

Article

Artificial intelligence in Brazilian public organizations:
Heterogeneities and capacity in information technologyManuella Maia Ribeiro¹Catarina Ianni Segatto²

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There is a growing debate about public organizations adopting artificial intelligence (AI), including its different technologies and techniques, as well as its effects on bureaucratic decisions. However, few studies have analyzed the characteristics associated with adopting these different types of AI technologies and techniques in the public sector. Furthermore, there is a gap in studies discussing AI adoption in the public sector in the Brazilian context. This article analyzes the AI technologies and techniques adopted by Brazilian governmental agencies and their association with characteristics related to information technology (IT) capabilities. Based on an analysis of microdata from the ICT Electronic Government 2021 Survey, this study shows that Brazilian government agencies have adopted AI technologies and techniques. However, this process is still restricted to only a few agencies. Furthermore, this process has been a heterogeneous among federal and state entities in the country and is associated with IT capacities in the public sector.

Keywords: Artificial intelligence; information technology; public organizations; Brazil.

Inteligência artificial nas organizações públicas brasileiras: heterogeneidades e capacidades em tecnologia da informação

Há um crescente debate sobre a adoção de tecnologias de inteligência artificial (IA) em organizações públicas e os diferentes tipos de tecnologias e técnicas utilizados por elas e seus efeitos nas decisões das burocracias. Poucos estudos analisam, no entanto, as características associadas à adoção pelas organizações públicas desses diferentes tipos de tecnologias e técnicas relacionadas à IA. Além disso, no que se refere ao contexto brasileiro, há uma lacuna de estudos que discutem a adoção da IA no setor público. Nesse contexto, este artigo analisa a adoção de IA por organizações governamentais brasileiras e sua associação com características relacionadas às capacidades em tecnologia da informação (TI) presentes nessas organizações. A partir de uma análise dos microdados da Pesquisa TIC Governo Eletrônico 2021, esse estudo mostra que as organizações governamentais brasileiras têm

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adotado tecnologias e técnicas em IA, mas esse processo ainda é restrito a um grupo pequeno delas. Além disso, esse processo tem sido heterogêneo entre as entidades federais e estaduais no país, e isso pode estar associado às diferentes capacidades em TI presentes no setor público.

Palavras-chave: inteligência artificial; tecnologia da informação; organizações públicas; Brasil.

Inteligencia artificial en las organizaciones *públicas* brasileñas: Heterogeneidades y capacidades en tecnologías de la información

Existe un creciente debate sobre la adopción de tecnologías de inteligencia artificial (IA) en las organizaciones públicas y los diferentes tipos de tecnologías y técnicas adoptadas por ellas y sus efectos en las decisiones de las burocracias. Sin embargo, pocos estudios analizan las características asociadas a la adopción de estos diferentes tipos de tecnologías y técnicas relacionados con la IA. Además, con respecto al contexto brasileño, existe una brecha en los estudios que discuten la adopción de la IA en el sector público. Este artículo analiza las tecnologías y técnicas de IA adoptadas por organizaciones gubernamentales brasileñas y su asociación con características relacionadas con las capacidades en tecnologías de la información (TI). Basado en un análisis de microdatos de la Encuesta TIC de Gobierno Electrónico 2021, este estudio muestra que las organizaciones gubernamentales brasileñas han adoptado tecnologías y técnicas de IA, pero este proceso aún está restringido a un pequeño grupo de ellas. Además, este proceso ha sido heterogêneo entre entidades federales y estatales del país y está asociado a las diferentes capacidades en TI en el sector público.

Palabras clave: inteligencia artificial; tecnología de la información; organizaciones públicas; Brasil

1. INTRODUCTION

The idea that information and communication technologies (ICT) have the potential to improve the efficiency and quality of government activities, including the provision of public policies (Chun, Shulman, Sandoval & Hovy, 2010), has resulted in its increasing adoption by public administration (Departamento das Nações Unidas para Assuntos Econômicos e Sociais, 2022). In the case of artificial intelligence (AI), new technologies and techniques have been incorporated into various phases of public policy, including the stages of formulation, decision-making, implementation, monitoring, and evaluation (Janssen, Hartog, Matheus, Yi Ding & Kuk, 2022), seeking to increase the speed and productivity of work in public administration, improve the quality of government decision-making, and reduce personnel costs in carrying out processes and policy implementation (Lindgren, 2024).

AI involves different technologies and techniques, such as machine learning and natural language processing, and can have different effects on bureaucracy and public policies (Madan & Ashok, 2023). The literature highlights that AI applications have been used in various fields in the public sector, especially in the areas of security, healthcare, childcare, and education, and in other public services such as tax returns (Andersson, Hallin & Ivory, 2022; Jeffares, 2021; Kerssens & Dijck, 2021; Selten, Robeer & Grimmelikhuijsen, 2023; Valle-Cruz, 2019). These studies have also shown that the different AI technologies and techniques also influence the types of use, including automated decision-making and data processing and analysis to support decisions, as well as recommendations for internal audits (Andersson et al., 2022; Jeffares, 2021; Kerssens & Dijck, 2021; Selten et al., 2023; Valle-Cruz, 2019).

However, the literature has shown that there are massive challenges in adopting these technologies and techniques, which are much more challenging than public managers might imagine (Lindgren, 2024). The challenges can be related to their effects on decision-making and discretion (Bovens & Zouridis, 2002; Lindgren, 2024; Newman & Mintrom, 2023; Selten et al., 2023; Zouridis, Van Eck & Bovens, 2020), access to public services (Boer & Raaphorst, 2021; Jeffares, 2021; Newman & Mintrom, 2023), privacy and data protection (Kerssens & Dijck, 2021), and the creation of biases (Boer & Raaphorst, 2021; Lindgren, 2024).

Furthermore, government organizations are at different stages of AI adoption. Although many

initiatives are underway in various countries and regions, such as Europe and Latin America (Misuraca, Noordt & Boukli, 2020; Organização para Cooperação e Desenvolvimento Econômico, 2022), the literature does little to address the factors and characteristics of the organizations themselves that are associated with AI adoption, which Madan and Ashok (2023) and Mergel, Dickinson, Stenvall & Gasco (2023) mention as fundamental to understanding this process.

Among these characteristics, the literature points out that contexts that are more advanced in information technology (IT) capacity allow for the development and monitoring of automated systems, i.e., the presence of prior technological resources can be considered a factor for the inclusion of AI in the daily activities of public administration (Lindgren, 2024; Madan & Ashok, 2023; Wirtz, Weyerer & Geyer, 2018). This study seeks to gain a deeper understanding of the characteristics related to the IT capacity of Brazilian government organizations in which AI has been adopted and used, including the identification of heterogeneities that point to the different contexts in which AI is used.

This paper aims to contribute to this debate through an analysis of the AI technologies and techniques adopted by Brazilian government organizations, seeking to understand which characteristics related to IT capacities are associated with the use of AI. It is also an exploratory study based on an analysis of microdata from the ICT Electronic Government 2021 survey, a national survey carried out every two years by the Regional Center for Studies on the Development of the Information Society (Cetic.br) in Brazil. In 2021, the survey included indicators related to emerging technologies—such as AI, Big Data analysis, Blockchain, and the Internet of Things—for federal and state government organizations in the Executive, Legislative, and Judicial branches and the Public Prosecutor's Offices.

According to the survey, in 2021, a quarter of federal and state government organizations used AI technologies (Comitê Gestor da Internet no Brasil, 2022). An unprecedented process was carried out for this paper, separating the indicators of the various dimensions of the ICT Electronic Government survey for the organizations that used and those that did not use AI technologies in the 12 months prior to the survey. These dimensions make it possible to identify which IT capacities are most present in organizations with some use of AI. Thus, the descriptive analysis comparing public organizations with and without AI initiatives provided information about the main characteristics of Brazilian government organizations that have already adopted these technologies.

This paper is organized into three sections, in addition to this Introduction. The first section presents a brief review of the literature on AI in the public sector. The second describes the methodology that details the steps for analyzing the data from the ICT Electronic Government 2021 survey. Finally, the third section is dedicated to presenting the results and discussing some findings, including the main contributions, limitations, and possibilities for future research in the field.

2. AI IN THE PUBLIC SECTOR

Recent studies have shown that AI has been widely disseminated in the public sector over the last decade, involving the use of different types of technologies and techniques (Andersson et al., 2022; Jeffares, 2021; Kerssens & Dijck, 2021; Selten et al., 2023; Valle-Cruz, 2019). AI initiatives are being used in the criminal justice system to predict high-risk crime areas, support the identification of offenders, analyze vehicle movement patterns, help citizens to report crimes, detect people through facial recognition, conduct automated interviews, and use robotic cars. They are being used in social welfare policies through speech transcription applications to capture and share meetings with

beneficiaries, robots for care and therapy and smart speakers for people who need care at home, and in applications to support decisions on benefit applications. They are being used in education with virtual teaching assistants and teacher bots, in facial recognition technology to manage attendance and teaching platforms, and in decision-support apps for student loan applications and class allocation. They are being used in health care, with wristbands to track patients, technologies to systematize patients' medical history, symptom-checking websites and apps, robots to move patients, and voice assistants to share health information. They are also being used in managing the environment, collecting data to solve environmental problems, and calculating and monitoring pollution (Andersson et al., 2022; Jeffares, 2021; Kerssens & Dijck, 2021; Selten et al., 2023; Valle-Cruz, 2019; Wirtz et al., 2018). AI has also been used in various public services, guiding citizens through government processes, issuing fines for traffic violations, and supporting tax collection, such as tax returns (Boer & Raaphorst, 2021; Jeffares, 2021; Valle-Cruz, 2019).

Based on this growing adoption, the public policy literature has focused on discussing the implications of AI for access to public services (Boer & Raaphorst, 2021; Jeffares, 2021; Newman & Mintrom, 2023), individuals' privacy and the protection of their personal data (Kerssens & Dijck, 2021), and the effects of these technologies on decision-making processes at different levels of bureaucracy (Bovens & Zouridis, 2002; Newman & Mintrom, 2023; Selten et al., 2023; Zouridis et al., 2020). Another focus has been possible tensions, including the amplification of biases and inequalities (Madan & Ashok, 2023). Some studies have argued that the use of AI has positive effects, such as decreasing the asymmetry of information between public servants and citizens, reducing fraud, improving the analysis of public policies, adding information for decision-making, ensuring more consistency and uniformity of decisions, and increasing efficiency by reducing cost and time. Others take a more pessimistic view, as AI could result in more datification and profiling of citizens, reinforcing the categorization of individuals and biased views (Boer & Raaphorst, 2021; Jeffares, 2021; Lindgren, 2024).

The literature mentions problems related to the privacy of individuals and the protection of their personal data due to the increasing datification, platformization, and surveillance provided by technologies such as AI, which has been reported, for example, in studies that analyze educational platforms (Kerssens & Dijck, 2021). Central to these studies are issues related to autonomy, privacy, and surveillance, including the autonomy of schools to organize their pedagogical content online and the privacy of students and professionals in relation to their data, especially in centralized and non-transparent systems (Kerssens & Dijck, 2021). In addition, Newman and Mintrom (2023) pointed out that the collection, storage, and use of information poses ethical problems, as AI selects and presents information autonomously and, by automating decision-making for the provision of public services, can transform the way in which policy analysis and decision-making are conducted.

Studies have also shown that the adoption and use of AI at different levels of bureaucracy have resulted in important changes in public sector work. Introducing technologies created "new" groups of bureaucrats, called system or screen-level bureaucrats (Madan & Ashok, 2023; Bovens & Zouridis, 2002). AI has reframed and reconfigured the relationship between street-level bureaucrats and citizens, as well as the role and discretion of bureaucracy and its forms of control (Bovens & Zouridis, 2002; Buffat, 2015; Hansen, Lundberg & Syltevik, 2018; Newman & Mintrom, 2023; Selten et al., 2023; Zouridis et al., 2020).

In some initiatives in the public sector, cases considered easy were decided by algorithms, while

cases considered difficult, more complex, or uncertain were decided by civil servants (Bovens & Zouridis, 2002; Zouridis et al., 2020). This involves not only profiling and categorization but also the institutionalization of differences in decisions, which is especially relevant in cases where the dynamics of algorithms and AI applications, especially feedback, are not transparent, as happened in the case of the automated detection of welfare fraud in the Netherlands and the data cross-checking system for identifying improper receipt of social benefits in Australia (Kao, 2024; Peeters & Widlak, 2023; Newman & Mintrom, 2023; Selten et al., 2023; Zouridis et al., 2020). Madan and Ashok (2023) pointed out that there is a consensus in the literature: The automation of decision-making made possible by AI is only appropriate in repetitive or low-discretion activities.

In the case of social assistance in the Netherlands, Peeters & Widlak (2023) drew attention to the importance of organizational factors, mainly related to technology, since the inter-organizational data exchange used for automated transactions and algorithmic analysis resulted in certain citizens being flagged as possible fraudsters. This made it impossible for decision-makers to anticipate the consequences of their decisions, as well as implementers, who were deprived of their discretionary capacity.

Although publications on this topic have increased in the last decade, seeking to understand its effects, it is essential to understand the heterogeneities in the adoption of AI in countries and the conditions of the contexts in which AI has been adopted (Madan & Ashok, 2023). The progress of AI adoption in the public sector is uneven between public organizations, countries, and regions of the world, especially in public policies (Misuraca et al., 2020). An example is that, in at least 60 countries with national AI strategies—based on the mapping of 230 cases of AI adoption in European government organizations—, most of the solutions were aimed at improving internal management, with few actions directly related to citizens or involving substantial changes in government and public services (Misuraca et al., 2020). In the Brazilian context, a national survey of federal government organizations came to similar conclusions when it found that AI technologies are generally adopted in internal administrative processes and actions related to audits and inspections and are still little used for public policies or interaction with citizens (Tribunal de Contas da União, 2022).

The literature points out that the adoption and use of AI are dependent on the context, especially IT capacities, making it necessary to understand in greater depth the characteristics of government organizations that facilitate (or hinder) the use of AI technologies (Madan & Ashok, 2023; Lindgren, 2024; Mergel et al., 2023; Wirtz et al., 2018). Madan and Ashok (2023) emphasized that the literature on the subject draws attention to different factors related to the adoption of AI in the public sector, such as the role of public managers, legitimacy and support, and the internal capacities of organizations. However, through a systematic review of studies, the authors pointed out that, although external factors and organizational contexts are important, the context related to IT capacity, including the presence of digital infrastructure, systems integration, data sharing, data-oriented culture, and specialized employees, is one of the most frequent factors associated with AI initiatives in the public sector in the literature.

Based on the importance of better understanding the relationship between the existence of technological resources and the adoption of AI in the public sector, this paper seeks to identify characteristics associated with IT capacities that lead to the use of these new technologies. Madan and

Ashok (2023) identified IT capacities as one of the factors identified in the literature that influence the adoption of AI in the context of technological resources. The authors also pointed to two main themes associated with these capacities: the level of adoption of electronic government and digitalization. The presence of IT resources and the maturity of adoption and knowledge about them also influence AI capacities.

Other studies have reinforced that the adoption and use of AI require human operators and specific functions and processes for the development and monitoring of automated systems, including their control, routine or emergency maintenance, and evaluation (Lindgren, 2024). Other factors are pointed out as relevant, such as the existence of strategic plans with objectives and resources, security mechanisms and processes, integrated systems, reliable data, data sharing, financial capacity, the existence of a group of specialized professionals with expertise who represent the diversity of society so that they can support the adoption and use of AI, and an institutional governance model and control mechanisms that promote accountability, privacy, and security (Sun & Medaglia, 2019; Wirtz et al., 2018).

This study seeks to understand the relationship between the characteristics related to IT capacities and the adoption and use of AI, in other words, it seeks to identify the characteristics associated with IT capacities that lead to the use of these technologies. Based on the aforementioned studies, we use the concept of IT capacities as the set of contextual characteristics related to the adoption and use of technology in public organizations, public services, and social participation, and the existence of a professionalized bureaucracy, organizational structures, and specific processes for IT management, following one of the results of the systematic review by Madan and Ashok (2023) that pointed to the implementation of technological resources in public organizations as one of the factors that influence the use of AI. In addition, this study seeks to deepen the understanding of the heterogeneities present in these contexts and their effects on the adoption of AI, which has not been sufficiently explored in the literature.

3. METHODOLOGY

This paper seeks to understand the adoption and use of AI in government organizations, including the heterogeneities in its adoption and use, and to verify whether those in more advanced contexts in terms of IT capacities adopt and use AI initiatives to a greater extent.

To analyze the characteristics related to the IT capacities of federal and state government organizations in Brazil that have adopted AI initiatives, microdata from the ICT Electronic Government survey were analyzed. This survey has been carried out every two years since 2013 by Cetic.br, a department of the Brazilian Network Information Center (NIC.br), which is responsible, among other activities, for measuring statistics and indicators on the information society in Brazil, with more than ten regular national surveys on various sectors, such as individuals, enterprises, schools, healthcare facilities and public organizations (Diniz, Cunha & Rodrigues-Santos, 2020).

Based on a multidimensional framework, the ICT Electronic Government survey aims to measure the use of digital technologies in the Brazilian public sector, including the adoption of these technologies by Brazilian public entities and their use in the provision of public services. The survey also investigates the existence of initiatives for access to public information and the participation of society

in public activities mediated by ICT. It includes two units of analysis: federal and state government organizations in the Executive, Legislative, and Judicial branches, and the Public Prosecutor's Office, and municipalities at the local level (Comitê Gestor da Internet no Brasil, 2022).

The survey data is collected through interviews using a structured questionnaire and the computer-assisted telephone interviewing technique. The target population covers 5,569 municipalities and all federal and state government subunits of the Executive, Legislative, and Judicial branches and the Public Prosecutor's Office listed in the survey register. The government subunits in the survey include entities such as ministries, secretariats, and regulatory agencies, including autonomous institutions with their own legal identity and substantial autonomy established to carry out specific functions. In the Executive branch, the survey focuses on the following subunits for both federal and state government organizations: ministries, secretariats, departments, autonomous agencies, and public foundations. The Legislative and Judicial branches and the Public Prosecutor's Office are represented by the main subunits, such as legislative assemblies, courts of justice, and superior courts.¹

The ICT Electronic Government survey adopts a census approach for federal and state government organizations in the Legislative and Judicial branches, the Public Prosecutor's Office, and the state executive secretariats of education, health, and finance, as well as municipalities. However, due to limited resources, a sampling approach is used for the other state government organizations in the Executive branch. The data collection process for the 2021 edition took place between August 2021 and April 2022, and 580 Brazilian federal and state government organizations responded to the survey, achieving a response rate of 75%. At the local level, interviews were obtained with 3,543 city halls with a response rate of 64% (Comitê Gestor da Internet no Brasil, 2022).

For this paper, data from the 2021 edition was analyzed. The main reason is that, for the first time, the survey collected data on the adoption of new technologies, such as AI, among federal and state government organizations. In addition, the ICT Electronic Government survey is the only regular multidimensional study on the subject that includes public organizations from different branches and levels of government. Generally, regular international studies on digital government focus only on executive branches and national or central governments, such as the United Nations E-Government Survey by the United Nations Department for Economic and Social Affairs (UN DESA); the Govtech Maturity Index by the World Bank; and the Digital Government Index by the Organisation for Economic Co-operation and Development (OECD) (Departamento das Nações Unidas para Assuntos Econômicos e Sociais, 2022; Banco Mundial, 2023; Organização para Cooperação e Desenvolvimento Econômico, 2024). In Brazil, these limitations are repeated in periodic national studies, such as the ABEP-TIC Index of Digital Public Services Offered by State and District Governments; the Brazilian Association of State ICT Entities (ABEP-TIC), which in addition to presenting information only on the state level did not measure the topic of AI until the edition released in 2022; and the Connected Smart Cities Ranking by Urban Systems, which only measures indicators for municipalities with more than 50,000 inhabitants and also did not provide data on AI in the data collection carried out in 2023 (Associação Brasileira de Entidades Estaduais de TIC, 2022; Urban Systems, 2023).

Until 2019, the ICT Electronic Government survey included 6 dimensions to analyze the adoption

¹ To access more detailed information on the methodology of the ICT Electronic Government 2021 survey, including the public organizations that are considered for the study, see the Methodological Report and the Data Collection Report (Comitê Gestor da Internet no Brasil, 2022).

of technologies among public organizations in Brazil: ICT infrastructure (module A); ICT management (module B); digital services (module C); access to information (module D); and e-participation (module E). An additional dimension, module F (Use of ICT in urban management), was collected only for municipalities. In 2021, two new dimensions were collected: privacy and protection of personal data (module G), and new technologies (module H). These gathered data on the adoption of emerging technologies such as AI, Big Data, blockchain, and the Internet of Things (IoT) (Comitê Gestor da Internet no Brasil, 2022). Data from municipalities was not analyzed due to the need for more data collection on AI initiatives for this level of government. This happened in both the ICT Electronic Government survey and in other similar studies, such as the Municipal Basic Information Survey (Munic) of the Brazilian Institute of Geography and Statistics (IBGE, 2020), where there is no fixed regularity for the collection of data for the Communication and Informatics module and there were no questions on the topic until the last edition of this module released in 2019.

For this paper, based on the objective of understanding how characteristics related to IT capacities are associated with the adoption and use of AI among Brazilian government organizations, public entities were divided into two groups: organizations with AI and those without AI. To do this, an unprecedented statistical process was carried out using microdata from the indicator modules in the 2021 edition of the ICT Electronic Government survey. The operationalization of the concept of IT capacities included the data collected in the questions on the adoption and use of technology in public organizations in public services, such as issuing tax slips or other payment forms; in online participation, such as access to information and communication and consultations; and the existence of a professionalized bureaucracy, organizational structures, and specific processes for IT management, such as IT infrastructure and IT management.

When they were released to the general public on the Cetic.br website, the published tables did not contain information that would allow users to differentiate between federal and state government organizations that do or do not use AI technologies. In this paper, the data is analyzed specifically considering federal and state government organizations that did (or did not) use these technologies. For example, in the tables published on the website, some indicators were calculated based on reference criteria, such as the total number of federal and state government organizations that had websites. These same indicators were calculated based on criteria specific to the study and disclosed only in this paper, such as: a) total federal and state government organizations that had websites and had used AI technologies in the last 12 months; and b) total federal and state government organizations that had websites and had not used AI technologies in the last 12 months.

Because only federal and state government organizations with IT departments answered the new technologies module, including the indicator on AI adoption, data on organizations without this sector was excluded. Respondents who did not know or did not answer whether they had adopted AI technologies in the last 12 months were also excluded from the analysis. After the exclusions, by weighting the microdata for the total number of federal and state government organizations with IT departments in 2021, the estimated total of organizations with AI in Brazil was 374 (279 from the Executive branch, 56 from the Judicial, 26 from the Legislative, and 15 from the Public Prosecutor's Office). The estimated total of organizations without AI initiatives was 974 (888 from the Executive branch, 43 from the Judicial, 28 from the Legislative, and 15 from the Public Prosecutor's Office). Among the levels of government, there were an estimated 70 federal and 304 state government organizations with AI initiatives and 78 and 896 organizations, respectively, at these levels without

the use of AI.

4. RESULTS

The ICT Electronic Government 2021 survey showed that almost half of federal government organizations and 22% of state organizations already used AI-based tools, totaling an estimated 374 federal and state organizations from the Executive, Legislative, Judicial branches and the Public Prosecutor's Office. The survey also found that the adoption of AI occurred in higher proportions in the Judicial and Legislative branches and the Public Prosecutor's Office (Comitê Gestor da Internet no Brasil, 2022). There is still room for growth in the use of different AI technologies in the Brazilian public sector, as approximately six out of ten federal and state organizations have not yet adopted AI (Comitê Gestor da Internet no Brasil, 2022). The survey also investigated the reasons for non-adoption; the most frequently cited reason among federal (41%) and state (38%) organizations was the lack of personnel qualified to use AI technologies. Other reasons were also pointed out, such as lack of need or interest, high costs, and incompatibility with existing equipment, software or systems in the organizations; these difficulties were especially relevant in state government organizations (Comitê Gestor da Internet no Brasil, 2022).

In addition, the 2021 ICT Electronic Government survey measured the types of AI adopted by federal and state government organizations that already worked with this technology. The types most mentioned at both levels of government were machine learning for data prediction and analysis (32% of federal government organizations and 9% of state organizations) and workflow automation (31% of federal government organizations and 11% of state organizations). It is worth noting that almost a quarter of federal government organizations had adopted AI for text mining and written language analysis.

Other AI technologies investigated by the survey were mentioned by less than a quarter of the federal and state organizations. For example, only 13% of federal government organizations and 6% of state organizations mentioned the adoption of image recognition and processing. These results suggest that there is a potential for adopting various AI technologies in the Brazilian public sector. In addition, as proposed by Madan and Ashoka (2023), it is necessary to understand how the use of this technology relates to the presence of IT resources among federal and state government organizations. To this end, specific processing of the survey microdata was carried out, dividing public entities with and without AI, in order to identify the characteristics of IT capacities.

As pointed out by Madan and Ashoka (2023), one of the ways to identify the technological context that influences AI is by identifying the level of use of technologies in public organizations, i.e., IT capacities. Digital technologies can be adopted in different areas of the public sector, including the improvement of government procedures and internal operations, the provision of public services, and the communication and participation of society (Organização das Nações Unidas para a Educação, a Ciência e a Cultura, 2005). IT capacities were analyzed based on the dimensions of the ICT Electronic Government 2021 survey: ICT infrastructure and management (modules A and B); digital service provision (module C); access to information, communication, and participation (modules D and E); use of ICT in urban management (module F); privacy and protection of personal data (module G); and new technologies (module H).

With regard to modules A and B of the ICT Electronic Government survey, which are related to

the dimensions of ICT infrastructure and management, there were no significant differences between government organizations with and without AI in the following indicators: presence of computers (100% in both groups), types of computers used and Internet access in the last 12 months (100% in both groups), having IT areas or departments (they all had them, as this was the filter question to answer about the adoption of AI technologies); and adoption of information security practices, such as backup and passwords to access computers and applications. In the case of the types of internet connection, almost all forms of connection measured showed no significant differences between the groups with and without AI, including access via optical fiber (present in virtually all organizations in both groups). The only exception was Internet access via 3G or 4G modem, which was mentioned to a greater extent by organizations that adopted AI (55%) compared to those that did not (39%).

On the other hand, significant differences were found in indicators related to the institutionalization of the IT sector and its activities, which were more present in organizations with AI, such as the presence of IT employees and information security plans, as well as risk management processes and IT governance or strategy committees or councils. Federal and state government organizations that had adopted AI technologies also used decision support systems (77% against 48%) and geographic information systems (60% against 44%) in greater proportions, as well as contracting more frequently for all the cloud computing services measured by the ICT Electronic Government survey in 2021 (Table 1). It is worth noting that the adoption of cloud computing was strongly associated, as it is one of the requirements for the widespread adoption of technologies that rely on large volumes of data, such as AI (Departamento das Nações Unidas para Assuntos Econômicos e Sociais, 2022). In the Brazilian context, this was demonstrated by the greater frequency of contracting cloud computing services among federal and state government organizations that already used AI technologies.

TABLE 1 ICT INFRASTRUCTURE AND MANAGEMENT INDICATORS THAT PRESENTED SIGNIFICANT DIFFERENCES BETWEEN FEDERAL AND STATE GOVERNMENT ORGANIZATIONS WITH AND WITHOUT AI

Indicators	Organizations with AI	Organizations without AI
A5A. Federal and state government organizations with internet access by type of connection in the last 12 months. Item: 3G or 4G modem connection.	55%	39%
B4. Federal and state government organizations that used information systems in the last 12 months, by purpose. Item: Decision support systems.	77%	48%

(Continue)

Indicators	Organizations with AI	Organizations without AI
B4. Federal and state government organizations that used information systems in the last 12 months, by purpose. Item: Geographic information, maps or GIS.	60%	44%
B5A. Federal and state government organizations with formally instituted information technology plans, by type. Item: Strategic or master information technology plans.	70%	58%
B5A Federal and state government organizations with formally instituted information technology plans, by type. Item: Information security plans.	68%	53%
B7. Federal and state government organizations that had steering committees or councils for information technology strategy or governance.	57%	39%
B8. Federal and state government organizations that had information technology management processes, by type. Item: Risk management.	64%	46%
B9B. Federal and state government organizations that used cloud computing services, by type of service. Item: E-mail in the cloud.	63%	44%
B9B. Federal and state government organizations that used cloud computing services, by type of service. Item: Office software in the cloud.	51%	24%
B9B. Federal and state government organizations that used cloud computing services, by type of service. Item: File storage or databases in the cloud.	50%	29%
B9B. Federal and state government organizations that used cloud computing services, by type of service. Item: Processing capacity in the cloud.	43%	21%

Source: Elaborated by the authors based on microdata from the ICT Electronic Government 2021 survey.

Although basic IT infrastructure, such as computers, Internet, and fiber optics, was available to the majority of organizations in both groups, other ICT management indicators were adopted by at least half of the government organizations with AI initiatives. The exception was the hiring of cloud processing capacity, which was mentioned by 43% of organizations with AI technologies, but was still in higher proportions than for those without AI initiatives (21%).

In the case of module C of the ICT Electronic Government 2021 survey, which focuses on the adoption of technologies for public services, for most indicators, the proportions of organizations with AI that were using technologies to offer services over the Internet were higher than for organizations without this type of technology. On the one hand, almost all the organizations in both groups had websites. In addition, there were no significant differences between the organizations in terms of offering the most sought-after public service online. Another similarity was that around half of government organizations with AI and those without AI offered the most sought-after public service entirely online, while less than one-third of the organizations in both groups offered this service partially online.

However, government organizations with AI adoption offered services via their websites (including transactional services) in greater proportions than organizations without AI initiatives. For example, services such as issuing documents such as licenses, certificates, permits, and others were offered by 65% of organizations with AI and 39% of organizations without AI initiatives. The exception was the service of downloading documents or forms, which was available in more than 80% of public organizations in both groups. Excluding the issuing of tax slips or other payment forms, other measured services were present in more than half of the government organizations with AI, meaning that most already had digital services available to the public on their websites.

Therefore, all the website features measured by the survey were offered in greater proportions by organizations with AI, including the availability of videos (84% vs. 61%) and live streaming (67% vs. 48%). Similar results were found in the indicators for mobile device resources. With the exception of receiving text messages from citizens via SMS and payments and transactions, federal and state government organizations that adopted AI initiatives had more services for citizens through mobile devices. For example, seven out of ten government organizations with AI had apps for mobile devices. In the case of governments without AI adoption, less than half offered this type of initiative (Table 2).

Although the majority of federal and state entities already had some online presence through websites, the organizations using AI offered more services and resources online. This shows that, in the dimension of online public services, those organizations with AI also offered more of these types of initiatives.

TABLE 2 INDICATORS FOR ONLINE SERVICE PROVISION THAT SHOWED SIGNIFICANT DIFFERENCES BETWEEN FEDERAL AND STATE GOVERNMENT ORGANIZATIONS WITH AND WITHOUT AI

Indicators	Organizations with AI	Organizations without AI
C3. Federal and state government organizations, by types of services offered on their websites. Item: Generating tax payment slips or other payment tabs.	41%	25%
C3. Federal and state government organizations, by types of services offered on their websites. Item: Checking ongoing administrative or judicial proceedings.	75%	42%
C3. Federal and state government organizations, by types of services offered on their websites. Item: Completing or sending forms through the websites.	79%	62%
C3. Federal and state government organizations, by types of services offered on their websites. Item: Generating documents such as licenses, certificates, permits, and others.	65%	39%
C3. Federal and state government organizations, by types of services offered on their websites. Item: Registering or enrolling in public service employee exams, courses, and schools.	54%	40%
C3 Federal and state government organizations, by types of services offered on their websites. Item: Scheduling appointments, assistance, services, and others.	63%	38%
C5. Federal and state government organizations, by types of resources offered to citizens on their websites. Item: Audio or web radio.	36%	21%
C5. Federal and state government organizations, by types of resources offered to citizens on their website. Item: Videos.	84%	61%

(Continue)

Indicators	Organizations with AI	Organizations without AI
C5. Federal and state government organizations, by types of resources offered to citizens on their websites. Item: Real-time live streaming or broadcasting of events, such as sessions, lectures, and meetings.	67%	48%
C6B. Federal and state government organizations that provided resources to citizens via mobile devices in the last 12 months, by type of resource. Item: Sending text messages to citizens by SMS.	32%	17%
C6B. Federal and state government organizations that provided resources to citizens via mobile devices in the last 12 months, by type of resource. Item: Applications created by the government organization.	70%	42%
C6B. Federal and state government organizations that provided resources to citizens via mobile devices in the last 12 months, by type of resource. Item: Applications created by third parties.	45%	30%
C6B. Federal and state government organizations that provided resources to citizens via mobile devices in the last 12 months, by type of resource. Item: Website version for mobile devices.	83%	69%
C6B. Federal and state government organizations that provided resources to citizens via mobile devices in the last 12 months, by type of resource. Item: Sending messages by WhatsApp or Telegram.	54%	34%

Source: Elaborated by the authors based on microdata from the ICT Electronic Government 2021 survey.

In Modules D and E, which relate to access to information (transparency) and the promotion of participation and online communication, there are no significant differences between organizations with AI and those without AI regarding the publication of information on the Internet (such as public accounts or financial reports, public service lists, legislation, etc.); the availability of different file formats on their websites; social media profiles or accounts; and the type of citizen participation online (such as online surveys and public consultations). However, there are significant differences between organizations with and without AI in the availability of certain types of contact offered to citizens and online ombudsman services. In the case of activities conducted on websites and social media, there is a significant difference only in the use of automated user support through virtual assistants

or chatbots. It is worth noting that the adoption of chatbots can benefit the use of AI technologies by enabling real-time, faster, and more personalized communication with individuals (Comitê Gestor da Internet no Brasil, 2022). Although there is still room to expand this type of use even among organizations with AI – for example, 40% of these organizations reported using this functionality on their websites –, among those without AI initiatives, this form of synchronous interaction is noted by approximately 10%.

Therefore, some actions are more common among government organizations with AI, particularly contact channels and the use of automated chat services (Table 3). However, no significant differences were found in indicators related to the use of IT for access to public information and digital participation initiatives.

TABLE 3 INDICATORS RELATED TO ONLINE ACCESS TO INFORMATION AND PARTICIPATION THAT SHOWED SIGNIFICANT DIFFERENCES BETWEEN FEDERAL AND STATE GOVERNMENT ORGANIZATIONS WITH AND WITHOUT AI

Indicators	Organizations with AI	Organizations without AI
E1. Federal and state government organizations that offered citizens some type of contact on the Internet in the last 12 months, by type of contact. Item: Electronic forms.	78%	62%
E1. Federal and state government organizations that offered citizens some type of contact on the Internet in the last 12 months, by type of contact. Item: Real-time online customer service, such as chats.	35%	16%
E1. Federal and state government organizations that offered citizens some type of contact on the Internet in the last 12 months, by type of contact. Item: Online reports.	80%	64%
E1. Federal and state government organizations that offered citizens some type of contact on the Internet in the last 12 months, by type of contact. Item: Automated customer service with virtual assistants or chatbots.	40%	13%
E2A. Federal and state government organizations that offered online ombudsmen in the last 12 months.	91%	79%
E3E. Federal and state government organizations with online social network profiles or accounts by activities performed on online social networks in the last 12 months. Item: Use of automated customer service with virtual assistants or chatbots.	32%	10%

Source: Elaborated by the authors based on microdata from the ICT Electronic Government 2021 survey.

In 2021, the ICT Electronic Government survey included two new dimensions of analysis related to emerging issues in digital public administration. Module G measures government activities related to privacy and data protection. Both groups had areas of their organizations that were responsible for implementing the Brazilian General Data Protection Law (LGPD), with no significant differences. Regarding the provision of LGPD training programs or courses for IT staff, the survey showed a greater presence among organizations with AI (68%), when compared to other organizations (48%). Excluding the implementation of response plans for information security incidents related to personal data, other actions related to the LGPD were more available in government organizations with AI adoption, such as the appointment of organization data officers (52% vs. 34%) and the availability of online service channels for citizens to send messages about the use of their personal data by government organizations (50% vs. 33%).

For module H, related to new technologies, there was only one significant difference between organizations with and without AI in Big Data analysis. Organizations with AI (52%) carried out Big Data analysis in greater proportions than organizations without AI (21%), which demonstrated greater use of large volumes of data by these entities. Less than a quarter of government organizations in both groups adopted blockchain and IoT, with room for expansion of this use in public organizations in general.

Considering the diversity of organizations at both the federal and state levels, as well as the different internal capacities, the results can also be analyzed separately between the levels of government. In organizations with and without AI, in general, there were no significant differences in IT adoption between federal and state government organizations. However, some exceptions were observed. Among government organizations with AI, there was greater adoption of certain initiatives among federal government organizations, especially in the institutionalization of IT actions, such as the presence of technology master plans (100% of federal organizations and 63% of state organizations with AI), information security (92% of federal organizations and 63% of state organizations) and IT governance committees (100% of federal organizations and 48% of state organizations).

Federal government organizations also used more decision-support systems (94% compared to 73%). Among the types of AI adopted, the only one that showed a significant difference was machine learning, which was cited by 70% of federal agencies with AI and less than half of state agencies (41%). Among organizations without AI, this situation was the same, with differences between the levels of government mainly in actions aimed at institutionalizing IT in these entities, such as the presence of IT committees, which was mentioned by 98% of federal entities and 34% of state entities without AI. Therefore, in addition to greater inclusion of technologies in the various dimensions investigated by the ICT Electronic Government survey among government organizations with AI in Brazil, processing the survey's microdata also revealed differences in some areas when comparing the levels of government. This makes it necessary to delve deeper into the specific characteristics of public organizations in order to identify factors that increase the adoption of AI technologies.

5. FINAL CONSIDERATIONS

Studies on the adoption of AI by government organizations have increased substantially in the last decade. Most have analyzed the uses of these new technologies and techniques and their effects on bureaucracy, decisions, and access to public services. However, few studies have focused on

understanding the relationship between the adoption and use of AI and the contexts related to IT capacities in which this adoption and use take place, particularly the heterogeneities that characterize them and their effects on this adoption.

This study makes an initial contribution to this debate by showing that, according to data from the ICT Electronic Government 2021 survey with regard to the adoption of AI by federal and state government organizations in Brazil, AI technologies have been used, although there is room to expand this use. In the Brazilian context, the most widely adopted technologies include machine learning for data prediction and analysis, workflow automation, and text and written language analysis. Technologies related to image recognition and processing, which have more potential and unknown risks, still have limited use in the country, especially among state-level government organizations.

The article also shows that the adoption of AI is already present among federal and state government organizations in Brazil, but its use has been restricted to only a few public organizations, and this process has been heterogeneous, being more present at the federal level and in the Judicial and Legislative branches and the Public Prosecutor's Offices. The heterogeneity is significant even when excluding organizations without IT departments from the analysis, which indicates that the heterogeneity may be even greater among all organizations. In addition, there are different challenges related to its use, with the lack of infrastructure, professionalized bureaucracy, organizational structures, and processes being some of the main obstacles, which reinforces the importance of understanding the contexts related to IT capacities in which AI is adopted.

When analyzing this issue, the study points out that there is no difference between organizations with AI and organizations without AI when it comes to the most adopted technologies, such as the use of different electronic devices and presence on platforms, social networks, and websites. However, in the case of services and resources offered online and the adoption of new technologies, there are significant differences between the two groups. This shows that the organizations that are most advanced in the adoption and use of IT are those that have adopted AI in their activities. This analysis is not intended to establish a causal relationship between ICT adoption and use and AI technologies and techniques, but it does show that there is an association between them.

Although it is possible to conclude that the contexts related to IT capacities vary between public organizations with and without AI technologies in the country, some limitations should be highlighted. There are other contextual variables that deserve to be included in future studies to understand the factors that influence the adoption and use of AI and the implementation of these technologies in the public sector, such as organizational factors. The complexity of the policies and services provided by government organizations can also affect the use of AI. The more complex and less routine the public policy processes to be impacted by AI, the more the uncertainties surrounding the benefits of these technologies can hinder their adoption by the public sector. This is an initial and exploratory study, but future research, including qualitative studies, should be proposed to deepen the understanding of the adoption and use of AI in Brazil.

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DATA AVAILABILITY

The dataset that supports the results of this study is available upon request to the Regional Center for Studies on the Development of the Information Society (Cetic.br). The dataset is not publicly available due to the organization's requirement to establish a term of access and use for using the de-identified microdata from quantitative surveys in order to minimize the risk of identifying the survey respondents. For more information, visit: <https://cetic.br/en/microdados/>

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