occurrence, VOSviewer, a software tool, will be used to create and display bibliometric networks (Van Eck & Waltman, 2010). Ultimately, the Biblioshiny application (Aria et al., 2017) will be utilised to conduct thematic evolution analysis, including keyword mapping and thematic trends.

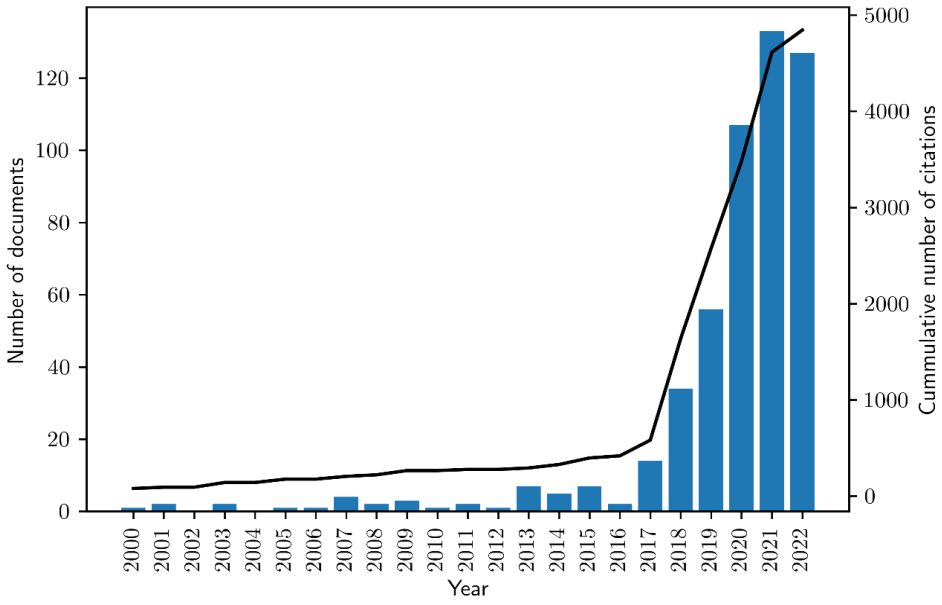
3 Results and discussion

This study relies on 526 documents written by 1,341 distinct authors and published in 315 sources between 1984 and 2022, with an annual growth rate of 4.7 %. The average age of documents was 3.73 years, and the average number of citations per document was 9.211. About one-fifth (143 or 27.2 %) of these documents were written by a single author. The relevant literature on AI in PA research covers 1,258 different authors' keywords. The average number of references per document is 42.72. Finally, the selected categories of documents type showed 255 articles, 222 conference papers, 41 book chapters and 8 books.

Figure 1 presents a frequency analysis of the number of documents and cumulative number of citations by year. During the period detected between 1984 and 2022, there were 526 documents, with documents growing on average by 4.7 % per year in the AI in PA literature which received 4,845 total cumulative citations. However, the initial increase in the number of documents can be observed in 2017, and the broad production period started in 2018, continuing with the exponential increase rate. More precisely, 8 documents were published before 2000, followed by 55 documents between 2000 and 2017, and most (468) were published in the last five years.

The flow of production of documents relating to AI in PA is aligned with the overall field of AI production – meaning, the number of documents is gradually increasing, however more steadily than the literature on AI in PA. Evidently, from Figure 1, the evolution of the AI branch of knowledge is rapidly expanding to other fields, progressively increasing in public administration science.

Figure 1: Distribution of publications and citations by year (2000–2022).



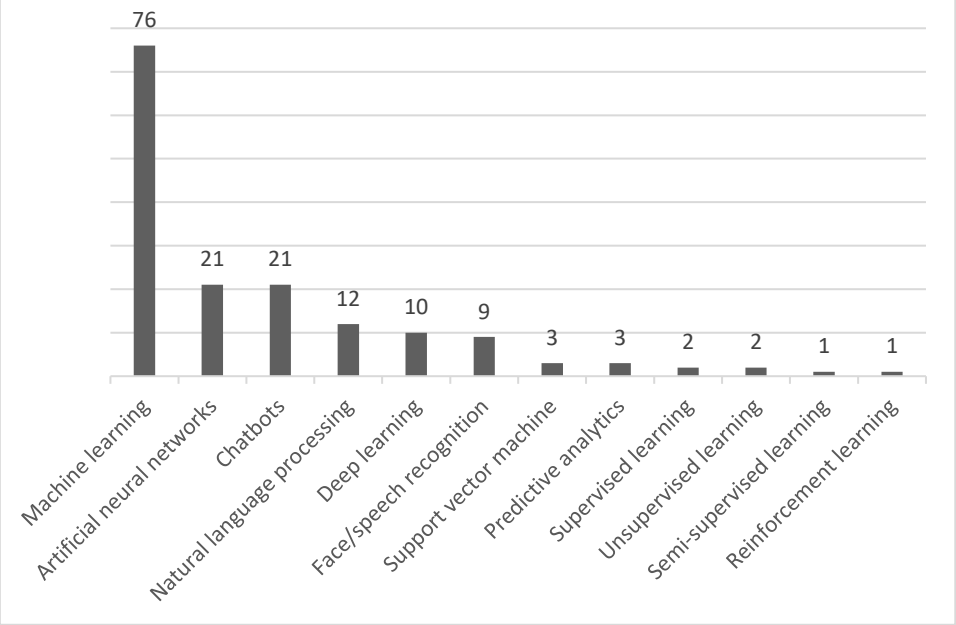
Source: Scopus database (526 documents; 8, published before 2000, were excluded).

Out of 526 documents, most do not specify the discipline of AI technology but generally refer to "artificial intelligence" towards various foci. Van Noordt (2022) stressed that many research papers and documents, also governmental, do not define the term "AI". As a result, the articles and discussions on the opportunities, challenges, impacts and consequences remain general and more focused on ethics, regulation or the development of fair AI (Floridi et al., 2018; Cath et al., 2018).

However, there are 161 documents with a specific focus, whose titles include at least one of the AI disciplines: Machine learning, Artificial neural networks, Chatbots, Natural language processing, Deep learning, Face/speech recognition, Support vector machine, Predictive analytics, Supervised learning, Unsupervised learning, Semi-supervised learning, Reinforcement learning (see Figure 2).

50.8 % of the documents included Machine Learning. Machine learning is a branch of AI technologies that enables systems to learn, make decisions, predict, adapt, and respond to changes independently, improving over time without explicit programming. Machine learning forms the cornerstone of AI systems. It is widely used in many applications, such as fraud detection, document quality improvement, data-based predictions, and automation of repetitive tasks with adaptation ability. Other types of learning, such as reinforcement, supervised, semi-supervised, unsupervised, and some NLP systems, also employ machine learning techniques (Samoili et al., 2021; Dwivedi et al., 2019). The public sector also adopts machine learning in various applications.

Figure 2: The number of documents' titles that included the presented AI disciplines.



Source: Scopus database (161 documents).

The scientific articles related to machine learning and the application of machine learning in various areas of the public sector generally focused on using machine learning to solve practical problems in government and public administration, such as energy efficiency, predicting the spread of Covid-19, evaluating public policies, assessing urban growth, and detecting fraud and tax avoidance (e.g. Zekić-Sušac et al., 2021; Anastasopoulos & Whitford, 2019; Alomari et al., 2021).

Some articles also explore the trade-off between the accuracy and explainability of machine learning for public policy and the challenges and difficulties in implementing machine learning in the public administration/sector. Machine learning involves logistic regression, text mining, semantic web, and deep learning. The articles cover various applications and aspects of machine learning, from its use in data analysis and decision-making to its deployment and management.

Deep learning is associated with the machine learning approach, a term gaining traction within the literature and associated with machine learning architectures and concepts but at a greater level and depth of neural network layers (Glauner et al., 2017). Studies have posited the potential benefits of deep learning applications in modelling energy costs for buildings, assessing debt risk or identifying purchase anomalies (Domingos et al., 2019; Zekić-Sušac et al., 2018; Guo & Qian et al., 2022) and highly specific healthcare areas of digital pathology and related medical applications, whilst cognisant of the limitations of this technology in terms of human reasoning and interpretation (Tizhoosh & Pantanowitz, 2018; Stead, 2018).

Notably, 21 documents considered chatbot technology and 12 Natural Language Processing (NLP) techniques. NLP is another subcategory of AI that focuses on the ability of systems to handle human language in written or spoken form. This includes text generation, mining, classification, and machine translation. Some common examples of NLP applications are document processing, chatbots, and virtual assistants (Tangi et al., 2022). These technologies' popularity has led to many documents containing the words "chatbots" and "natural language processing", making it the second most frequently mentioned AI technology. The articles that focus on using chatbots in public administration explore the potential of AI-powered chatbots for transforming the communication between citizens and government, improving public trust in these technologies, and creating value for citizens and the public sector (Aoki, 2020; Wang et al., 2021; Androutsopoulou et al., 2019). The articles discuss the design and implementation of chatbots and their application in various contexts, such as customer services, e-government, and mental health. The authors also examine the challenges and opportunities of using chatbots, including privacy, security, and data protection issues. Additionally, some articles propose new approaches for developing chatbots, such as machine translation, and evaluate the usability and effectiveness of existing chatbot systems (Hagen et al., 2015; Pandey et al., 2017; Kowalski et al., 2020).

Finally, most articles (365 out of 526) focus on general artificial intelligence from several points of view. Some focus on the challenges and opportunities of AI implementation in the public sector. These papers explore how AI can be used in the public sector to improve public services and governance and the challenges and risks involved. Others focus on the governance and regulatory frameworks for AI implementation in the public sector, exploring issues such as accountability, transparency, ethics, and privacy, which are critical in using AI systems in public administration. The impact of AI on public management and decision-making and legal and ethical issues are also present.

On the other hand, the European Commission has analysed 686 use cases where AI has been utilised in the public sector across 30 European nations. The significant number of cases indicates the widespread adoption of AI technology in European countries. Moreover, the growing number of cases every year is a positive trend and a clear indication of the increasing use of AI in public administration. In contrast to a decade ago, when only a handful of AI cases were initiated, the current trend shows a substantial increase, suggesting that the use of AI in public administration will likely continue to rise. The upward trend of AI cases aligns with AI technology's growing interest and importance, as reflected in research production.

According to their survey, machine learning was the most commonly used subdomain, accounting for 58 % of the cases. It is widely used in the public sector for various applications such as fraud detection, quality improvement of documents, predictions based on available data, and automation of repetitive tasks with adaptation capability. Automated Reasoning techniques (logic/knowledge-based approaches, inference and deductive engines, symbolic reasoning, expert system, etc.) accounted for 30 % of usage. These techniques are used in various decision-making support systems like the CityFlows project that automates the flow analysis of crowds in large public spaces in cities like Amsterdam, Milano, and

Barcelona. Planning and Scheduling (PS), accounting for 26 % of the cases, includes various smart processing automation, sometimes involving robotics, used in planning and management tools in the public sector for taxes, resources, employment, healthcare, energy, materials, etc. Notably, 24 % of the cases involved the use of Natural Language Processing (NLP) techniques. Examples of NLP use cases include automatic document processing (applied differently to procurement or legislative or administrative documents) or services such as chatbots and virtual assistants.

The dominant area of governmental function in which AI is emerging is General Public Services (30 %), followed by Economic Affairs (18 %), Health (15 %) and Public Order and Safety (14 %). On the other hand, relatively few AI cases focus on Social Protection (9 %), Environmental Protection (4 %), Defence, Recreation, Culture and Religion sectors. Taking a closer look at the General Public Services category reveals various examples of AI applications, including the use of chatbots and virtual assistants to streamline both external interactions with citizens and businesses and internal processes, monitoring, recognition, and notification of different types of public spaces using cameras, microphones, or other sensors, detection, comparison, and management of misinformation, automatic classification, storage, and search of documents (including handwritten), videos, and recorded speeches with metadata and information extraction, detection of various types of data anomalies or potential fraud.

Furthermore, there are deficient AI cases related to adjudication tasks, suggesting that AI solutions are rarely used to automate the assignment of social benefits contributions. Instead, AI is mainly used to automate or predict enforcements related to the assignment, indicating a preference for an ex-post approach rather than ex-ante decision-making. The most common application type within the General Public Services category is service personalisation, indicating that AI is mainly used to provide more personalised user-centric services in public service delivery. Internal management is another crucial area spanning government organisations, with several cases facilitating internal processes, some of which involve multiple public organisations, to increase efficiency.

The initial analysis of the EC survey shows that AI technologies mainly contributed (in 283 cases) to more responsive, efficient, and cost-effective public services and to improved management of public resources, which aligns with the often-highlighted value-creation potential of AI applications in the scientific literature. On the other hand, enabled greater fairness, honesty and equality have been detected only in nine cases and reduced or eliminated risk of corruption in only 16 cases – these are essential research gaps; for example, the word “fair” appears in only 19 abstracts out of 526 documents, whereas the word “corruption” appears in only 8.

Conclusion

The public sector's use of AI is growing surprisingly, surpassing the scientific community's attention. However, the body of knowledge is growing as well, but the practical applications seem to be misaligned with the research community. This has led to a seemingly paradoxical situation where public administrations use AI without much support or evidence from researchers. The research on AI mainly focuses on theoretical aspects, discussing principles, potential challenges, and risks, but there is a lack of solid empirical evidence and knowledge sharing (Sun & Medaglia, 2019; Tangi et al., 2022). While it is clear that AI is now being implemented in public administrations, as highlighted in the report by AI Watch (Tangi et al., 2022), there is a need for more research to move beyond pilot studies and provide insights that can assist public administrations in the implementation phase. This step has been identified as critical in enabling the widespread use of AI in public sector settings (Venkatesh, 2022).

Based on the initial results, there appears to be a discrepancy between the research community and the practical applications of AI in public administration. The search of scientific papers yielded 526 documents, but only 161 specifically focused on one of the AI technologies. This indicates that most research on AI in public administration is still quite broad and exploratory rather than focused on specific AI technologies.

In contrast, the European Commission's database described 686 specific cases of AI application in the public sector across the EU. This suggests that practical applications of AI in public administration are more numerous and varied than what is being researched and published in academic literature. There is a risk related to the limitation of our study, which is the possibility of our research query not detecting all the relevant papers regarding these two domains (AI and PA). However, when exploring gaps where research and practice diverge, we can initially identify potential opportunities for future research by focusing on specific AI technologies for specific use cases, addressing the research lack in the role of public administration as a user of AI, which received far less attention that the government's regulator role. Specifically, automated reasoning and planning and scheduling are AI technologies already implemented in various cases around the European public sector, while they are exceptionally rarely mentioned among the scientific papers for our study. On the other hand, the research and practice gap is shown in social and environmental protection. The use cases in these domains are very scarce. Last but not least, with all the cases already in use, there is a research gap in measuring these applications' impact.

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