Use of artificial intelligence in government control activities

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Abstract: This exploratory research, limited to a bibliographic (scientific papers) and documentary (legislation and institutional documents) survey, analyzed the adoption of artificial intelligence in government control, based on the scientific production, identification of the tools in use, and the opportunities, challenges and strategies proposed by literature. A search was performed in the Web of Science database for scientific papers published as of 2015 using the descriptor artificial intelligence and government, which resulted in 272 papers analyzed by bibliometrics. Articles that could contribute to the discussion were then selected. The investigation showed the growth in scientific production, identified numerous tools, and reported the opportunities, challenges, and strategies suggested. In conclusion, using AI contributes significantly to government control, facilitating decision-making and risk prediction, and ensuring more effective actions, as long as ethical and legal issues are respected.

Keywords: artificial intelligence. government control. public procurement.

OBJECTIVES AND RESEARCH QUESTION

This study sought to answer the following question: has artificial intelligence been used in government control activities? From this research question, we defined the general objective of analyzing the adoption of artificial intelligence in government control, based on the evolution of scientific production, identification of the tools in use, and the opportunities, challenges and strategies proposed by the literature.

THEORETICAL BASIS

Public administration plays a key role within society, as it is by this authority that many services are delivered to the population. Consequently, to ensure that the State achieve its purposes, some mechanisms were created, such as governmental control, which, in turn, has always proved to be a challenge to control bodies (BEUREN; ZONATTO, 2014). On the other hand, new technologies such as artificial intelligence (AI), the Internet of Things (IoT), big data, behavioral/predictive analysis and blockchain are about to revolutionize data management and consequently government performance (ENGIN; TRELEAVEN, 2019; CARUSO, 2017).

Given this innovative scenario and the need to establish solutions for improving efficiency in the public sector, the adoption of such technologies is an opportunity to develop valuable services to the population (KANKANHALLI et al., 2019).

Hence, control is one of the areas of public administration conducive to the use of these new technologies, especially those derived from artificial intelligence, such as machine learning, capable of identifying data patterns, assisting in the prevention and detection of any irregularities, thus contributing to as more assertive decision-making (ANDROUTSOPOULOU et al., 2019).

The first studies on artificial intelligence appeared in the 1940s, during World War II, period in which technological methods were developed focusing on ballistic analysis, code breaking and calculations for nuclear weapons designs (ALVES et al., 2018).

Shortly afterwards, the term Artificial Intelligence (AI) acquired several definitions that, in general, were based on the concept that AI was a branch of computing, where inanimate beings could, by computational means, acquire the ability to reason similar or even superior to that of humans (RUSSEL; NORVIG, 2013).

For some contemporary authors, artificial intelligence can be understood as a set of programming techniques and methodologies used to solve problems more efficiently, as close as possible to a human being (ENGIN; TRELEAVEN, 2019). For Kaplan and Haenlein (2019), however, AI can be defined as the ability of a system to interpret data correctly, learn and, through adaptation, use such learning to achieve certain tasks.

Having presented the definitions of artificial intelligence, we must now contextualize government control. According to the 1988 Federal Constitution, the accounting, financial, budgetary and patrimonial inspection of the Union and direct and indirect administration entities, as to legality, legitimacy,

economicity, application of subsidies and revenue waiver, will be exercised by the National Congress, with help of the General Accounting Office (TCU), via External Control, and by the Internal Control system of each Branch: Executive, Legislative and Judiciary (BRASIL, 1988).

External Control is a political control of accounting and financial legality responsible for auditing: probity of administration acts; regularity of public spending and the use of public assets, values and money; and faithful budget execution (BRASIL, 1988). Note that they constitute distinct controls: while Internal Control has an opinionative and preventive character, overseeing compliance with legislation, External Control is exercised by an autonomous and independent body that is responsible, among the attributions listed by the Constitution, for exercising supervision with powers to impose corrections on the Administration, as well as the power to intervene in bids and apply sanctions, such as fines or, depending on the severity, seizure of assets and ineligibility of the responsible party (BARBOSA et al., 2015).

METHODS

This is an exploratory research, an approach that aims to provide greater familiarity with a phenomenon, improve ideas, and facilitate the discovery of intuitions. Its planning is, therefore, flexible, to provide the study with many different aspects related to the topic and in most cases involves bibliographic search and analysis of examples that expands our understanding (SELLTIZ et al. 1967, apud GIL, 2002).

Hence, we performed a bibliographic search, limited to scientific papers and doctrine, and a documentary search, encompassing law and institutional documents. In this sense, documentary research is very similar to bibliographic research. The difference lies in the nature of the sources, for, while the former comprises materials that received no analytical treatment, the latter uses the contributions of various authors on a given subject (GIL, 2002).

As for the analysis, we used both qualitative and quantitative methods. The latter was performed by means of bibliometrics, a quantitative and statistical technique for measuring the production and dissemination rates of scientific knowledge. It consists in applying statistics to bibliography (FONSECA, 1986). The search for scientific papers was performed on the Web of Science database (https://www.periodicos.capes.gov.br/), main collection, using the keywords and Boolean operator: artificial intelligence and government. Importantly, the choice of nomenclature occurred after previous attempts using various combinations with the terms "public" (812), "control" (39), "audit" (8), "accountability" (12), and "corruption" (1), but the keywords we ended up using proved to be more efficient, since the former was too comprehensive and the others were contemplated in the search strategy.

As for the criteria adopted, we selected "basic search" and "topic" (which includes the title, abstract and keywords in the search) in the search box, and the period was fixed from 2015, resulting in 491 papers. Inclusion criteria regarding type of document was limited to published scientific papers, resulting in 272 articles for bibliometric analysis. The titles, and in some cases the abstracts, were then read to select those articles that could contribute to our discussion.

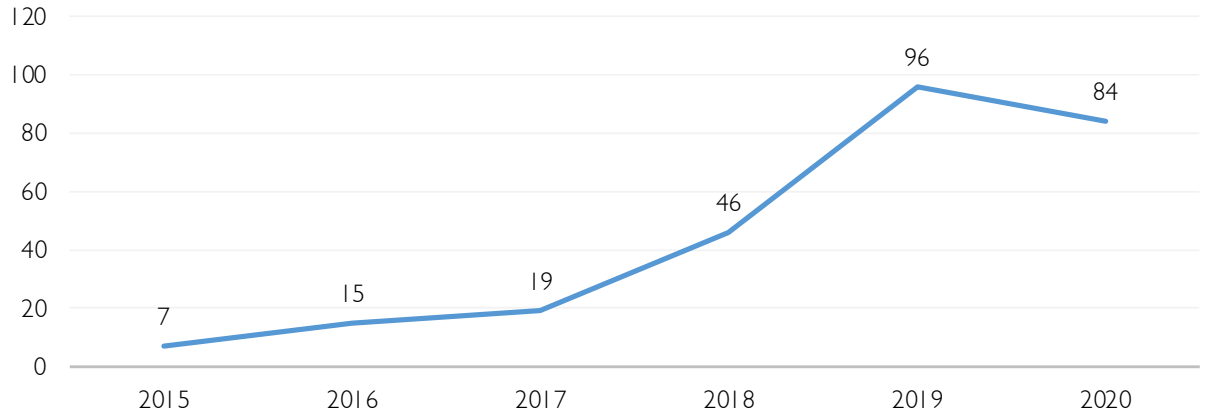
We chose 2015 as our starting point because only from that year on does a significant number of scientific papers appear (7). Such conclusion was reached after a preliminary research using the previously mentioned terminology with no predetermined period, thus covering all the years available in the database (1945-2020). Data collection was carried out in August 2020. According to the Oslo Manual, bibliometric indicators provide complementary information to Science and Technology indicators (R&D-directed resources and patent statistics) for measuring innovation (OECD, 2019).

RESULTS AND DISCUSSIONS

Results showed a significant evolution of the scientific papers published on the adoption of artificial intelligence in the public sphere from 2015 to September 2020. In 2018 and 2019, results doubled when compared with the previous year—a result that can be attributed to several factors.

A study conducted by WIPO (2019) on technology trends titled "Artificial Intelligence" showed that AI has gained increasing importance in multiple technological and other activities, and discussed how AI-powered technologies are rapidly entering global markets. Besides, the use of AI-based tools has generated broad discussions regarding ethical and legal aspects. Given this evolution, the year 2020 will probably surpass the result obtained in 2019 (Graph 1).

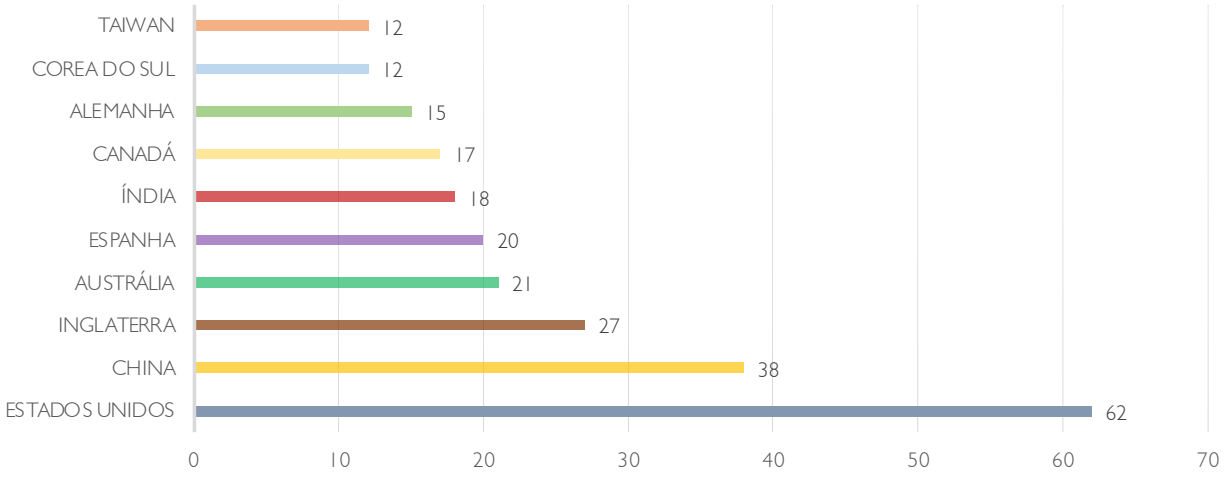
GRAPH 1 – ANNUAL EVOLUTION OF PUBLICATIONS.



Source: *Elaborated with data from the Web of Science database (2020).*

Graph 2 highlights the ten countries with the most published articles.

GRAPH 2 – THE TEN COUNTRIES WITH THE MOST PUBLISHED ARTICLES.



Source: *Elaborated with data from the Web of Science database (2020).*

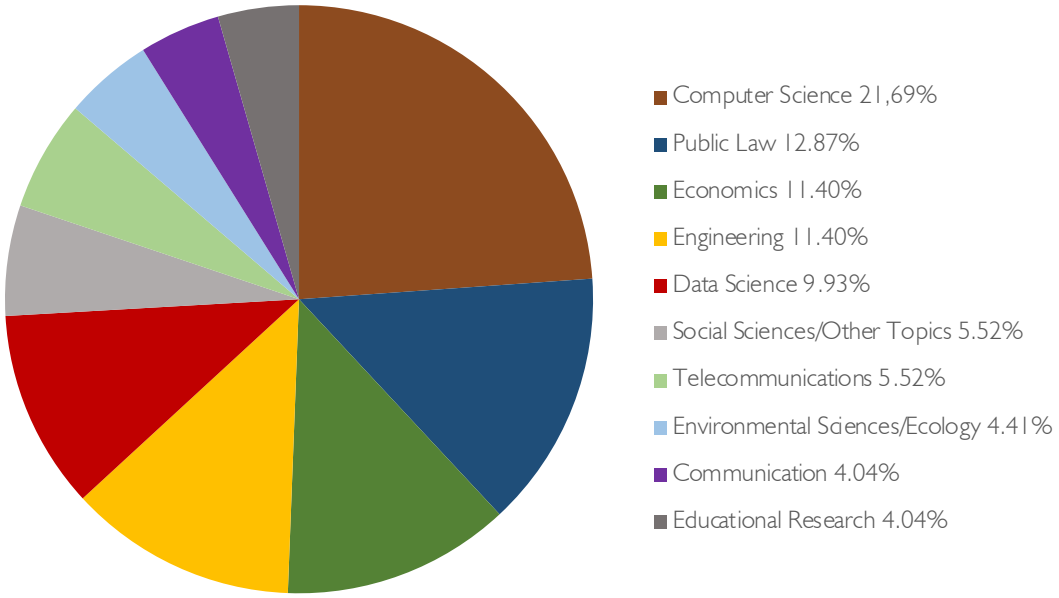
Among the countries with the most published articles, the United States stands out with 62 papers (22.80%), followed by China with 38 (14%). Other countries that stood out were England with 27 papers, Australia with 21, Spain with 19, India with 18, Canada with 17, Germany with 15, and South Korea and Taiwan with 12 papers each.

According to the WIPO study (2019), trends in technology can be identified by patent analysis. As such, it identified a rapid increase in AI-related patenting starting from 2013, especially in the US and China, which may have impacted the increase in scientific production. As for China, one can observe the contribution of scholars, especially health scholars, in collaboration with foreign researchers (DENG, 2018).

Our study found a clear concern, especially from the US, England and Canada about risk management and regulation on the use of AI by the government, denoting a trend in the discussion about AI adoption by the public sector, including due to the emergence of the COVID-19 pandemic. Similarly, India, besides addressing several ethical and legal issues in applying AI to improve public services, raised the possibility of using AI for risk management to help the government develop a sustainable social health insurance structure (NAYAK, 2019). Thus, demonstrating the claim to use AI for preventive purposes, which in a way corresponds to a kind of internal control.

Graph 3 presents the percentage of articles published per area.

GRAPH 3 – PERCENTAGE OF ARTICLES PUBLISHED BY HIGHLIGHT AREA.



Source: *Elaborated with data from the Web of Science database (2020).*

By analyzing the main research areas, we observed that despite the current multidisciplinary nature of the topic, most discussions take place in the area of computer science, which is probably related to the growing number of AI-based tools developed. Such finding was similarly demonstrated by the WIPO study (2019), which found exponential growth in patent applications for AI-based innovation. And although the study points to a drop in the number of scientific publications on artificial intelligence compared to the growth in the number of patent applications, we see an exponential increase in publications when associated with the public area. This is evident when we analyze the result of the search performed. Moreover, the percentage of scientific articles published in the area of public law suggests a broadening of the discussion focused on the ethical and legal challenges faced in applying artificial intelligence in the public sphere.

As for the authors, we highlight the four authors with the most publications (Table 1). Indian scholar Sheshadri Chatterjee is the author with the highest percentage, followed by Vietnamese Hielp Nguyen and Binh Thai Pham, with three papers each. Author Wen Chen, who also signs three articles, is of Chinese origin.

TABLE 1 – THE FOUR AUTHORS WITH THE MOST PAPERS

AUTHOR	COUNTRY	NUMBER OF PAPERS	PERCENTAGE
Chatterjee S	India	05	1.84%
Chen W	China	03	1.10%
N Guyen HD	Vietnam	03	1.10%
Pham BT	Vietnam	03	1.10%

Source: *Elaborated with data from the Web of Science database (2020).*

According to the featured author, India has a national strategy on AI and among its objectives is the creation of 100 smart cities. The opportunities and challenges of AI adoption in the public sector, mainly related to its regulation and implementation of intellectual property and copyright laws, are thus addressed in their studies (CHATTERJEE, 2020). Similarly, Wen Chen also addresses AI application to improve public services, which generally encompasses methods of government control. Although the other authors also AI application in the public area, they focus on AI adoption for preventing natural disasters.

Table 2 presents the articles with the highest number of citations.

TABLE 2 – THE TEN PAPERS WITH THE HIGHEST NUMBER OF CITATIONS

TITLE	TOTAL
Siri, Siri, in my hand: who's the fairest in the land? On the interpretations, illustrations, and implications of artificial intelligence	83
Application of fuzzy weight of evidence and data mining techniques in construction of flood susceptibility map of Poyang County, China	76
Forecasting municipal solid waste generation using artificial intelligence modelling approaches	52
Artificial Intelligence and the 'Good Society': the US, EU, and UK approach	49
Regulating by Robot: Administrative decision making in the Machine-Learning Era	39
Success of IoT in Smart Cities of India: An empirical analysis	31
Towards Artificial Argumentation	30
An Empathy-Driven, Conversational Artificial Intelligence Agent (Wysa) for digital mental well-being: real-world data evaluation mixed-methods study	23
Smart system for children's chronic illness monitoring	21
Robust intelligent malware detection using deep learning	18

Source: *Elaborated with data from the Web of Science database (2020).*

Among the above articles, four address the application of AI in healthcare and two in the ICT area. The remainder generally discuss the opportunities, challenges and strategies for AI adoption for improving public services, which includes risk management and prevention. The first paper tackles ethical and legal challenges, proposing a model to be followed by private organizations to succeed. A modeling that can be adopted by the public service, as will be discussed further on. Similarly, the fourth article analyzes several institutional reports from the US, EU and UK, which address the challenges of using AI. While concluding that robotics (AI) can contribute to make judicial decisions more efficient and fairer, the fifth paper also points out its difficulties, especially regarding legality.

In turn, Chatterjee's (2018) article on the challenges for creating smart cities in India, author who stands out with a greater highest number of publications, appears in sixth place. Finally, the seventh article, despite being the field of Information Technology, addresses, based on the need to develop a robust system that can deal with inconsistent information, a review of tools developed for argument mining to discuss technologies and solutions, which strengthens the trend for debates on the topic, given the importance of its use by public authorities.

This quantitative analysis showed a significant increase in scientific production regarding the use of artificial intelligence, especially in the public sector. Consequently, in order to investigate the adoption of AI in government control activities, we selected a few articles retrieved from the Web of Science database—after reading the titles and, in some cases, the abstracts—for analysis, to identify possible tools in use, as well as the opportunities, challenges, and strategies adopted. We also carried out a document search to locate reports and institutional information from government agencies that could contribute to the discussion.

Overall, the qualitative analysis showed that all authors point to the adoption of artificial intelligence by the public administration as an opportunity to

improve the quality of services provided to the population. Among them, some point out the importance AI adoption in government control.

Regarding the opportunities of AI adoption in the public sector, Mikhaylov et al. (2018) state that such technology provides greater accuracy in public service adequacy, generating numerous benefits such as: demand forecasting; response automation; risk identification; development of targeted interventions; increased efficiency; intelligent solutions; improved public service delivery; empathy in public service delivery; relief of administrative burden; correction of delays and reduction of bureaucracy.

Similarly, Engin and Treleaven (2019) analyzed the implementation of these new technologies by government agencies worldwide and listed some situations in which AI adoption became a significant ally, such as: maintenance of public infrastructure; provision of intelligent advisory tools to help public officials manage situations, monitor impact and performance, including real-time management; self-compliance (coding, verification, simulation) of laws and regulations; combined regulation; more secure maintenance and storage of public records; contract drafting; administration of courts, the Judiciary branch, and police agencies; online resolution of judicial matters, and public policy development.

Likewise, although prior control procedures are considered the most efficient means of preventing irregularities in public administration, several obstacles hinder executing such procedures to a greater extent, which is why adopting technologies such as AI contributes significantly (PINTO et al., 2019).

Among those new AI-based technologies aimed at improving the public sector identified we highlight: machine learning (MIKHAYLOV et al., 2018); robotics; blockchain, and algorithms (AGARWAL, 2018).

Regarding the adoption of these new technologies by public organizations, the so-called electronic or digital governments stand out. They use several AI-related technologies to improve public services, aiming to become intelligent countries, such as Estonia, Singapore and the United Kingdom (ENGIN; TRELEAVEN, 2019). Furthermore, the development of several government solutions via platforms, aiming to create smarter cities, among them the so-called GovTech used by several cities, such as Amsterdam, Barcelona, Madrid, Stockholm, and New York, in several areas and by several government agencies like the United States Army (to improve the efficiency of its recruitment process). Such AI-based technologies were also used to create systems to support public officials, including the possibility of detecting abuse and fraud. Agarwal (2018) cites Barcelona as an example of a city with more than one hundred active smart city projects, including some focused on public transparency.

In a study of the many countries that already use AI tools or other emerging technologies, Engin e Treleaven (2019) highlighted Estonia, Singapore and the United Kingdom. According to the authors, besides tools aimed at improving the public service provided, potential systems to detect abuse and fraud were also developed to support the work of government workers. Following the trend, studies already show the different initiatives of using these new technologies for governmental control.

In Brazil we highlight the projects developed by the Comptroller General of the Union (CGU) and used by the Federal Court of Accounts (TCU), which use artificial intelligence to improve their audits: the Analysis of Bids and Notices (Alice) robot, which identifies potential evidence of non-conformity; the Guidance System on Facts and Evidence for Auditors (Sofia), which works as a broker and helps auditors by pointing out possible irregularities; and the Integrated Monitoring for Procurement Control (Monica), responsible for monitoring contracting in an integrated manner and carrying out bid monitoring (TCE, 2018; MCTIC, 2020).

Besides the projects listed above, focused on governmental control, we also identified other AI-based Brazilian projects aimed at improving public service, such as the "Bem-Te-Vi" system of the Superior Labor Court (TST), which manages judicial proceedings through AI; the "Victor" tool, developed by the Supreme Federal Court (STF) in partnership with the University of Brasilia (UNB) to read all Extraordinary Appeals and identify which ones are linked to certain issues of general repercussion, which involves a high level of complexity (MCTIC, 2020). At the state level, we identified: the Paraná Artificial Intelligence (PIÁ), an AI program focused on providing services to the population. The platform and the application gather more than 380 services in one place and serve as dialogue channels with citizens, and is integrated with federal and municipal government tools; the "Elis" system, developed by the Pernambuco Court of Justice to speed up cases; and the systems of the Public Prosecutor's Office of Rio de Janeiro, used to speed up investigations and avoid the statute of limitation for crimes (MCTIC, 2020).

At the national level, we also highlight the article "The application of artificial intelligence and big

data in controlling Public Administration and fighting corruption: the experience of the Brazilian Government" (BENTO, 2019). The study refers to the 2003 United Nations Convention against Corruption, the Inter-American Convention against Corruption, the Convention on Combating Bribery of Foreign Public Officials in International Business Transactions, all ratified by Brazil, and the fact that transparency is mentioned a key component of the accountability process. Hence, it highlights the creation of the Public Spending Observatory by CGU, in order to monitor expenditure implementation and deal with information distributed in several databases, by means of data mining techniques, aiming at anticipating critical situations to take preventive measures; build scenarios in strategic support; provide information to help identify incidents in the control process; facilitate immediate knowledge production to meet specific control and management demands; and increase punctuality and accuracy in strategic decision-making. It also cites some experiences with AI incorporation and big data tools in CGU's work routines via the Observatory: data and text mining to calculate reference prices in government procurement; data mining to detect cartels and fraud in government procurement; predictive analysis to prevent risks in public procurement and to prevent corruption risks in public administration bodies; and text mining to classify complaints filed with the agency.

Bento (2019) clarifies that one of CGU's responsibilities is to identify government procurement with values above the market price, which becomes practically unfeasible without the aid of some automated mechanism, given the volume and diversity of the purchases made. As such, the Federal Government uses the Integrated System for the Administration of General Services (SIASG), where all purchases are registered, and later made available on the transparency portal that makes public the information about direct federal government spending in compliance with Law no. 12,527/2011, the so-called Access to Information Law. But this system had some difficulties, such as the lack of detailed information and standardization. To solve the issue, the CGU developed a methodology that uses several statistical techniques, including artificial intelligence, to calculate a reference price for the various products purchased by the Federal Government.

According to the study, the initiative meets the principles of open government, helps increase public transparency, and provides greater clarity in the expenditure estimates of public entities and bodies, contributing to the elaboration of budgets and bids, and to a better use of public resources. Besides, it allows control bodies to identify possible irregularities in advance and prioritize audit activities (BENTO, 2019).

Open government partnership, in turn, refers to a new perspective in Public Administration that promotes projects and actions based on transparency, accountability, citizen participation, and technology and innovation (CGU, 2020).

The adoption of AI-based technologies, although a great opportunity to improve public service efficiency, presents numerous challenges, such as: difficulties in using and sharing citizen data due to issues related to confidentiality standards, lack of resources, absence of a collaborative culture, lack of agents with specific technical skills and responsibility in decision-making (MIKHAYLOV et al., 2018).

A study conducted in India revealed that studies on AI adoption should be focused on security, privacy, and governance issues (CHATTERJEE, 2020).

As such, AI presents fundamental questions about its ethical, social and economic impact. According to a study by Cath (2019), the White House Office of Science and Technology Policy, the European Parliament's Legal Affairs Committee, and the UK House of Commons Science and Technology Committee released their initial reports on how to prepare for the future of AI, which suggests how synchronized efforts to address the challenges posed by AI are. After a comparative evaluation of these reports, the author concludes that all three reflect a positive view of technology remaining from that found in Silicon Valley, and are aimed at the technology sector and the general public. These reports define AI as a technology that, when used with the necessary care, can help enhance human abilities rather than replace them.

This new reality demands specific knowledge and skills, which can provide space for the private sector via companies capable of adapting to these new technologies, focused on governmental needs, such as GovTech startups, to redefine public services in a decentralized, lower-cost, more efficient and personalized manner (ENGIN; TRELEAVEN, 2019). On the other hand, Agarwal (2018) argues that public entities' lack of skills in dealing with these new technologies can generate productive partnerships, provided they are well delineated. If done without criteria, they can lead to outsourcing, which,

according to the author, removes the autonomy of the government body.

Such difficulty, however, also applies to the private sphere. According to research conducted in six Latin American countries (Argentina, Brazil, Chile, Colombia, Mexico and Peru) to diagnose the current AI development in each country and disclose good practices, in order to establish the future of AI in Latin American companies, the experiences of different Brazilian industries showed the need for partnership with experts in data science, science and technology, since it is a multidisciplinary field, which can be solved with the support of universities (REVIEW, 2020).

As for AI-based technologies, a key argument against its application in the public sector is the possibility of obtaining biased, incomplete or flawed data, combined with the lack of transparency of the processes that produce the result.

Legal liability when a decision is made by an algorithm during development and implementation of public policy can have an adverse impact, which leaves room for several legal inquiries regarding its accountability, and so, at the very least, such systems should be available for public audit, testing and review, and subject to accountability standards (MIKHAYLOV et al., 2018).

As Bento (2019) argues, when addressing big data and fundamental rights, the large amount of personal information stored in databases, analyzed for public and private use, brings up ethical and legal issues, such as: the protection of citizens' privacy; protection from discriminatory use of personal data and from the damages of its misuse; ownership of the data; and the corresponding rights and consents for their treatment, maintenance, operation, and use.

To overcome such challenges, the studies point to some strategies: the transfer, receipt and integration of knowledge between the various organizations (public and private); the strategic stimulus for sharing new information and skills aimed at boosting knowledge transfer; the establishment of trust between partners; and the breaking of cultural barriers regarding practical and legal restrictions, as in the United Kingdom, which created the General Data Protection Regulation and the Center for Ethics and Data Innovation to provide legal certainty (CHURCH, 2018; SIMONCINI, 2018; SUN; MEDAGLIA, 2019; WIRTZ et al., 2018).

Similarly, Brazil issued Law no. 13,709/2018, known as the General Personal Data Protection Law (LGPD), which provides for the processing of personal data, including in digital media, by natural persons or by legal entity under public or private law, aiming to protect the fundamental rights of freedom and privacy and the free development of the natural person's personality (BRASIL, 2018).

Among the strategies pointed out for a successful AI adoption in government control is the intersectoral collaboration between government, industry and academia, through public-private partnerships or even informal agreements geared towards finding new strategies to overcome the challenges arising from these partnerships, since the risk management, structure, values and public and private interests differ (MIKHAYLOV et al., 2018; ANDROUTSOPOULOU et al., 2019).

Hence, governments have approached universities in order to use their laboratories, which usually have a platform format, to find solutions to problems related to AI adoption. Which generally provide knowledge and skills to public workers for smarter management (MIKHAYLOV et al., 2018).

Regarding this approach, Kaplan et al. (2019) discuss the importance of AI application based on academic, business and governmental experiences, pointing out two sides: on the one hand, concern about the need for immediate AI regulation; on the other, concern regarding the harm regulations may cause, so as to slow down AI development and limit innovation. For the authors, the middle ground would be to develop common standards, including requirements for testing and transparency of algorithms with some form of assurance, rather than trying to regulate technology itself. The study also recommends observing three characteristics: trust, change, and control. Thus: employees need to exude confidence, consumers need to trust the skills and recommendations of an AI system, employees need to adapt their roles and skills by continuous training, competitors need to be permanently monitored, and managers need to act as data-driven decision makers. Finally, the authors argue that the vast AI abilities combined with increased data availability make it likely that the shift to AI will have a greater impact on the workforce than the Industrial Revolution of 1820-1840 (KAPLAN et al., 2019).

Similarly, Mikhaylov et al. (2018) add that to develop AI tools in the public sector, collaboration is needed between all actors involved (universities, companies and governments). This cross-sector collaboration is required in artificial intelligence centers around the world, since it implies a series of challenges, including

ethical and legal ones, which, if not observed, makes its success impossible.

Current advances in machine learning and AI provide opportunities for data analysis, but require innovative research to make them widely applicable. To transition the technology to Industry 4.0, academic institutions, industry participants, and government agencies must work collaboratively. It takes not only technological innovations, but also human resource training (QIN; CHIANG, 2019)

Such collaboration is as promising as it is challenging. Just as there are numerous benefits stemming from this cross-sector interaction for implementing AI tools, it is also very complex (MIKHAYLOV et al., 2018).

According to the Public Consultation "Brazilian Strategy for Artificial Intelligence" (2020), by the Ministry of Science, Technology, Innovations and Communications (MCTIC), of the 50 countries with national AI strategies, 36 have specific strategies for transforming the public sector via AI or focus on the public sector within a broader strategy, among them: collaboration between different sectors (public-private partnerships), facilitated by innovation labs; creation of councils, networks and communities involving different areas; process automation to increase efficiency; use of AI to support decision-making; strategic management and opening of government data, including to boost the private sector; guidelines regarding transparent and ethical use in the public sector.

As such, the use of artificial intelligence in Public Administration, especially in government control, provides these agencies a real transformation in how public spending is monitored and significant gain in actions, optimizing time and improving preventive control (ANDROUTSOPOULOU et al., 2019).

CONCLUSION

This paper concluded that artificial intelligence has been adopted in government control activities in several countries, including Brazil.

Our quantitative analysis showed a significant growth in the number of publications related to AI in the public sector in the last six years, especially in Public Law, which concentrates the second largest number of papers. Among them, many address the use of AI for government control, either at risk prevention, fraud prevention in public procurement, or in improving services in general.

We identified several AI-based tools used around the world to improve public services, many of which focused on government control. Some of the technologies employed to develop these tools were machine learning, robotics, blockchain, and algorithms.

Moreover, the adoption of these new tools by public agencies can contribute significantly to control, helping in the decision-making process by indicating and predicting potential risks, thus ensuring economicity and greater effectiveness of the actions. The study also identified several strategies to overcome the related challenges, such as the lack of specific knowledge and skills, both public and private, and the ethical and legal problems arising from data sharing.

Among these strategies are the need to regulate the use of these technologies and data protection, the creation of ethics centers and innovation programs, and the sharing and transfer of knowledge between university, company, and government.

And although numerous challenges have been presented, there has already been significant advances. At the national level, for example, besides the tools listed here, we highlight the Access to Information Law (Federal Law no. 12,527/2011), which required the adoption of numerous actions to ensure public information transparency, and the General Personal Data Protection Law (Federal Law no. 13709/2018), which has important provisions for increasing transparency. Both meet the OECD recommendations (2019) regarding the ethical limits of AI use, by applying the principle of transparency to justify the rationale in the decision-making process.

Although the research achieved its goal, making it clear that adopting AI tools can help a greatly assist in preventive control, especially for reducing risk in public procurement, we were unable to assess the effective impact of its use on improving public service (quality of life of the population), economicity and government control (especially in reducing cases of irregularities, fraud and corruption), which may be addressed in future research.

Likewise, legal accountability of the use of such tools, the role of intellectual property, and the practical reflections of the Brazilian Data Protection Law in this context may be the subject of future studies.

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