



Technological frames, CIOs, and Artificial Intelligence in public administration: A socio-cognitive exploratory study in Spanish local governments

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ABSTRACT

Artificial Intelligence (AI) policies and strategies have been designed and adopted in the public sector during the last few years, with Chief Information Officers (CIOs) playing a key role. Using socio-cognitive and institutional approaches on Information Technologies (ITs) in (public) organizations, we consider that the assumptions, expectations, and knowledge (technological frames) of those in charge (CIOs) of designing AI strategies are guiding the future of these emerging systems in the public sector. In this study, we focus on the technological frames of CIOs in the largest Spanish local governments. Based on a survey administered to CIOs leading IT departments, this article presents original data about their technological frames on AI. Our results: (1) provide insights about how CIOs tend to focus on the technological features of AI implementation while often overlook some of the social, political, and ethical challenges in the public sector; (2) expand the theory on AI by enabling the construction of propositions and testable hypotheses for future research in the field. Therefore, the comparative study of technological frames will be key to successfully design and implement AI policies and strategies in the public sector and to tackle future challenges and opportunities.

1. Introduction

The adoption, implementation, and use of Artificial Intelligence (AI) is an increasing trend in public organizations. Recent studies have highlighted the transformational capacities of AI technologies in the public sector across different services areas and policy sectors (Janssen & Kuk, 2016; Sun & Medaglia, 2019), or regarding to their implications for people working in public administrations (Criado, Valero, & Villodre, 2020; Margetts & Dorobantu, 2019), or addressing how citizens interact with public authorities (Agarwal, 2018; Androutsopoulou, Karacapilidis, Loukis, & Charalabidis, 2019; Vigoda, 2002). At the same time, empirical evidence about the different implications of this new wave of technological innovations in public administration and its organizational challenges is relatively limited (Medaglia, Gil-Garcia, & Pardo, 2021). Hence, departing from the literature about technological frames and through the analysis of a case study (CIOs of Spanish local city councils), this article is intended to contribute to the debate about the implications of AI implementation in (public) organizations. The approach is based on the work of Orlikowski and Gash (1994), and the

most recent studies of Sun and Medaglia (2019), Guenduez, Mettler, and Schedler (2020), Van Hulst and Yanow (2014), Ahn and Chen (2021), among others. Our goal is: (1) to land original results on the frames of technological leaders in the public sector to get a first approach to how CIOs are framing AI; (2) to state theoretical propositions that can be tested in future research on AI design and implementation in public organizations and thus, expanding the theory on technological frames in public administration.

The rise of new and disruptive technologies in recent years, including AI, has somehow extended the nature of the smart/intelligent governance debate in the public sector (Dunleavy, Margetts, Bastow, & Tinkler, 2006). Smartness in government has been studied from different perspectives (Gil-Garcia, Helbig, & Ojo, 2014; Gil-Garcia, Pardo, & Nam, 2015; Rodriguez-Bolívar & Meijer, 2016). Thus, the nascent development of AI in government is driving scholars to the study of how to govern algorithms in the public sector (Janssen & Kuk, 2016; Just & Latzer, 2017), requiring a more sophisticated interplay between public management and digital government to cope increasingly wicked problems (Gil-Garcia, Dawes, & Pardo, 2018). Different authors have

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acknowledged AI systems as a unique set of technological innovations that will make public services more efficient and effective, but also bring major changes to public administration and management (Dwivedi et al., 2020; Wirtz & Müller, 2019), and will shape the future of (public) organizations (Margetts & Dorobantu, 2019; Van der Voort, Klievink, Arnaboldi, & Meijer, 2019).

Recently, the study of Sun and Medaglia (2019) inaugurated the interest in the study of different actors involved in the adoption of AI systems, with their analysis of the Chinese health system. Consequently, the position of Chief Information Officers (CIOs) has gained attention allowing them to emerge as those shaping the future and potential success in the implementation of this new technological wave in the public sector. Understanding their perceptions, assumptions and knowledge regarding technology and AI has become a fundamental goal (De Tuya, Cook, Sutherland, & Luna-Reyes, 2020). In order to fill this gap in the research, we have assumed a socio-cognitive approach of CIOs' interpretations about AI in local public administrations. Socio-cognitive studies are based on the idea of existing cognitive structures in peoples' minds containing knowledge about the world (Augoustinos, Walker, & Donaghue, 2014; Neisser, 1976). These cognitive structures operate shaping our perceptions of the world and determining our behavior in organizations. Here, we follow Orlikowski's approach to ICTs in organizations named "technological framing" (Orlikowski & Gash, 1994). Regarding public sector settings, the effort to identify CIOs existing cognitive structures on AI might help understanding key features in the design, adoption, and implementation of strategies and policies in public organizations (Hong, 2019). Then, this article is intended to move forward this theoretical approach regarding to the contribution of the public sector.

The first part of this study is oriented to understand CIOs' interpretation of AI in the public sector and presents a research question (RQ) focused on the local level of government: *What are the technological frames of Spanish CIOs on AI?* Following our theoretical approach on technological frames (Orlikowski & Gash, 1994), we have broken down the main RQ into three exploratory research sub-questions. Each of them corresponding with one of the dimensions of Orlikowski's theory on technological frames: (a) nature of technology (b) technology strategy; and (c) technology in use. The RQ is based on previous research on the relevance of frames in organizational contexts (Guenduez et al., 2020; Orlikowski & Gash, 1994; Sun & Medaglia, 2019) and the importance of technology perceptions' from this group of civil servants on successful adoption and implementation processes in public organizations (Ganapati & Reddick, 2012). Secondly, due to emergence of this field of research study and the lack of previous work on the topic, we make propositions within the literature on organizational theory, technological implementation, and public administration that could be interesting to test in future research aimed to advance the use of AI in the public sector. Thus, this study advances an exploratory investigation about the situation of AI technologies in the local layer of government, including the study of official strategies and internal uses in public organizations, based on the perceptions of local CIOs.

The remainder of this article is as follows. In Section 2 we present our theoretical framework that focuses on socio-cognitive approaches to technology, using the literature on organizational studies and the notion of "technological frames". Here, we also present the application of technological frames in public administration highlighting the framing role of CIOs in the public sector and the analytical framework of the research as an exploratory case study that can be used to generate hypotheses. The third section displays the research design and methods of the study. Our fourth section presents the results of the analysis of the three dimensions framing AI in Spanish local governments. Then, the discussion section identifies the main results of the study and suggests testable propositions for future research on AI use and implementation (as hypothesis). Finally, the conclusion includes some final remarks, limitations, and future research avenues.

2. Theoretical framework

2.1. Approaching technological frames in organizations

Socio-cognitive studies depart from the idea of existing structures in human's minds that act as pattern simplifications of the world and allow us to interact with it fluidly through information acquisition and processing. These cognitive structures are also known as "frames" and they are decisive to understand the ideas and prejudices underlying human behavior as they enable and constrain our behavior, both at the same time. On the one side, "frames" facilitate our interaction with the world by simplifying it through mental schemas. On the other hand, besides guiding our behavior, "frames" work as filters. Hence, due to the existence of these cognitive schemas we do not perceive everything around us, but a small portion of it (Augoustinos et al., 2014). This is relevant in social contexts, but also in organizational settings, as these processes shape the behavior of individuals and groups.

During the last decades of the twentieth century, socio-cognitive psychologists and organizational researchers extended the notion of individual frames to groups and organizations. Orlikowski and Gash (1994), Weick (1979) or Van Hulst and Yanow (2014), popularized, within the academic literature on organizational studies, the idea that besides having individual frames, humans also hold shared cognitive frames. In this work, and following Orlikowski's approach, we will refer to "frame" as the "definitions of organizational reality that serve as vehicles for understanding and action" (Gioia, 1986; p.50). Thus, frames are sets of assumptions, expectations, and knowledge, as well as, metaphors, visual images, etc., shared by a certain community (Orlikowski & Gash, 1994). In the context of organizations, frames are believed to be shared by groups of actors who play a similar role within an organization (Moch & Bartunek, 1990). Hence, as individual cases, shared frames also guide and determine the behavior and interactions of the group with its environment.

This perspective about framing technology has been applied to different studies in organizations (Cornelissen & Werner, 2014; Daft & Weick, 1984; Mazmanian, 2013; Orlikowski, 1992; Weick, Sutcliffe, & Obstfeld, 2005) with noticeable results. Particularly, Orlikowski & Gash's socio-cognitive approach to technology (1994) has allowed researchers to understand the shared assumptions, expectations, and knowledge that different social groups have about technology within an organization. As cognitive approaches are based on the idea that "people act on the basis of their interpretations of the world" (Bougon, Weick, & Binkhorst, 1977; Orlikowski & Gash, 1994; Porac & Thomas, 1990), then, a technological frame refers to the "subset of members organizational frames that concern the assumptions, expectations, and knowledge they use to understand technology in organizations" (Orlikowski & Gash, 1994: 178). This understanding of the concept of technology limits the scope of the theory of technological frames and operationalizes it for the purposes of this study.

The theory of technological frames developed by Orlikowski and Gash (1994) identified three different dimension or domains to characterize the interpretations, assumptions, and expectations (frames) of technology: the *nature of technology*, the *technology strategy*, and *technology in use*. Each technological dimension focuses on different aspects of the technology that are relevant to determine people's interactions. At the same time, dimensions are comprised by a set of core beliefs, that is, assumptions, perceptions, and knowledge on the relevant aspects of technology.

2.2. AI and the framing role of CIOs in the public sector

Following Orlikowski's organizational theory (Orlikowski, 1992; Orlikowski, 2007; Orlikowski & Gash, 1994) and its applications on the public sector, we recognized three social groups in this type of organizations: managers, technologists, and users. In the case of public administrations (Guenduez et al., 2020), we have identified managers with

elected politicians, technologists with ICTs people (primarily, Chief Information Officers (CIOs)), and users with bureaucrats who work in public administrations. Among the three above mentioned social groups, the role of CIOs has increased since the 1980s due to the emergence of the so-called “infocracy” (Bovens & Zouridis, 2002; Zuurmond, 1998), the digital transformation of the workplace (Haffke, Kalgovas, & Benlian, 2016), and the emergent algocracy (Lorenz, Meijer, & Schuppan, 2021).

The emergence of this new type of control configurations has only been possible given the introduction of ICTs in the public sector, with CIOs playing a critical role. As these “newly” emergent ideal type of public servants are in charge of designing and implementing new technologies in the public sector, they have gained importance during the last decades, and have become central figures of the new bureaucratic structures based on technology. CIOs are key actors within public organizations as they lead technological strategies, ICTs implementation processes, and, thus, organizational changes related to technology. In this context, these public servants are the ones who are able to transform technology-related political proposals into tangible public services (Bovens & Zouridis, 2002; De Tuya et al., 2020), digital transformation of the public sector (Mergel, 2019), or responsible and accountable algorithmization (Meijer & Grimmelikhuisen, 2020).

Particularly, CIOs perceptions have become highly valuable to understand the future of local governments, as well as its technological strategies and future opportunities (McClure & Bertot, 2000), and their pre-adoption ideas have been proven as significantly influential in previous technology implementation processes (Ginsberg & Venkatraman, 1992; Thomas, Clark, & Gioia, 1993). Specially during preliminary states of technological implementation, when governments are in need for orientation and guidance. Thus, CIOs have turned into a reliable source of information regarding technology in public administration, in particular about the opportunities, expectations, and assumptions on technology in the public sector (Ganapati & Reddick, 2012).

CIOs comprise the group in charge of technology design and implementation within public organizations, at different layers of government. Due to the nature of their profile—most of them being engineers or people with a technological background—and following Orlikowski and Gash (1994), they will represent the group of technologists in our research, sharing some common ideas, beliefs, and expectations about technology, in general, and AI, in particular, within the public sector. The reason to predominantly focus on AI is due to the distinguish relevance that this set of emergent technologies has recently gained in government agendas in comparison to other in different contexts (European Commission, 2020; Van Roy, Rossetti, Perset, & Galindo-Romero, 2021).

Thus, due to the relevance of CIOs technological frames for AI implementation, in this work we seek to understand: RQ: *What are the technological frames of Spanish CIOs on AI?*

Following Orlikowski and Gash’s (1994) conceptualization of technological frames: *nature of technology*, *technology strategy*, and *technology in use*. We have broken down the RQ in three exploratory research sub-questions, each of them corresponding with one of the dimensions of technological frames: RQ1: *What is the nature of AI according to Spanish CIOs?*; RQ2: *What is the strategy of AI according to Spanish CIOs?*; RQ3: *What is the use of AI according to Spanish CIOs?*

For this work, we have used CIOs of Spanish local governments (city councils) as a case study to develop exploratory research on AI implementation in the public sector through their perceptions. Case studies are widely used in social science to study complex phenomena (Stake, 1995) and can be useful to explore emergent areas or research fields where consensus and solid knowledge has not been settled (Bell, Bryman, & Harley, 2018; Bryman, 2012; Thomas, 2011). Hence, the aim of exploratory research applied to a case study is to get a first-hand understanding of somewhat unexplored events and, from there, develop theory and propose new hypotheses and forms to study the AI phenomenon (Bell & Bryman, 2007; Stebbins, 2001). In this case, we focus

on the perceptions of CIOs about AI in the public sector and how they frame this type of technology in this stage of implementation.

In order to be able to tackle the exploratory research sub-questions of this study through a survey content, we have followed Orlikowski and Gash (1994) operationalization of the three dimensions of technological frames. Thus, in the case of the *nature of AI* we will focus on the “capabilities in isolation” (Orlikowski & Gash, 1994, p. 192) of this technology. The technology (AI) strategy refers to people’s motivations to adopt a certain technology and how the technology is envisioned in the future. Therefore, the strategy of AI can be understood as the goals and objectives to be achieved through technological change but, also the obstacles to overcome and the strengths that can be exploited (Burri, 2015; Paltieli, 2021). Finally, *technology in use* is described by Orlikowski & Gash as “people’s understanding of how the technology will be used on a day-to-day basis” (1994: 183–184), and the consequences of its use.

3. Research methods

The authors of this study administered a survey to CIOs of the Spanish largest city councils (heads of IT departments in local governments). According to the National Statistics Institute (INE) this group (over 50.000 inhabitants) encompasses a total of 146 municipalities (in 2019). The selection of these city councils is partly due to the particularity of a Spanish structural phenomenon named “inframunicipalism”. The term “inframunicipalism” refers to the large number of Spanish rural municipalities with <5000 inhabitants (Olmeda, Parrado, & Colino, 2017). Also, this group of large municipalities concentrates more than 53% of the population of the country. Additionally, due to the nascent state of AI implementation in the public sector, only large municipalities are in real conditions to adopt these emergent technologies. As we mentioned before, despite the lack of experience with AI technologies due to its recent implementation in the public sector, these group of city councils are relatively advanced users regarding to the last technological developments. At the same time, we decided to use a sample of cases for the study sharing common institutional challenges, expectations, and organizational dilemmas, as other previous and related studies have identified in the Spanish context about apps in smart cities (Alcaide-Muñoz & Rodríguez-Bolívar, 2019), e-participation (Pina, Torres, & Royo, 2017), open government and data (Ruvalcaba-Gómez, Criado, & Gil-García, 2020), social media in government (Bonsón, Royo, & Ratkai, 2015) or, web 2.0 technologies (Rodríguez-Bolívar, 2017).

The survey was delivered to CIOs leading ICTs in each city council via their email address, offering the option to fill it electronically. The contact information was gathered through an online search on the council’s websites included in the sample, and through telephone calls to their institutions. Once the contact information was confirmed the survey was sent to them through email. The survey included a presentation letter of the research authors and the study content, and objectives. Besides, contact information about the authors of the research was added in case CIOs had any further questions or concerns regarding the survey or the research study.

The survey was designed and constructed based on previous studies. It reflects the work from different authors (Pombo, Gupta, & Stankovic, 2018; Russell & Norvig, 2016; Tinholt, Carrara, & Linden, 2017; Zhang & Dafoe, 2019) and it contained twenty questions, following the previous work of Criado, Sandoval-Almazan, Valle-Cruz, and Ruvalcaba-Gómez (2021) (see Annex 1). Some of the questions had an open format so the respondents of the survey could express freely; other questions had a closed format, so respondents could only choose among the given options. For this last kind of questions, in some of them we used Likert-scales (with 7 options) to answer among a variety of possibilities, and for others we proportionate questions with multi-answers options and CIOs had to select at least three of them. The questionnaire was opened from February 27th to May 12th, 2020, and we obtained a significant level of

commitment from CIOs in Spanish city councils: 73 of them answered the questionnaire, meaning that more than 50% of CIOs contacted successfully completed the survey, surpassing the minimal level of response rates acceptable in organizational studies and, thus, ensuring the representativeness and validity of results (Baruch & Holtom, 2008). No biases were identified regarding the type of city councils, including size, location, or other variables that could be used for the analysis as moderator variables.

Therefore, this article presents primary data about each of the three dimensions of our analytical framework, based on an exploratory research design (Bell et al., 2018; Bryman, 2012). Once the survey was completed, data obtained was analyzed with the statistical software *Stata*, using descriptive statistics. For many of the answers, media statistics are reported, since the median is a better measure of central tendency for ordinal data. In this case, the use of descriptive statistics is aligned with the exploratory scope of the study, and is intended to understand Spanish CIOs technological frames on AI. Also, the study is oriented to unravel propositions regarding each dimension and incorporating them into the discussion about technological frames in public sector organizations.

4. Results

The results of this research derive from primary data gathered through a survey distributed among the CIOs of the largest Spanish city councils. This section shows results in the three dimensions of technological frames identified by Orlikowski and Gash (1994): (1) nature of technology, (2) technology strategy, and (3) technology in use. By approaching the implementation of AI in Spanish public administrations through the lenses of technological frames, we intend to characterize the assumptions, expectations, and knowledge of CIOs managing ICTs in these kinds of processes.

First, we show the demographic data of CIOs in our sample of local governments (Table 1). Demographic variables show that most local CIOs in Spain are usually between 40 and 56 years old, being the average 50. At the same time, most Spanish CIOs hold a bachelor's degree (72.60%) in some technological discipline, mainly computer science (64.38%) or other degrees with an engineering or scientific background (24.66%). A significant number of them have a master's degree (24.66%). However, only 1.37% hold a PhD or equivalent academic degree. What is most striking is the unbalance proportion of male CIOs. Male CIOs correspond to 84.93% of the total, and their female counter

Table 1
Demographic data of Spanish local CIOs.

CIO (n = 73)	
Average Age (yrs.)	50
Genre	
Male	84.93%
Female	15.07%
Academic degree	
Bachelor's	72.60%
Master's	24.66%
PhD	1.37%
Other:	1.37%
Academic background	
Computer Science	64.38%
Engineering	16.44%
Social Science	9.59%
Physics	5.48%
Mathematics	1.37%
Chemistry	1.37%
Other:	1.37%

Source: Own elaboration.

partners only represent 15.07%, representing a gender gap in ICTs management. Despite this is not the purpose of this study, this factor needs to be addressed in future analysis about the potential causes and implications of this situation.

4.1. On the nature of AI in the public sector

An adequate way to study CIOs perceptions on AI capabilities (nature of AI) is through their acknowledgment of AI implications for public administrations. Studying these features implies reflecting on their vision of the future of work in the public sector, their openness towards AI adoption, their views on AI groundbreaking capacity, etc. (Ginsberg & Venkatraman, 1992; Guenduez et al., 2020). Consequently, the first part of the questionnaire aimed at understanding CIOs shared ideas and perceptions on the capabilities and functionalities of AI, in other words, in this section we try to find an answer to RQ1: *What is the nature of AI according to Spanish CIOs?*

Following with the characterization of AIs nature from the perspective of local Spanish CIOs, our survey asked about CIOs agreement with some statements related to the introduction of AI in the public sector. The survey question here was, *"to what extent do you agree with the following ideas regarding to AI?"*. The responses for the question in the survey were on a seven-point Likert scale, ranging from "totally agree" (7) to "totally disagree" (1). From the results shown in Table 2 we can assume that most CIOs feel totally open with the idea of introducing AI in the public sector. They also agree with the idea that new professions in the public sector linked to AI will have to be tackled thoroughly and that other "intelligences" or capabilities will be required from public sector employees. Also, CIOs seem to assume naturally that the workplace will be a shared space between robots and humans and the fact that this will have a great impact and will imply major changes. Probably, the most interesting outcome here is the difference between AI in the public and the private sector. Here, most Spanish local CIOs agree with the idea that AI will not differ greatly from one sector to the other.

Fig. 1 displays the organizational functionalities that are expected to be most affected by the introduction of AI in public sector. In order to understand this dimension, the survey question was, *"from your point of view, what of the following functions will be more affected by AI in the short term?"*. The responses in the survey were on a multi-answer question (with a minimum of three options to answer from the complete list). Here, local CIOs highlighted "Processing of transactions" (91.78%) and "Public service delivery" (67.12%). Also, other functionalities such as "Capacitation" (45.20%), "Management of organizational networks" (43.83%), and "Clerical and assistant tasks" (35.62%) are also perceived as potentially affected. On the other hand, "Technical duties" (20.55%), "Regulation" (13.70%), "Political advisory" (12.33%), and "Executive management" (9.59%) are the functionalities less likely to be affected by AI according to CIOs. Therefore, organizational functionalities that are

Table 2
General ideas related to AI in the public sector.

	CIO (n = 73)	
	Average	Standard Deviation
I am totally open to the adoption of AI	6.11	1.15
AI in the public sector is not very different than AI in the private sector	5.34	1.44
I assume naturally that robots and humans will share jobs	5.68	1.31
Envisioning future occupations of public employees is complex, as the replacement process will have profound impacts	5.32	1.42
Other "intelligences" will be required for public employees	5.96	1.36
The new professions in the public sector linked to AI will have to be tackled thoroughly	6.32	0.85

Source: Own elaboration.

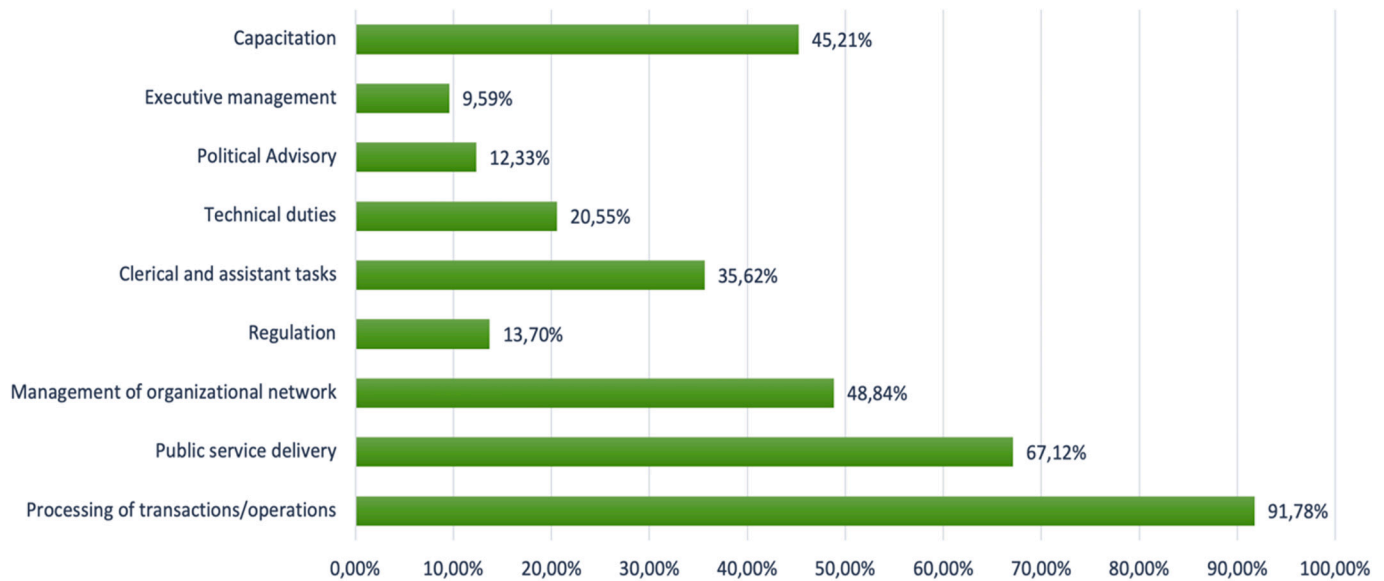


Fig. 1. Functionalities affected by AI.
(Source: Own Elaboration.)

most frequently perceived as being affected by the introduction of AI in the public sector are those that are highly repetitive and easily automatized.

4.2. On the AI strategy in the public sector

The second dimension of the study is oriented to explore the strategy of adoption of AI in public administration. In this case we have associated the dimension on the strategy of AI to RQ2: *What is the strategy of AI according to Spanish CIOs?* On the one hand, and in line with the literature on technological narratives and strategies (Burri, 2015; Paltieli,

2021), we seek to comprehend the elements that more often are perceived as hinderers in the implementation of AI in the public sector. Despite having a national strategy on AI (Ministry of Economics, 2020), Spain is not among the countries that are leading this technological transformation so, what is slowing down this transition within this country according to CIOs? On the other hand, the perceived facilitators of AI in the public sector are also investigated. What would facilitate AI implementation in the public sector according to CIOs? This aspect is important in order to be able to implement AI successfully in the public sector, as CIOs share the role of designing and implementing it within their organizations. Lastly, we also aim to understand where AI is likely

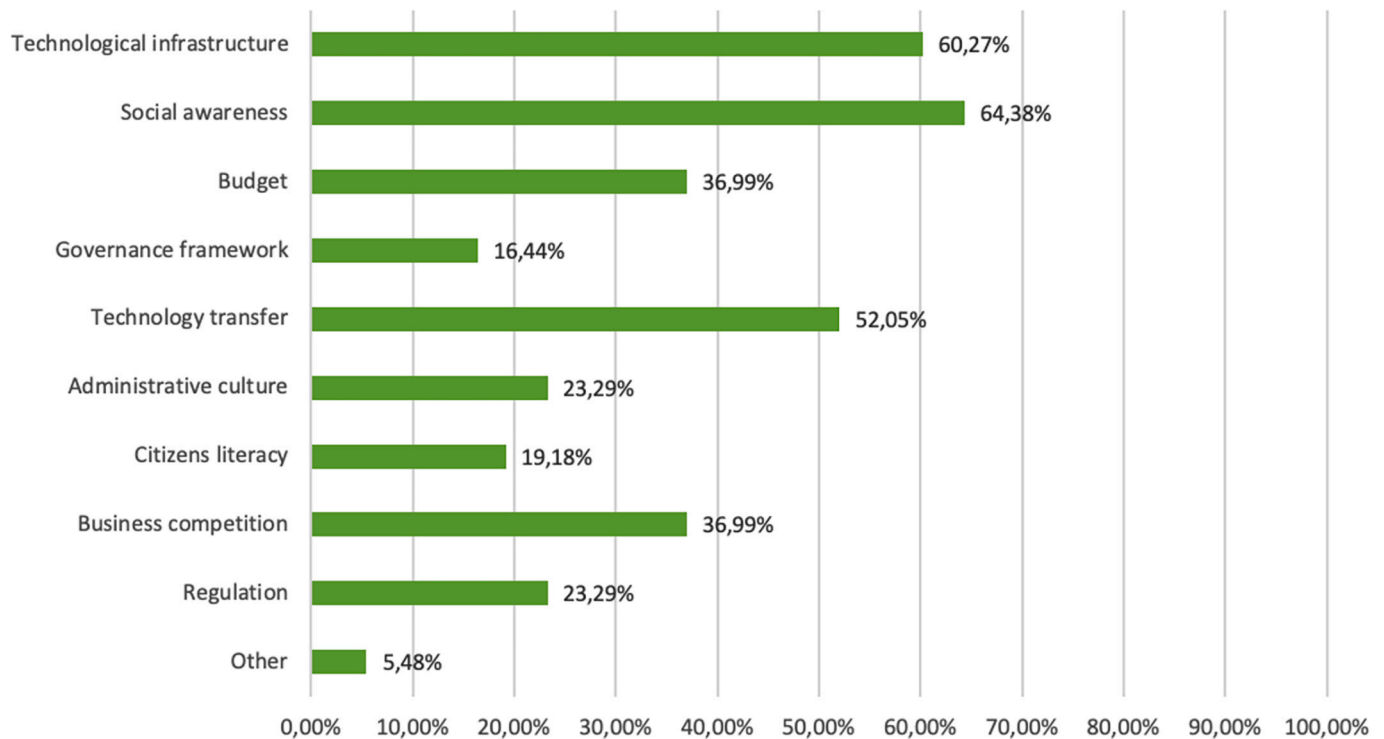


Fig. 2. Perceived facilitators of AI implementation in the public sector.
(Source: Own Elaboration.)

to be adopted first, that is, policy sub-sectors expected to have the greatest impact in a shorter period of time.

Fig. 2 displays the perceived facilitators of AI implementation in the public sector. With respect to facilitators, the survey question was, “*what are the main enablers for the implementation of AI in the public sector?*”. The responses in the survey were on a multi-answer question (with a minimum of three options to answer from the complete list). In this case, “Social awareness” (64.38%), the “Technological infrastructure” (60.27%), and “Technological transfer” (52.05%) are seen as the most decisive facilitators for the introduction of AI into the public sphere. Then, other important elements for the implementation of AI are: a sufficient “Budget” (36.99%) and “Business competition” (36.99%). Finally, “Administrative culture” (23.29%), current “Regulation” (23.29%), “Citizens literacy” (19.18%), and “Governance framework” (16.44%) are rarely seen as enablers of AI. From results displayed, we might state that while most elements perceived as hinderers are socially, culturally, economically, and politically determined, technological features such as the “Technological transfer” and the “Technological infrastructure” are perceived as facilitators on the implementation of AI in the public sector.

On the other hand, Fig. 3 shows the perceived hinderers of AI adoption in the public sector. In order to understand this dimension, the survey question was, “*what are the main inhibitors for the implementation of AI in the public sector?*”. The responses in the survey were on a multi-answer question (with a minimum of three options to answer from the complete list). We can see that, according to CIOs, the biggest obstacle is “Administrative culture” (72.60%). Also, an insufficient “Budget” (63.01%), existing “Technological infrastructure” (46.57%), “Digital divide” (46.57%), current “Regulation” (41.10%), “Human labor elimination” (41.10%) and “Social unawareness” (41.10%) are perceived as serious hinderers of AI implementation. The elements that are less frequently identified as obstacles are “Data Privacy” (9.59%), “Suppliers’ control” (8.22%), “Data security” (5.48%), and “Inequality” (4.11%). Finally, the “Governance framework” (30.14%) and “Citizens literacy” (16.44%) are perceived as moderate hinderers of AI.

4.3. On the AI in use in the public sector

Lastly, the third dimension of technological frames identified in Orlikowski & Gash’s work is the technology in use. This domain refers “*to people’s understanding of how the technology will be used on a day-to-day basis and the likely or actual conditions and consequences associated with such use*” (Orlikowski & Gash, 1994: 183–184). The questions of the survey about this dimension include perceived benefits and disadvantages of AI implementation in the public sector on a daily basis. The data in this dimension will shed light on RQ3: *What is the use of AI according to Spanish CIOs?* and, therefore, how CIOs perceive the changes that AI will bring to our lives and in which manner this transformation could take place; whether or not they envision AI as a disruptive technology regarding its use; and which human behaviors and capacities might be potentially replaced by AI according to them.

First, results on the perceived benefits of AI in the public sector are displayed in Table 3. In order to understand this dimension, the survey question was, “*What benefits do you expect from the implementation of AI in the following aspects of the public sector?*”. The responses in the survey were on a multi-answer question (with a minimum of three options to answer from the complete list). “Efficiency” (6.16/7) and “Digitalization” (5.70) seem to be the main benefits brought by AI according to

Table 3

Expected benefits of AI in the public sector.

	CIO (n = 73)	
	Average	Standard Deviation
Efficiency	6.16	0.91
Digitalization	5.70	1.39
Transparency	4.90	1.64
Data security	4.66	1.58
Citizens’ participation	4.40	1.36
Interoperability	5.45	1.31
Equity	4.56	1.50
Accountability	4.71	1.58
Trust	4.38	1.39
Flexibility	5.04	1.43

Source: Own Elaboration.

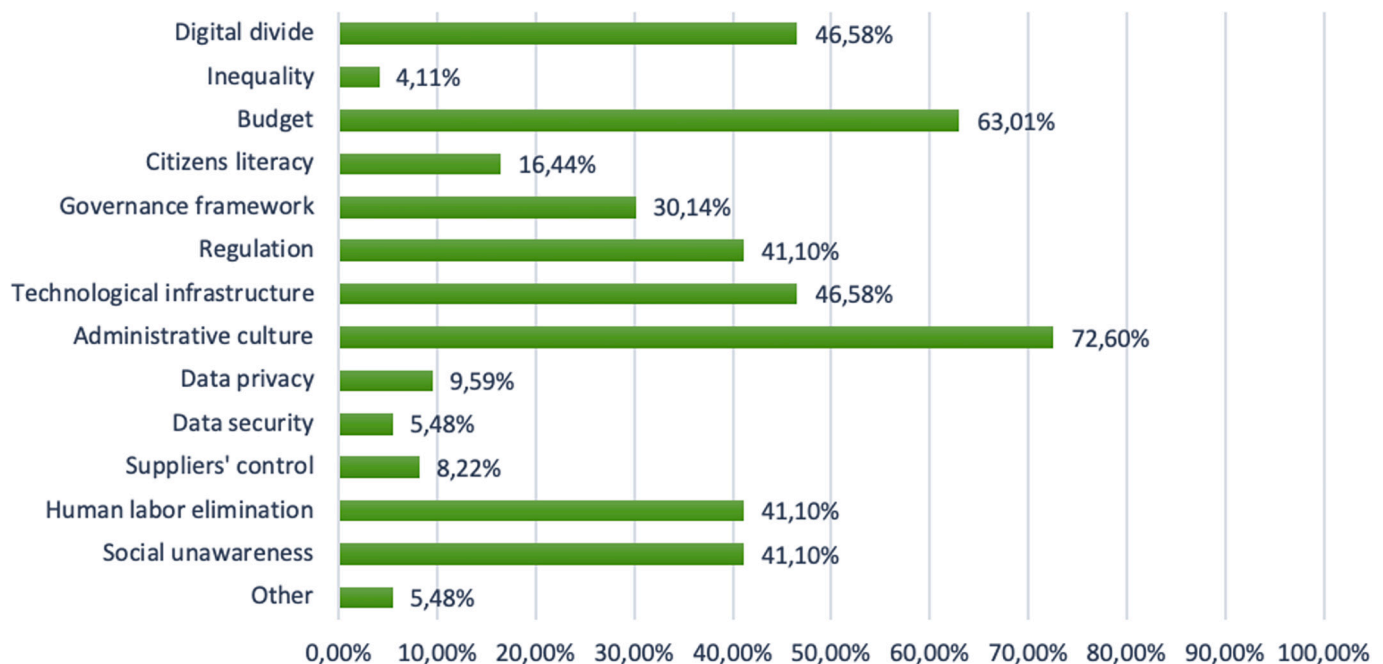


Fig. 3. Perceived hinderers of AI implementation in the public sector.
(Source: Own Elaboration)

Spanish local CIOs. Very closely, “Interoperability” (5.45/7) and “Flexibility” (5.04/7) are also highly perceived as advantages from this intelligent technology. Despite the fact that most features listed on question 6 are perceived as more advantageous than disadvantageous, it is interesting to note that issues such as “Citizens’ participation” (4.40/7) and “Trust” (4.38/7) appeared at the bottom of the list. Meanwhile, “Equity” (4.56/7), “Data security” (4.66/7), “Accountability” (4.71/7) and, “Transparency” (4.90/7) seem to be less critical issues from this perspective of expected benefits.

Data regarding disadvantages perceived by local CIOs are displayed in Table 4. In order to understand this dimension, the survey question was, “What disadvantages do you expect from the implementation of AI in the following aspects of the public sector?”. The responses in the survey were on a multi-answer question (with a minimum of three options to answer from the complete list). Here, “De-humanization” (5.05/7), “Algorithmic opacity” (4.96/7), “High costs” (4.86/7), and “Human replacement” (4.66/7) are the main disadvantages of using AI in the public sector. Also, “Distrust” (4.51/7), “Ethical Problems” (4.45/7), “Social Exclusion” (4.22/7), and “Invasive Control” (4.22/7) are mostly perceived as disadvantages of AI implementation in the public sector. At the bottom part of the list of Spanish local CIOs we can find “Inflexibility” (3.97/7), “Inequality” (3.68/7), and “Vulnerability of data and information” (3.64/7), as they are consequences of AI implementation that are most rarely seen as disadvantages.

5. Discussion

The results of this study show that the technological frames of Spanish local CIOs tend to focus on the engineering and technological features of AI. In all the analyzed dimensions the engineering perspective of technology has played a key part on the frames that we have identified in our group of CIOs. This conclusion is coherent with previous research on the literature about technology and organizations (Markus & Bjørn-Andersen, 1987; Orlikowski, 1988), and somehow reflects the technological background of this group, as more than 90% of them hold a bachelor’s degree in some technological discipline (mainly in computer science or other degrees with an engineering or scientific background). The limited acknowledgment of other potential implications of AI (i.e., social, political, cultural, or economic) is a key issue, as most of the opportunities and challenges linked to AI in governments and public administrations stand on new ethical and philosophical dilemmas, emerging social inequalities, democratic and political polarization, or fair distribution of economic resources, just to mention a few.

This conclusion about the focus on the engineering and technological features of AI could not only be due to CIOs’ educational background, but also other variables, including gender or age. Previous studies showed that education, age, and gender can partially explain different attitudes towards technology and innovation (Hoff & Bashir, 2015; Lobera, Jesús, & Rodríguez, 2020). In this sense, we find that it could be

interesting to explore the explanatory role of sociodemographic factors regarding CIOs and other people in charge of directing and managing technological change within public organizations. This does not mean that other sociodemographic variables (income, religion, political ideology, etc.) could also play a significant role in explaining CIOs’ perspectives and attitudes.

Also, we suggest that other promising lines for future research in the field of AI in public administration could be found in its intersection with gender studies (McDonald, Hall, O’Flynn, & van Thiel, 2022). The fact that most CIOs are males, in our case, suggests the unbalance between females and males within managerial and leading positions in the AI design process within public administrations. This lack of female perspectives regarding AI adoption and implementation could involve difficulties to implement ethical, fair, and unbiased AI, as other previous studies have suggested regarding national strategies (Guevara-Gómez, de Zárate-Alcarazo, & Criado, 2021). From this finding, we support an urgent call to explore the impact to AI implementation from a gender perspective, as well as from the lenses of other vulnerable groups in order to achieve trustworthy AI in the public sector.

Regarding the three dimensions of technological frames and their application in our study, we now proceed to propose other lines of study and propositions to be tested in future research on AI adoption and implementation in the public sector. Hence, we debate our results by proposing future ways of development in the study of AI in public administrations by debating the different dimensions of technological frames in public organizations, and suggesting propositions to develop in coming studies in the field. This approach is aligned with the emergent stage of development of AI in the public sector, mostly at the local level of government, and the lack of theoretical perspectives to guide an ethical and human-centered implementation of AI systems and technologies in public settings.

5.1. Debating on the nature of AI

The first dimension of the study, *nature of AI*, presented the results of questions resembling the most spread notions about AI among our surveyed CIOs. Our results show that CIOs are fully open to adopt AI, assuming that robots will work with humans in the future, and other intelligences will be needed, at the same time, that new professions in the public sector associated with AI will have to be tackled thoroughly. Openness as well as trusting attitudes towards technology has been proven to be strong indicators of technological acceptance (Horst, Kuttuschreuter, & Gutteling, 2007; Venkatesh, Morris, Davis, & Davis, 2003). Hence, it would be interesting to explore whether it exists any significant relation between CIOs holding these ideas and AI implementation rates in local governments. In this regard, we suggest the following:

Proposition 1. CIOs’ openness and trust towards AI technologies will be positively related with AI implementation rates in local public administration.

Also, most CIOs agree with the idea that “AI in the public sector is not very different than AI in the private sector”. Given the difference between public and private sectors in terms of values, goals, and infrastructure (Boyne, 2002; Hughes, 2012; Kernaghan & Langford, 1990; Lui & Cooper, 1997) it may be interesting to test whether these ideas on AI can affect AI implementation differently. When CIOs think about AI, they seem to take for granted its technological dimension, but this is not paired with neither social or politico-administrative aspects, nor archetypical values of the public sector, including transparency, accountability, participation, equality, or impartiality (Margetts & Dorobantu, 2019). Hence, an appropriate understanding of AI and its potential consequences would not be compatible with the belief that AI could remain the same independently of the context of adoption. AI materiality has different reverberations depending on the environment the technology is embedded and the frames of the different social groups

Table 4
Expected disadvantages of AI in the public sector.

	CIO (n = 73)	
	Average	Standard Deviation
Human replacement	4.66	1.77
High costs	4.86	1.51
De-humanization	5.05	1.54
Distrust	4.51	1.60
Inflexibility	3.97	1.58
Vulnerability of data and information	3.64	1.62
Ethical problems	4.45	1.76
Social exclusion	4.22	1.70
Inequality	3.68	1.65
Invasive control	4.22	1.68
Algorithmic opacity	4.96	1.78

Source: Own Elaboration.

that interact with it (Orlikowski & Scott, 2015). Thus, the nature of AI in the public sector should be different from AI in the private sector, in order to make an adequate and ethical use of this technology (Ananny, 2016). And this aspect should also be acknowledged by people leading its design, adoption, management, and implementation.

We also expect that more ethical approaches towards AI implementation mean better and more successful implementation processes, than those that are less ethical and human-centered, as it is stated by the European Commission (2019, 2020). Hence, following the idea that values guide attitudes and behaviors (Ho, Brossard, & Scheufele, 2008; Kahneman, 1984), it could be the case that in city councils where CIOs acknowledgement of public and private sector differences are more significant, and thus, more aligned with the indications of Spanish digitalization plans and the Spanish National Strategy on Artificial Intelligence (Ministry of Economic Affairs and Digital Transformation, 2020), AI implementation will be more human-centered. In this case, we suggest the following propositions:

Proposition 2. Public administrations lead by CIOs guided by public values will implement more ethical AI technologies.

Proposition 3. Public administrations lead by CIOs guided by public values will experience more successful AI implementation processes.

At the same time, we have observed that CIOs highlighted that some of the functionalities of public administrations that will most likely be affected by AI will be relate to the processing of transactions/operations, public service delivery, training, or management of organizational networks. Probably, this last statement is supported on the fact that these types of tasks are those that have been so far the most affected by digitalization (Chui, Manyika, & Miremadi, 2016). Despite some CIOs seem to be aware of AI technologies potential and disruptiveness, they tend to link this phenomenon to its robotic capabilities and automatization functionalities. Here, we believe that overlooking fundamental functionalities of AI, such as those that involve management and technical skills, could result in a misused of these technologies within public administrations. Thus, we hold the following surmise for future studies:

Proposition 4. CIOs misunderstanding of AI functionalities will be positively related with misused of AI technologies within local public administrations.

5.2. Debating the AI strategy

The second dimension of the study, *strategy of AI*, presented the results of variables displaying our surveyed CIO's motivations to adopt AI and how it is envisioned in the future. By exploring this dimension, we aimed to answer the question RQ2: *What is the strategy of AI according to Spanish CIOs?* The results of the study indicate that CIOs' opinions about enablers of AI strategies are more oriented towards technology-driven factors, than other features, whereas hinderers point to administrative socio-administrative variables (culture, budget, or digital gaps). In this sense, one of the key challenges for AI strategies in the public sector is how to tackle with pre-existing institutional constraints in public bureaucracies. To put it differently, administrative cultures and the lack of financial support are among the issues that CIOs highlighted as obstacles to implement IA in public agencies. This is not surprising in local governmental contexts with noticeable fiscal constraints or administrative limitations to invest in emerging technologies, and embedded in traditional administrative cultures, too rigid or legalistic to facilitate public innovation (Mulgan & Albury, 2003).

As it was the case with other previous technologies (Fountain, 2001; Gil-Garcia, 2013), pre-existing institutional design in public settings, including here bureaucratic structures, norms, and regulations, and other social factors, will shape the adoption and implementation processes of these new disruptive technologies (Criado & Gil-Garcia, 2019; Dwivedi et al., 2020). AI strategies should be aligned with the institutional context to foresee potential limitations and opportunities during

the adoption and implementation stages. Therefore, we propose that:

Proposition 5. Local public administrations that hold rigid institutional contexts and a strong administrative culture will have lower rates of AI implementation.

It is also important to notice that CIOs tend to identify regulation as a significant hinder of AI implementation in the public sector. Similarly, within the list of facilitators, the existence of a governance framework also is perceived as some of the least efficient elements to conduct AI implementation. These preexisting ideas on regulation and governance frameworks as innovations and technology implementation burden could be related to ideas previously mentioned on administrative culture within public administrations (Mulgan & Albury, 2003). Although regulation, governance frameworks, and administrative culture are connected in some way (Gil-Garcia, 2013), the existence of the former does not necessarily have the same implications that the latter. In this case, it could be interesting to conduct compare analysis between different countries or regions to explore the relationship between regulation, governance frameworks, and AI implementation rates and models. Then, we suggest the following:

Proposition 6. The existence of national regulation and governance frameworks regarding AI will be positively related with high AI implementation success rates in local public administration.

Proposition 7. The existence of national regulation and governance frameworks regarding AI will be positively related with the ethical implementation of AI technologies in local public administrations.

5.3. Debating the AI in use

Finally, the third dimension of the study, *on the AI in use*, presented the results of variables regarding to CIO's perceptions about how the technology will be used on a day-a-day basis and the likely conditions/consequences of these uses. Here, we have observed that, despite acknowledging the importance of algorithmic opacity, CIOs perceived the benefits of AI mostly in regard to its internal management dimensions, instead of the ethical and value-based issues. This does not mean that CIOs do not identified disadvantages of AI in public agencies related to internal management (i.e., high-costs or de-humanization of work). However, functionalities encompassing advisory and decision-making capabilities are those that appear to be the less perceived as potentially affected by AI.

It is also important to note that some issues, that have been pointed out in previous studies as essential during the algorithmization process in the public sector (Androutopoulou et al., 2019; Mikhaylov, Esteve, & Campion, 2018). This is connected with the role of citizens when public administrations use IA, and it seems to be at the bottom line of CIOs agendas, including citizens' participation, trust, or equality. International organizations have raised their voices on this regard and towards the lack of attention on ethical and social factors in AI design and implementation (European Commission, 2020). Thus, we suggest that:

Proposition 8. An efficiency-oriented AI implementation strategy will be negatively linked to AI ethical implementation in local public administrations.

Proposition 9. CIOs overlooking ethical implications of AI will lead to unsuccessful implementation processes in local public administrations.

Besides, the utilization of AI in public settings will be determined by the interaction with citizens, and they should be involved from the design of algorithms to the evaluation and audit of decisions made as a result of AI systems (Burrell, 2016). The contrary to algorithmic opacity is algorithmic transparency, based on explicability and accessibility (Covels & Floridi, 2018; Mittelstadt, Allo, Taddeo, Wachter, & Floridi, 2016). Surveillance capitalism models based on AI technologies and data opacity (Zuboff, 2015), either controlled by non-democratic

governments or platform monopolistic companies, represent a threat to our democracies, and they need to be confronted with greater transparency and involvement of citizens, with full capacity to (re)define priorities and control of data at all stages.

Trust in government is becoming a limited asset in our societies, mostly in western democracies. Therefore, more than ever AI use introduces an extraordinary challenge to our governments and public administrations in democratic contexts. Here, some balance between regulation and innovation will open the way to move forward the process of AI implementation in the public sector (European Commission, 2020). Then, social trust on AI in government is a (pre)condition for successful deployment of future applications, including algorithms helping to make crucial decisions about who gets a social benefit, how migration controls operate, or what requisites are accounted to apply for public programs (Grimmelikhuijsen & Meijer, 2014; Meijer & Wessels, 2019; Van der Voort et al., 2019). Either these or different utilizations of AI technologies will have an impact on citizens' trust and building entrusted systems to interact with citizens will become a key aspect of AI development in the public sector, that CIOs need to accommodate into their agendas.

Therefore, these exploratory findings shed light on the organizational dimension of AI in the public sector. More precisely, they provide some potential clues for future research in the field of AI with a socio-cognitive perspective, underlying the key aspects of technological frames and how they can be operationalized in empirical studies, both with qualitative and quantitative designs. Besides, our study contributes to the analysis of the increasing role of CIOs in public organizations, as they are leading, or will lead, the design and implementation of AI. Also, some practical ideas for public managers involved in AI strategies and projects emerge, including the fact that more diverse actors, roles, and functions need to be integrated in these processes to take full advantage of the potential of AI technologies and systems.

6. Conclusion. Practical implications, limitations, and future research

This article provided an analysis about AI in the public sector including sound theoretical and empirical roots. Here, we followed the theoretical approach on technological frames in the public sector, based on seminal work of Orlikowski and Gash (1994), and more recent studies by Sun and Medaglia (2019), Guenduez et al. (2020), or Van Hulst and Yanow (2014), including three dimensions of analysis: *nature of AI*, *AI strategy*, and *AI in use* in the public sector. The findings and conclusions of this study have emerged from the exploratory analysis of data based on a survey administered to the municipal CIOs of the largest cities in Spain. Building on the perceptions of CIOs, some empirical evidence shed light on the situation of AI technologies in the local layer of government, including their primary focus on technological capabilities and functionalities, the techno-centric approach of AI strategies, or some lack of attention to actual ethical and human challenges that public agencies face managing AI and interacting with citizens (i.e., algorithmic biases and opacity, AI fairness, data privacy, etc.). Particularly, our study was intended to explore our general research question (*What are the assumptions, expectations, and knowledge of Spanish CIOs on AI?*), and has proposed future lines for possible research in AI implementation in the public sector. This study has added value to the theory on technology frames, encountering key issues about AI in government. This attempt encompasses opening up the debate about the future regulation of AI in our democracies or the involvement of citizens in processes that directly affect their day-a-day behaviors and lives. At the same time, the values that AI systems engender during their design and then applied in the later implementation, or the leadership that CIOs and other members of the emerging infocracy exert in public organizations, will have a deep impact on the configuration of our public services, political institutions, and our democracies.

Our respondents (CIOs) provided noticeable insights on the use of AI

in public administrations for the future. Here, de-humanization or human replacement by robots at work (Wirtz & Müller, 2019), organization and coordination of tasks or decision-making discretion of public managers and employees (Criado et al., 2020), emerge among other key issues in public sector management based in AI technologies. Some public managers still see the process of AI data generation, collection, storage, and processing based on algorithms as neutral, or at least more neutral than human-based management (Agarwal, 2018). In fact, these hyper-rational technological devices perform positivistic analytics (Vydra & Klievink, 2019). However, assumptions about AI embedded in the logic of big data, connectivity (Kolb, 2008; Kolb, Caza, & Collins, 2012), and the inscrutability of algorithms make complicated for public sector managers apprising the potential risks and benefits of public services, policy-making processes, and public decisions based on biased sets of data or unethical algorithms.

Regarding the practical dimension of public administration, this study raised some issues on the role of public managers (CIOs) involved in the design, adoption, and implementation of AI systems in the public sector. Particularly, our study has clearly identified the need of IT teams with diverse backgrounds and multi-dimensional approaches in governmental settings. At the same time, CIOs leading AI adoption in the public sector must advocate the implementation of these new technological systems in services and policy sub-fields with clear and direct implications in citizens' lives, not just areas with technological affordances. Additionally, governments and public administrations have a critical role to protect data and privacy of individuals, as trust and confidence on fair processes and interactions will delineate the extent of success in AI utilization. Therefore, awareness about potential opportunities, and risks, of AI technologies in public organizations need to be widely (and wisely) fostered in governmental settings, including political appointees, general managers, and street-level bureaucrats in the recipe. Hence, technological frames need to be disclosed and designed for the benefit of the commons and AI for good.

This article also presents some limitations. First, our study is founded on local CIOs in Spain, and our findings and conclusions cannot be directly generalized in other different countries and levels of government. Despite we have conducted research with all potential cases in the sample (heads of IT departments in local governments), our municipal CIOs are a selected key group with technological backgrounds and particular cognitive frames regarding AI. Other potential key groups, for future research to better understand organizational frames regarding AI, could be elected officials (politicians) or general managers (users) (Young, Mathiassen, & Davidson, 2016). Likewise, more granulated statistical analysis may provide deeper insights about potential differences among the cases in our sample. Also, different research techniques, including mixed-methods, might develop the conclusions of framing studies. Finally, the technological frames approach only provides a picture on AI perceptions. In this sense, it would be interesting for future studies to conduct a longitudinal approximation on perceptions that moves behind the implementation stage of AI, and how AI frames change over time. Then, our agenda of research will be partially in debt with these areas of improvement.

In our opinion, the next steps of AI in, and from, governments and public administrations will be critical for the future of our democracies. This study has focused on the internal dimension of AI in public services and organizations looking at technological frames. At the same time, governments and public administrations should collaborate in promoting algorithmic governance in their societies setting the rules of the game (framing) of AI use in different social sectors. For example, in the case of the European Union, framing AI between innovation and regulation is becoming a key debate to build a distinctive route for the future of data use, looking at the growing implications of these applications in companies and people's life. Scholarly research in both areas of AI development, in governments and public administrations, and from governments and public administrations, will be critical and equally deserve attention. Besides, studying the connection of technological

frames with policy and democratic values will also nurture the future research of AI in the public sector.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence

the work reported in this paper.

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Annex 1

Questionnaire on CIOs technological frames on AI		
Question	Item	Answers' options
1. Have you heard about Artificial Intelligence in the public sector?	- Yes - No	Select just one option
2. From your own perspective, and briefly, how would you define Artificial Intelligence?		Open question.
3. To what extent do you agree with the following ideas about Artificial Intelligence?	- I am totally open to the adoption of AI. - AI in the public sector is not very different than AI in the private sector. - I assume naturally that robots and humans will share jobs. - Envisioning future occupations of public employees is complex, as the replacement process will have profound impacts. - Other "intelligences" will be required for public employees. - The new professions in the public sector linked to AI will have to be tackled thoroughly.	1 being strongly disagree and 7 totally agree.
4. Among the following options, identify the concepts with a higher level of association to Artificial Intelligence	- Machine learning - Data mining - Genetic algorithms - Artificial neural networks - Deep learning - Autonomous vehicles - Robotics - Artificial vision - Pattern recognition - Intelligent agents - Expert systems - Artificial life - Fuzzy logic - Natural language processing - Classification systems - Sentiment analyses - Virtual reality	Select at least three options.
5. Do you think that it is necessary to develop new laws and public policies regarding Artificial Intelligence in the public sector?	- Yes, as soon as possible - Yes, when we have more experience - No	Select just one option.
6. From your point of view, what are the main benefits you perceive from the implementation of Artificial Intelligence in the public sector?	- Efficiency - Digitalization - Transparency - Data security - Citizen's participation - Interoperability - Equity - Accountability - Trust - Flexibility	1 being strongly disagree and 7 totally agree.
7. From your point of view, what are the main disadvantages you perceive from the implementation of Artificial Intelligence in the public sector?	- Human replacement - High costs - De-humanization - Distrust - Inflexibility - Vulnerability of data and information - Ethical problems - Social exclusion - Inequality - Invasive control - Algorithmic opacity	1 being strongly disagree and 7 totally agree.
8. From your point of view, which among the following functionalities will be most affected by Artificial Intelligence in a short period of time?	- Processing of transactions/operations - Public service delivery - Management of organizational networks - Regulation - Clerical and assistant tasks	Select at least three options.

(continued on next page)

(continued)

Questionnaire on CIOs technological frames on AI		
Question	Item	Answers' options
9. From your point of view, what are the main inhibitors in the implementation of Artificial Intelligence in the public sector?	<ul style="list-style-type: none"> - Technical duties - Political advisory - Executive management - Capacitation - Digital gap - Inequality - Budget - Citizen's literacy - Governance framework - Regulation - Technological infrastructure - Administrative culture - Data privacy - Data security - Supplier's control - Elimination of human labor - Lack of social acknowledge - Other 	Select at least three options.
10. From your point of view, what are the main enablers in the implementation of Artificial Intelligence in the public sector?	<ul style="list-style-type: none"> - Technological infrastructure - Knowledge - Budget - Governance framework - Technological transfer - Administrative culture - Citizen's literacy - Bussiness competition - Regulation - Other 	Select at least three options.
11. From your own point of view, in which public policy domain will Artificial Intelligence be adopted earlier?	<ul style="list-style-type: none"> - Defense - Public order and security - Economic affairs - Environmental protection - Household and community services - Health - Culture - Education - Social protection - Citizen's participation - Tourism - Mobility - Justice 	Select at least three options.
12. Among the following human behaviors and capacities listed, to what extend do you agree with its replacement by Artificial Intelligence in the public sector?	<ul style="list-style-type: none"> - Monitor - Analyze - Act - Interact - Remember - Anticipate - Feel - Moralize - Create - Decide 	1 being strongly disagree and 7 totally agree.
13. How important do you think Artificial Intelligence is in the city council you work for?	<ul style="list-style-type: none"> - 1 - 2 - 3 - 4 - 5 - 6 - 7 	Being 1 not implemented at all and 7 fully implemented.
14. From your point of view, what is the level of implementation of Artificial Intelligence in the city council you work for?	<ul style="list-style-type: none"> - 1 - 2 - 3 - 4 - 5 - 6 - 7 	Being 1 not implemented at all and 7 fully implemented.
15. Now, if you wish to, you can indicate some of the on-going or expected projects in your city council that are related to Artificial Intelligence.		Open question.
16. Please, indicate the name of the city council you belong to, the name of the person who took the questionnaire, the department he or she belongs to, and his or her position in it.		Open question.
17. How old are you?		Open question.
18. Academic degree (Bachelors, Masters, PhD...)		Open question.
19. Area of expertise (engineering, computer science, physics...)		Open question.
20. Gender	<ul style="list-style-type: none"> - Male - Female 	Select just one option.

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