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# Explaining public officials' opinions on blockchain adoption: a vignette experiment

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**Abstract:**

Blockchain is emerging as one of the major disruptive technologies of our times. In the context of public administration, blockchain heralds major transformations of public service provision, and has the potential to increase the transparency of, and citizens' trust in, public administration and its services. However, the introduction of blockchain to public administrations means potentially changing aspects of the job performed by public officials, including their day-to-day activities and responsibilities, and even their very control over administrative processes. Whilst some public officials may view blockchain positively as a means of improving current administrative practices, others may view it more negatively, and resist it. The acceptance or otherwise of blockchain is, therefore, a fundamental issue for analysis. We conduct a vignette experiment to probe public officials' opinions on the introduction of blockchain in the provision of public services in a local council. We follow an influential classification of blockchain configurations to analyse whether different configurations of blockchain affect public officials' opinions towards its implementation. Results show that a more public configuration of certain aspects of the blockchain increases the likelihood that public officials will accept

blockchain, whilst it is also associated with an increase in trust in public administration and its services.

Keywords: Blockchain, Public Officials, Public Services, Innovation Policy, e-government

## INTRODUCTION

Public administrations around the world are facing a new set of social, economic, and political challenges. Among these challenges are those related to managing risk and uncertainty, ensuring trust and legitimacy in public institutions, and increasing the agility and efficiency of institutions, whilst striving for diversity, social inclusion, and improved service delivery. All these challenges are coupled with the need to maintain balanced management through tight budgets. The incorporation of new technologies into the management of day-to-day work of public administrations as a means of providing solutions to these challenges is conceived to as a way to save money, avoid corruption, increase tax revenues and increase economic efficiency (Gil-Garcia et al., 2018). Indeed, the digitalization of public administrations has become a strategic priority for public administrations around the world (OECD, 2016). E-government includes a toolkit of policy instruments wherein new technologies play an increasingly important role. Within these new technologies, one sub-set that is currently being adopted is referred to as "disruptive technologies" (Christensen et al., 2006), such as Artificial Intelligence, robotics, Internet of Things, 3D printing, Advanced Virtual Reality and blockchain. These technologies are said to be disruptive because of their potential to perform tasks in a fundamentally different way. Disruptive technologies are set to bring about profound changes in the way processes are carried out, leading in turn to cost reductions and operational improvements. However, the concrete economic and social consequences of their implementation are yet to be determined.

This article analyses the introduction of blockchain into public administration. A blockchain is an information technology that is mainly used to register transactions that require authentication and trust. Blockchain consists of a series of blocks (collections) of recorded data which are stored and updated simultaneously by different nodes (parties) within the ledger (bookkeeping) (Crosby et al., 2016). Since blockchain does not rely on a central point, the information validated and stored within the blockchain cannot be modified unilaterally without the consent of the rest of the network. Blockchain's specific characteristics make it a strong candidate to disrupt many public services. The ability to trace items from the point of origin to the point of delivery, ensuring that the information recorded has not been tampered with, has great transformative potential in sectors such as medicine or food distribution (Kouhizadeh et al., 2021). This advantage, together with its capacity for transparency, anonymity, and process automation, makes blockchain potentially ideal for administrative processes, public procurement and record-keeping (Cagigas et al., 2021). In this respect, one of the most advanced large-scale use cases is EBSI (European Blockchain Services Infrastructure), which aims to use blockchain to create cross-border, decentralized services for European public administrations, allowing citizens to control their own identity whilst, simultaneously, standardizing and streamlining interactions with the EU and national administrations.

Despite these advantages, the costs and risks of implementing blockchain are significant, such as the infancy of the technology, regulatory uncertainty and scalability problems (Batubara et al., 2018). As in the cases of other technologies, such as Artificial Intelligence and robotization (Clifton et al., 2020; Acemoglu and Restrepo, 2020), successful blockchain adoption requires workers' acceptance of the technology. However, the literature shows that acceptance depends on a range of contextual factors (Janssen et al., 2020).

In this light, this article contributes to understanding public officials' opinions on the acceptance of blockchain in public administration and on the effects of blockchain as regards trust in public administration and its services. To do so, we conduct a vignette experiment on public officials in the city of Santander, Spain. We test whether different options in the configuration of blockchain affect public officials' opinions as well as their views on their colleagues' and citizens' opinions on blockchain. Our vignette experiment is based on a hypothetical scenario related to the introduction of blockchain to create a digital identity for the provision of local public services. Using the influential classification of blockchain configurations Ølnes et al. (2017)., we distinguish four different options in blockchain configuration, according to two dimensions: more or less "Public Write" (who has permission to access to the network and input data into the blockchain: all users or just public officials), and more or less "Public Read" (who has permission to read information that lies within the blockchain: all users or just public officials). We find that, while the configuration regarding "Read" is non-significant, a more "Public Write" improves public officials' opinions both on their acceptance of blockchain and on its effects on trust in public administration and its services.

The rest of the article is organised into six sections. The second section includes a contextualization of blockchain in public administration and presents the research questions and the hypotheses based on them. The third section describes the experiment design and research method. The fourth section presents the results of the experiment. The fifth section discusses the main outcomes and empirical limitations. The sixth section concludes.

## BLOCKCHAIN IN PUBLIC ADMINISTRATION

### *Blockchain configurations*

Blockchain is not a given: there are multiple ways to configure a blockchain. An influential conceptual approach to the different possible configurations of blockchain has been provided by Ølnes et al. (2017). This is based on two key disjunctions: public/private and permissionless/permissioned. The public/private configuration of the blockchain determines who has access to the information that is inside the ledger. The permissionless/permissioned dimension determines who maintains the network and is involved in the consensus-making process (unknown independent nodes, if permissionless; authorised nodes, if permissioned), thus, the protocol to add new blocks of information to the ledger. Bitcoin and Ethereum are two typical examples of public permissionless blockchains. However, the use of permissionless infrastructures in public service provision is far from an obvious policy application (at least, at present):it is rather

improbable that a public administration will opt to leave maintenance of the infrastructure of relevant public services to unknown nodes. Along with technical, operational and economic aspects, a permissioned blockchain facilitates compliance with data protection laws such as GDPR (Finck, 2018).

As regards the public/private dimension, this is not an extreme dichotomy, rather, a spectrum of different elements that can be used to position a blockchain on a point across these two axes. Blockchain can be configured in various ways giving different degrees of openness to citizen involvement and data transparency. To mobilise this, we use two particular elements that determine the openness of a blockchain: "Read" and "Write". "Read" refers to who has permission to read information that lies within the ledger. "Write" refers to who has permission to access the network and input data into the blockchain. Table 1 relates these two concepts to our vignette experiment.

*Table 1: Public/private configurations*

| Public/private mechanisms | *"Public Read"* | *"Private Read"* |
|---|---|---|
| *"Public Write"* | Citizens register and transact on their own and (non-personal) information is available to any user. | Citizens register and transact on their own but information is only available to authorised public officials. |
| *"Private Write"* | Individual registration process is validated by a public official, but (non-personal) information is available to any user. | Individual registration process is validated by a public official and (non-personal) information is only available to authorised public officials. |

As seen in Table 1, a variety of configurations may lead to different permissions and responsibilities. On the one hand, the more public the "Read" mechanism, the more accessible the information. In contrast, a private "Read" mechanism would restrict the number of people able to access the information inside the blockchain. On the other hand, the more public the "Write" mechanism, the greater the number of users able to contribute to actions and transactions of the ledger. The more private the "Write" mechanism, the tighter the control over who inputs into the ledger. This Read/Write classification will be applied and discussed in regard to our specific case, since the level of disruption to public administration (and subsequently, public officials' opinions regarding blockchain adoption) may depend on the specific configuration of each blockchain solution (Tan & Rodriguez Müller, 2020).

### *What Determines Public Officials' Opinions towards blockchain?*

The introduction of new technologies has triggered profound organisational changes in public administration processes, particularly from the late 1990s onwards (Dunleavy et al., 2006). The spread of information technologies implies that changes no longer affect solely administrative processes, but the whole terms of relations between government agencies and civil society (Weiss & Biermann, 2021). At present, the spread of open government practices challenges siloed and hierarchical work models within public administration and drives new models based on transparency, public engagement, and co-

production (Altayar, 2018; Osborne, 2018). The adoption of "disruptive technologies" into public administration and the attitudes regarding the transformations they potentially create, justifies the need for an updated analysis.

Public officials' opinions about the implementation of blockchain can be contextualised as part of the larger literature on workers' resistance to change (Ajzen, 1991; Piderit, 2000; Dent & Goldberg, 1999). Additionally, this literature on workers resistance to change is complemented with insights from the more recent field of public sector innovation (Berry & Berry, 2014; Hartley, 2016; De Vries et al., 2016). A central idea from this latter body of literature is that individuals' cognition about the predicted outcomes of the innovation process has a profound effect on subsequent attitudes toward technology. Based on all of this literature, we identify a number of factors that may influence public officials' perceptions about blockchain adoption. These can be divided into factors associated with a more positive and with a more negative opinion on blockchain adoption. A summary of these factors is presented in Table 2.

*Positive*

Based on the literature, there are five major factors or conditions under which public officials are more likely to view blockchain positively. First, where public officials think that blockchain is going to improve public service delivery in terms of access to information, economic efficiency gains and inter-agency coordination (Baldwin, 2012). In this scenario, public officials believe blockchain is positive for society as a whole, since the quality and performance of services provided by public administrations would improve. Second, where public officials perceive that blockchain can reduce every-day human errors as a result of the automatization of administrative processes and saves time due to the reduction of paperwork. Third, where the innovation process goes along with explicit top management support (Clohessy et al., 2018). Fourth, internal participation. Previous results show that involving employees through the dissemination of critical information and a system of feed-back communication creates a sense of ownership and reduces internal resistance (Fernandez & Rainey, 2017). This is particularly important in the public sector as public officials may be able to resist new initiatives until a new administration comes into power. Finally, organizational readiness, understood as the availability of technological and human resources (including both technical and organizational capabilities). Management and staff motivation, availability of resources and having the right staff attributes and the organizational climate to support the change are determinants of the success of innovations.

Public officials' views regarding their colleagues' attitudes are a critical factor in the success of innovation processes. Should public officials think their colleagues will resist change, despite their own efforts, innovation will be blocked or negatively impacted. Hence, it is also relevant to ask public officials about their views on their colleagues' opinions towards blockchain. There are three main motives which can result in a more favourable opinion regarding their colleagues' willingness to adopt blockchain. First, the introduction of blockchain is a further step in the automation of certain administrative processes which reduces paperwork and tedious day-to-day tasks. Second, blockchain technology could increase accountability in the provision of services. Third, public officials might consider that their colleagues will not understand the complexities of the

technology but will voluntarily follow the instruction from top managers and the innovation department. The literature includes examples of successful innovation and change in public agencies, taking into account diverse ecosystems (Arundel, 2017; Zhenbin et al., 2020).

Finally, citizens' attitudes are another crucial factor in innovation processes. Positive attitudes of citizens towards blockchain may positively influence those of public officials. However, public officials' and citizens' motivations and attitudes towards blockchain can differ. For this reason, we also test citizens' views (as perceived by public officials) on blockchain. Public officials might think most citizens will have a positive opinion about the introduction of blockchain based on the expected benefits of blockchain for citizens. The literature highlights three major benefits of blockchain for citizens. First, an improvement in the security of information contained in public administration servers. Second, greater control of personal data, and third, a higher level of transparency. Transparency refers to the availability and flow of timely, comprehensive, relevant, high-quality, and trustworthy information on government activities to the general public. Transparency thus refers to the extent to which the government makes data available to the public in order for them to evaluate government actions. Transparency is vital for establishing an ongoing basis for government accountability since citizens delegate decision-making authority. A public blockchain is transparent by design and, at the same time, it is able to assure the information included is not modified after its inclusion. Furthermore, positive citizens' opinions could be based on the idea that citizens appreciate a digital transformation of public administration that includes less human interaction and less public officials' discretion in administrative processes (Reddick, 2005).

*Negative*

Blockchain adoption can also lead to negative opinions from public officials. A public official may understand that blockchain applications will not improve public service delivery, if the benefits do not outweigh costs or, if the technology is still too immature to offer tangible advantages in certain applications. However, even if public officials consider blockchain implementation as positive for the general interest, they could express negative opinions about it. Eight elements identified in the literature could motivate a negative opinion. First, people and organizations may tend to hold onto traditional ongoing practices, independent of how dysfunctional or illogical they may appear to others (De Vries & Balazs, 1999). In the case of blockchain, this effect increases, since blockchain implies many challenges in terms of technological infrastructure, professional and personal relationships (Papathanasiou, 2020). Second, public officials may consider that the introduction of a new technology challenges their current way of working and may mean their past work is subject to criticism. Third, public officials are generally risk-averse, which suggests they tend to resist change (including resistance to the introduction of a disruptive technology) (Buurman et al., 2012). Fourth, resistance to blockchain from public officials may be associated with fears about job security, and a potential decrease in income. This feeling would be stronger in the cases where the introduction of the technology is more likely to replace jobs. Fifth, public

officials may perceive the introduction of blockchain as a further step towards opening up the work done by public administration to the public eye (Janssen et al., 2012), hence, some public officials may show negative attitudes towards it. Sixth, public officials may fear that an inappropriate disclosure of information due to blockchain technology could harm their job. Seventh, public officials' lack of experience, technical skills and/or knowledge to manage the technology can create resistance, as found in the case of private companies (Lember et al., 2019). Finally, change can represent a threat to current hierarchy inside the organization. The public officials that benefit from the status quo will probably oppose internal resistance to the adoption of blockchain.

Several reasons may lead public officials to think their colleagues might refuse blockchain. Potential reasons for rejection among colleagues will be similar to those previously described for public officials' own opinions. Among those reasons, key ones are threats to job security, loss of control from established responsibilities due to a higher involvement of citizens, and the tendency to hold onto current ways of working. However, even if a public official considers that the introduction of blockchain is positive for public service delivery, they may still perceive potential resistance from their peers. This line of thought is characterized by a pessimistic view of public bureaucracy, which has been traditionally stressed to be subject to dysfunction due to issues related to red tape, rigidity, and caution (Tullock, 1965). Public administration bureaucracy is often described as a rigid organization that fundamentally resists change (Osborne & Gaebler, 1992).

Finally, regarding citizens' opinion, public officials could think that citizens will hold negative views towards blockchain in public services due to a more general rejection of the digital transformation of public administrations. Blockchain can be viewed as another step in the further depersonalisation of the relationship between citizens and public officials (Kolsaker & Lee-Kelley, 2008). Moreover, the use of smart contracts in administrative processes further decreases the range of flexibility to adapt to distinct situations. In this respect, citizens could be also negatively affected by the potential reduction of human resources on public administrations as a consequence of the digitalization of processes.

*Table 2: Motives for Public officials' opinions towards blockchain*

| | ***Positive*** | ***Negative*** |
|---|---|---|
| *Own opinion* | - Benefits for public service delivery<br>-Improvements on own job<br>-Top management support<br>-Bottom-up participation<br>-Readiness in terms of technical and organizational skills | - Economic costs and/or technical immatureness of the technology<br>- Inertia towards existent work patterns<br>-Fear of questioning past actions<br>-Loss of job security<br>- Negative attitudes towards the opening of public administrations to the public eye<br>- Fear of inappropriate disclosure of information<br>-Lack of technological experience and awareness<br>-Changes in current hierarchy |

| | | |
|---|---|---|
| *Other public officials' opinion* | -Reduction of paperwork and tedious workload<br>-Diffusion of accountability | -Threat to job security<br>- Loss of control<br>-Tendency to hold onto traditional work patterns |
| *Citizens' opinion* | -Security of data<br>-Control over personal data<br>- Transparency<br>- Less human interaction and less discretion in administrative processes | -Depersonalisation<br>-Loss of flexibility<br>- Negative consequences of the reduction of human resources on public administration |

***Hypotheses***

To develop our hypotheses, we assume that the more public the configuration of blockchain, the more profound its disruption on organizational changes will be. Therefore, all the aspects discussed above will have a stronger effect in a case where a blockchain with a more public configuration is implemented than if a blockchain with a more private configuration is implemented. In particular, in our experiment, we probe whether different options in the configuration of blockchain impact public officials' opinions on: 1) Acceptance of blockchain; and 2) Trust in public administration and its services. We analyse public officials' opinions from three points of view: a) their own opinion; b) their views on their colleagues' opinions; and c) their views regarding citizens' opinions.

As regards acceptance, a more public blockchain can enhance transparency as well as data security, be used to provide greater feedback, spark more agile administrative processes, and make for less tedious tasks and ultimately, better public services (Janssen et al., 2012; Dawes, 2010; Wang & Lo, 2016). However, it can also cause a sense of loss of control among public officials. Reasons for this include the perception that a public blockchain may transform their current tasks and working hierarchies, make them feel more vulnerable as their work is made more accountable and demand a new set of skills (McDermott, 2010). In our hypotheses, we consider the possible configuration of blockchain within a spectrum between public and private, where the specific point will be determined by the two mechanisms previously described: "Read" (who has permission to read information that lies within the ledger) and "Write" (who has permission to access to the network and input data into the blockchain).

Hence, we formulate the following hypothesis:

> ***Hypothesis 1A:*** *When Blockchain is configured as more public, public officials are more likely to accept it.*
>
> ***Hypothesis 1B:*** *When Blockchain is configured as more public, public officials are more likely to think other public officials will accept it.*
>
> ***Hypothesis 1C:*** *When Blockchain is configured as more public, public officials are more likely to think citizens will accept it.*

Trust in public administration is vital for good governance (Van de Walle and Migchelbrink, 2020). Potential changes in the level of trust in public administration resulting from blockchain technology can be analysed. A core element of blockchain is

its potential to establish a new form of trust, due to its characteristics regarding immutability, transparency, and auditability which allows traceability (Shahaab et al., 2020). In this regard, the more public the blockchain introduced the greater is its transparency (related with the "Read" mechanism) and control over personal data (related with the "Write" mechanism). However, the effect of both mechanisms on trust is not straightforward. Regarding transparency, the literature shows that the relationship between a more open public administration (including transparency and public engagement) and trust in public administration could be positive (Cucciniello & Nasi, 2014; Schmidthuber et al., 2021) but generally, it is more nuanced (Grimmelikhuijsen, 2012; Morgeson et al., 2011) or could even be negative (Moore, 2018; Grimmelikhuijsen et al., 2013). On the other hand, a positive relationship between user control over data and trust of the services should not be taken for granted (Lazaro & Metayer, 2015). We test these possibilities for the three actors we consider and formulate a second set of hypotheses:

> ***Hypothesis 2A****: When Blockchain is configured as more public, public officials are more likely to increase their trust in public administration and its services.*
>
> ***Hypothesis 2B****: When Blockchain is configured as more public, public officials are more likely to think other public officials' trust in public administration and its services will increase.*
>
> ***Hypothesis 2C****: When Blockchain is configured as more public, public officials are more likely to think citizens' trust in public administration and its services will increase.*

## RESEARCH METHOD

### *Experimental Design*

The hypotheses are tested using a vignette experiment. This method combines the internal validity of experiments with the external validity of surveys (Migchelbrink & Van de Walle, 2020). A vignette experiment consists of a survey-type exercise in which participants are presented with a set of different vignettes and are requested to rate or react to each of them. Each vignette is slightly manipulated to include different features that are going to explain the rating variability. With this method, vignettes are able to test the causal impacts of those different features or variables (Jilke & Van Ryzin, 2017). Vignette experiments are useful to treat with the effect of beliefs, norms, opinions, or values on actual behaviour, especially those delicate or socially controversial opinions (Atzmüller & Steiner 2010).

The design of our vignette experiment includes two variables (factors), each of them containing two alternatives (levels). In this way, we present a 2 x 2 full-factorial design (Mee, 2009). The two factors we consider are two dimensions regarding possible blockchain configuration of "Read" (who has permission to see the information included in the system) and "Write" (who has permission to validate individual registration) mechanisms. Both elements of the blockchain can be presented either through a more or a less open configuration. As regards the "Read" factor, one level represents the situation

of a more public or open "Read" configuration of blockchain ("Public Read": any resident with a digital identity can see the information included in the system), whilst the other represents a less public or open one ("Private Read": only council officials can do it). As regards the "Write" factor, one level represents a more public or open configuration of blockchain ("Public Write": the user can validate themselves in the registration processes), whilst the other represents a less public or open one ("Private Write": only a council official can do this). In order to prevent participants answering based on predefined opinions about blockchain, we do not name blockchain explicitly, although the description includes a reference to a decentralized technology. Moreover, we included a control vignette where neither of the factors are specified. This control vignette is useful to test the general opinion about the introduction of a technology with similar characteristics to blockchain, without considering its specificities, in the provision of public services. Thus, each vignette included a specific combination of factors and levels that constitute five different vignettes (including the control vignette).

The vignettes were identically tested through a recurrent scenario in the realm of "Smart Cities". Specifically, the vignette scenario considered a situation in which blockchain is introduced in the provision of a local Digital Identity. This scenario is not currently being discussed by policy makers in the context where the experiment is conducted. This is vital to avoid respondents' political ideology playing a major role in their answers, beyond their considerations about the concrete implementation of the technology. Hence, this scenario is appropriate when seeking to obtain conclusions about policy issues around the introduction of blockchain in public service provision, removed from more general political biases. The scenario described the situation of a fictional resident, who is going to use the service for the first time. The vignettes were administered to public officials in their own language. Figure 1 presents an English translation of the vignettes. The bold aspects represent the two factors and their two possible levels.

*Figure 1: The vignette.*

Imagine the following scenario:

The City Council where you work is considering introducing a "Digital Citizen Card". We will ask you a series of questions regarding your opinion on the matter. To do so, consider the case of Juan, a fictitious citizen living in Santander.

Juan, as a user of the "Digital Citizen Card", will be able to digitally store personal information (ID card, date of birth, address, etc.), and share it in case he needs it. Juan's personal data will be stored in a way that guarantees his anonymity. This personal data will be stored in a decentralised manner (i.e. on several servers simultaneously), which increases the security of the information, and ensures that it cannot be modified without his consent.

The "Digital Citizen Card" will be used to facilitate access to services such as bicycle rental, sports facilities, libraries, cultural events, urban transport and parking, among others. Thanks to the "Digital Citizen Card", municipal services will be integrated into the same platform, which will streamline administrative processes and allow residents like Juan to access these services.

To obtain the "Digital Citizen Card", Juan has to download the application on his mobile phone. His registration in the application has to be validated online (without being physically present) **by a council official/by the user** before he can start using it. After registration, **Juan and all residents of the municipality using the "Digital Citizen Card"/council officials** will be able to access global statistics about the total number of citizens and the frequency with which they use each of the municipal services.

After the vignette was presented, we asked respondents to express their opinions on two main questions. Firstly, as regards acceptance of blockchain technology, we asked public officials whether the technology should be adopted ("The local council should use this "Digital Identity App" to deliver public services"). Secondly, as regards the effects of blockchain on trust, we asked public officials whether a potential adoption of this technology would influence trust ("This "Digital Identity App" will increase trust in public administration and its services"). Along with their own opinions ("According to you"), we asked public officials about their views of their colleagues' opinions ("According to what you think the majority of public officials in the Council will say"), and about their views on citizens' opinions ("According to what you think the majority of citizens in Santander will say"). To sum up, we estimated the effects of different options in the configuration of blockchain (as regards the "Read" and "Write" mechanisms) on six different outcome variables (two dimensions -acceptance and trust-, and three points of view -own opinion, colleagues' opinion and citizens' opinion-). All six variables were asked to be rated on a 7-point Likert-like scale (1=strongly disagree, 7= totally agree).

In the experiment, the vignettes were assigned using a within-subjects design, in which each public official responded to two randomly assigned vignettes.

### *Sampling*

The sample included all the public officials of the City of Santander, a medium-sized city in the north of Spain, with a population of around 180.000 inhabitants. Santander is

known to be one of the cities that have made the greatest commitment to innovation within the framework of "Smart Cities" with the aim of improving the efficiency and quality of municipal public services (Sanchez et al., 2014). The sample contains the whole workforce of public officials of the city council (N=1038), given that the introduction of a technology such as blockchain potentially concerns not only those public officials in charge of making policy, but also those street-level public officials whose everyday work would be affected by a new way of managing the local services. We administered the survey online, through the specialized program Qualtrics. Every public official received an email with the information about the survey and its objectives. We sent a reminder email one week prior to the closure of the vignette experiment. The survey took around 15 minutes to complete.

### *Fielding*

The vignette experiment was launched on 20 January and closed on 12 February 2021. Of the 1,038 individuals of the population, 330 answered the invitation to participate and 149 individuals completed the whole survey. Using Pearson's chi-square tests, no significant differences on background characteristics (gender, age, professional rank and self-perceived technological skills) were found between dropouts and the final sample of respondents. Our sample includes 64% of women and 36% of men. The age of the majority of respondents is between 40 and 60 years (74%) while 17% of them are below 40 and 9% are over 60. Regarding administrative rank, 41% of the respondents have a position which requires a university degree (rank A) and 28% of them have a position that requires higher secondary education (rank C1) or lower secondary education (C2). Finally, respondents' rate of their own technological skills is good or very good (55%), good (39%) or poor or very poor (6%). Comparing the characteristics of the sample of respondents and the sampled population of public officials of the city council, our sample overrepresented women (64% in our sample, 34% in the population) and public officials in positions which require a university degree (41% and 25%, respectively). This reflects the challenge of this kind of experiment (conducted online) to reach those workers who have less daily contact with email (for instance, the police and firemen departments, where the majority of workforce are men and occupy positions which do not require a university degree). We assessed the randomization of vignette combinations using four balance tests. Specifically, four chi-square tests of vignettes independence were performed to confirm there were no statistical differences in the parameters of the overall sample compared with the individual vignette samples of respondents ($p>0.05$).

### *Method of analysis*

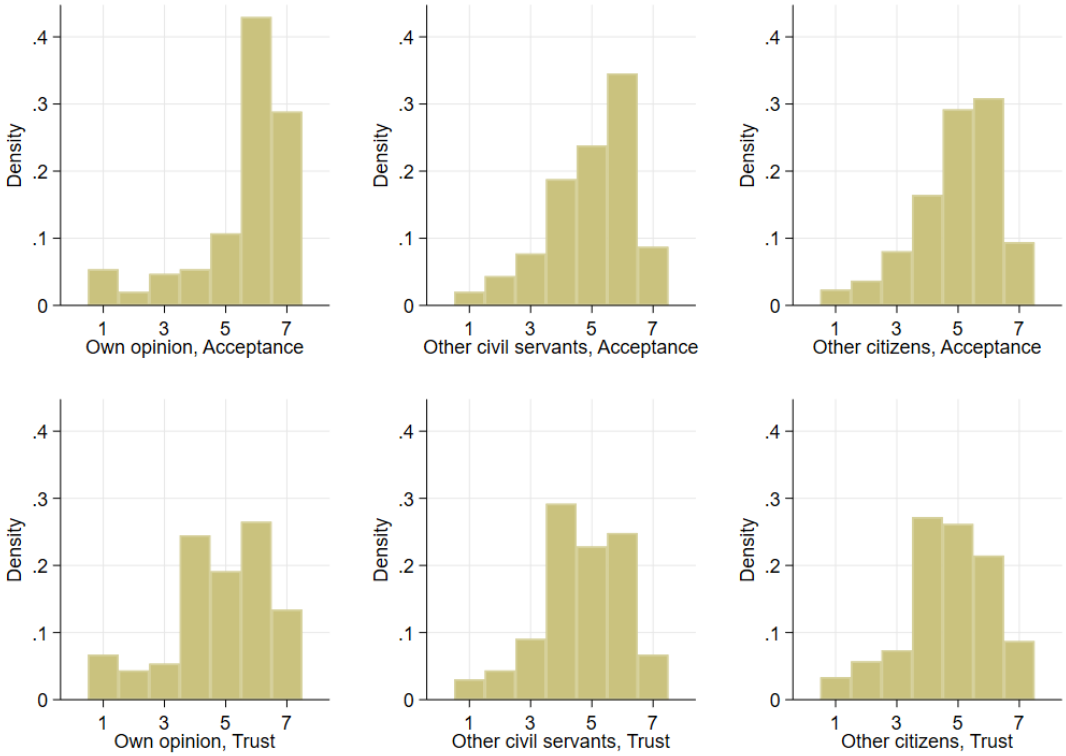
To examine the results of the experiment, we conduct three separate exercises. First, we show the distribution of the outcome variables to assess the general opinion toward blockchain (jointly considering all possible vignette combinations). Second, we display the vignette means and standard errors for the outcome variables, separately for each possible vignette combination. This shows a visual representation of public officials' opinions based on outcome means depending on the combination of factors and levels

which represent variations in blockchain mechanisms of "Read" and "Write". Third, we estimate the average treatment effects (ATEs) of "Read" and "Write" mechanisms following Mee's 2 x 2 factorial design model (Mee, 2009). To this end, we transform the variables into two orthogonal factors that take the code of 1 when the mechanism is "public" ("Public Read" and "Public Write", respectively) and -1 when it is not ("Private Read" and "Private Write", respectively). For this exercise, the control vignette is excluded, resulting in a total of 230 individual vignettes. In order to account for the within-subjects design, we estimate confidence intervals using cluster-robust standard errors at the individual level (Hainmueller et al., 2014).

## RESULTS

Figure 2 displays the density plots of the answers for each of the six outcome variables: on acceptance (above) and on trust (below), for respondents' own opinions, their views on their colleagues' opinions and their views on citizens' opinions. Regarding the acceptance of the technology, 71.8% of respondents either moderately agree (6) or strongly agree (7) with the introduction of blockchain to provide a local digital identity (own opinion). The percentage decreases to 43.3% and 40.3% who moderately or strongly agree when asked about their views on their colleagues' opinions and citizens' opinions, respectively. As regards the effects of blockchain on increasing trust in public administration and its services, 39.9% of respondents they moderately agree (6) or strongly agree (7) (own opinion), and 31.5% and 30.2% either moderately or strongly agree when asked about their views on their colleagues' opinions and citizens' opinions, respectively.

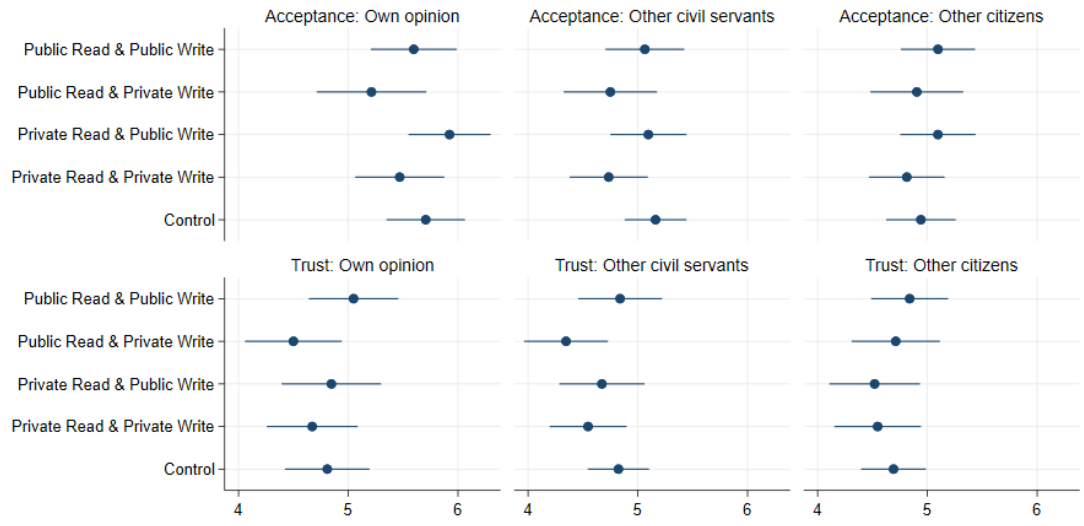
*Figure 2: Density plots for each dependent variable*




The previous figures can be compared across different socio-economical groups. First, there is no significant difference between women's and men's average scores. Second, differences across age groups are almost negligible. Third, respondents' rank positions do not have any clear correlation with views on blockchain adoption or blockchain effects on trust. Fourth, there is a strong correlation between self-perceived technological skills and more positive views of blockchain.

Figure 3 shows the mean and standard deviation of public officials' responses for each outcome variable, for each vignette combination of factors and levels. Regarding public officials' opinions on the acceptance of blockchain, the combinations that include "Public Write" are the ones with the highest mean scores. This is also observed regarding public officials' opinions on the effect of blockchain on trust in public administration and its services (except for their views on citizens' opinions). These results suggest a preference of public officials towards a "Public Write" option in blockchain configuration, instead of a "Private Write" option. Figure 3 shows also that the average scores for the control vignette are similar to those for the combinations that include "Public Write".

*Figure 3: Mean and standard deviation by combination of configurations*




Next, Table 4 presents the estimated Average Treatment Effect (ATEs) of "Read" and "Write" options in blockchain configuration on public officials' opinions on the introduction of blockchain. On the one hand, a "Public Write" configuration of blockchain (all users, not only council officials, can validate the registration process) has a positive effect on public officials' own opinions on both acceptance of blockchain and on blockchain effects on trust in public administration and its services. The same result is observed for public officials' views on their colleagues' opinions, both for blockchain acceptance and for blockchain effects on trust. In other words, public officials think that a "Public Write" configuration of blockchain is preferred by themselves, and also by their colleagues. In contrast, there is not a significant effect of a "Public Write" configuration of blockchain on public officials' views on citizens' opinion, neither for acceptance nor for trust. On the other hand, a "Public Read" configuration of blockchain (all residents with a digital identity and not just council officials, can see the information included in the system) has non-significant effects on any of the six outcomes considered (acceptance and trust, public officials' own opinion and their views on their colleagues' and citizens' opinions).

*Table 3: ATEs of Public Read and Public Write*

| | Own opinion (accept) | Colleagues (accept) | Citizens (accept) | Own opinion (trust) | Colleagues (trust) | Citizens (trust) |
|---|---|---|---|---|---|---|
| Public Read | -0.146 | -0.004 | 0.023 | 0.008 | -0.009 | 0.121 |
| | (0.107) | (0.091) | (0.090) | (0.103) | (0.088) | (0.092) |
| Public Write | 0.210* | 0.169* | 0.119 | 0.181* | 0.155* | 0.025 |
| | (0.094) | (0.082) | (0.081) | (0.089) | (0.078) | (0.076) |
| Pub.Read*Pub.Write | -0.017 | -0.012 | -0.023 | 0.093 | 0.092 | 0.039 |
| | (0.090) | (0.084) | (0.080) | (0.099) | (0.089) | (0.093) |
| Constant | 5.550* | 4.911* | 4.977* | 4.767* | 4.601* | 4.654* |
| | (0.131) | (0.118) | (0.115) | (0.140) | (0.122) | (0.129) |
| Observations | 230 | 230 | 230 | 230 | 230 | 230 |
| Adjusted $R^2$ | 0.010 | 0.001 | -0.005 | 0.002 | 0.002 | -0.005 |
| F | 2.119 | 1.501 | 0.867 | 1.791 | 1.595 | 0.735 |

Standard errors in parentheses
* $p < 0.05$

## DISCUSSION AND LIMITATIONS

Our results show that a blockchain that includes "Public Write" mechanisms (all users can validate the system's registration processes) has a higher degree of acceptance by public officials than a blockchain including "Private Write" mechanisms (only council officials can do this). A perceived improvement in service quality, greater efficiency in service provision, and the fact that there is a reduction in daily work and thus a reduction in the tasks public officials must do, may be arguments for such visions (Baldwin, 2012). In addition, this result shows that public officials in our experiment consider that the perceived benefits described above overshadow the potential risks that may arise when the provision of the public services is configured in a "Public Write" setting. Thus, evidence of a fear of the automation of certain processes and the replacement of human supervision by technological supervision among public officials does not prevail in our experiment. Alternatively, even if this fear exists, it does not overshadow the perceived benefits in the case of blockchain acceptance (Meijer, 2015). In terms of the effects of blockchain on trust, the shift of responsibility from public officials to citizens is not viewed by public officials as a point of instability but as a positive point for service provision (Linders, 2012). The key reasons for this opinion could be the confidence in blockchain's properties (immutability, transparency, and auditability) and the ability to track every piece of information.

In contrast, a more "Public Read" mechanism (any user can see the information included in the system) does not present a significant effect on public officials' acceptance or trust in public administration and its services, with respect to "Private Read" (only council officials can do it). There are several reasons that play for and against increasing transparency in the administration of public services from the point of view of public officials (Janssen et al., 2012). On the one hand, it has been noted how transparency can contribute to improving legitimacy and trust in public administrations through greater levels of accountability, improving public services and stimulating economic and social innovation (Harrison et al. 2012). In addition, public officials may benefit from feedback, now possible based on the fact citizens have access to more data about public services. On the other hand, public officials may feel their personal rights are infringed upon by publishing the administrative data (Wirtz et al., 2016). Moreover, public officials may think that data that could lead to greater criticism of the public administration and, therefore, should not be made available to general users. Our results indicate that none of the possible reasons is of any defining importance, or that positive and negative points counteract each other.

Interestingly, we also found that public officials' own opinions coincide to a large extent with their views on their colleagues' opinions on how blockchain configuration affects both blockchain acceptance and blockchain effects on trust. These results show that public officials consider that their co-workers generally share with them a common set of opinions and interests as regards the motivation in favour and against the introduction of blockchain technology in public service provision. In contrast, this is not the case for public officials' views on citizens' opinions: citizens are perceived to have different motivations and attitudes. City council public officials do not find a defining effect of a more public configuration of blockchain (neither "Public Write" nor "Public Read") on citizens' opinions. This may be because the advantages and disadvantages for citizens of

a service with a higher degree of digitalisation cancel each other out (Hupe & Hill, 2007), or result from the idea that the changes introduced by the technology will not generate strong attitudes among citizens.

The study presents some limitations, which need to be considered in order to interpret its results and to generalize them to other settings. First, it is important to consider that the way in which the survey was provided to the city council workers (via email) presented more difficulties for reaching public officials with less frequent daily access to email. Thus, the survey over-represents women and public officials in positions which require a university degree. The results may be influenced by particular attitudes of public officials within these groups. Second, the scenario is based on the introduction of blockchain for providing a local digital identity. The results may change if other scenarios are considered due to differences between various applications of blockchain, for example, in terms of accountability, need for control, privacy or usefulness of public data. Third, Santander is a city with years of experience in the field of innovation and the introduction of new technologies to provide local services. Local public officials may have a more favourable starting opinion compared to those in other places with a different background and, specifically, a more favourable opinion on certain configurations of blockchain. Fourth, the majority of public officials in Spain, including those at the municipal level, face a hard and long process to obtain their jobs, but once attained, these jobs are very stable. The shift of responsibilities from public officials to citizens may result in a more reluctant view towards blockchain in other contexts where the risk of losing one´s job is greater. Given these limitations, further research is needed to confirm and complement the insights found in this study.

## CONCLUSION

Recent developments in blockchain make it an attractive option for application in a wide range of sectors within public administration, since it potentially has the capacity to improve the provision and quality of many public services. However, it should be borne in mind that it is not a one-size-fits-all technology: blockchain can be adapted to the needs and interests of each application, taking advantage of the flexibility in its configuration. A more public configuration of blockchain (in terms of the permission to access to the network and to input data into the ledger) may increase public officials' acceptance of, and trust in, the introduction of blockchain in public administration. However, this effect may differ depending on the context and specific setting. For this reason, careful evaluation ex-ante and also ex-post is required.

In this paper. we conducted a vignette experiment to analyse public officials' opinions on different options in the configuration of blockchain introduced for the provision of a local digital identity. The experiment was conducted in the city of Santander, Spain, and addressed public officials' views on the impact of different blockchain configurations on the acceptance of the technology and its effects on trust in public administration and its services. Unlike a survey, the use of a vignette experiment allows us to extract causal effects from a combination of variables.

The main contributions of the paper are twofold. First, from an academic perspective, the experiment applies an innovative methodology to an emerging field; the implementation of blockchain into public services. The paper establishes a classification of the technology based on its main mechanisms from a policy point of view which helps to focus some of the determinants of its adoption. Hence, it shows the usefulness of vignette experiments to evaluate innovation processes in public administration. Second, the paper draws some public policy implications regarding the attitudes of public officials towards the adoption of a technology that is essentially decentralised, such as blockchain. The results of the experiment show that, in aggregate, public officials positively value the decentralisation of some bureaucratic processes, which can be delegated to citizens through the use of the decentralised technology. At the same time, public officials do not value as highly the transparency that a decentralised technology such as blockchain can offer for the management of public services and information. The careful consideration of these two aspects could be central to assure a successful application of a blockchain in a public service.

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