Addressing the public acceptance of electronic identification: a longitudinal analysis of the Spanish e-ID

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1. Introduction

During the last years the world has been changing into a much more digitalised environment. This has caused for the number of transactions that people can make through Internet to grow exponentially (Banco Santander, 2023; The World Bank, 2022). These transactions are not only constrained to the private sector or citizen's personal interactions but also include the public sector (European Commission, 2022a; OECD, 2011). But that could prove to be problematic not only for the citizens, who could be more expose to privacy and cybersecurity threads, but for the public administration too since scammers may use fake identities in order to benefit themselves (López García, 2023; McLellan, 2021; Tad Simons, n.d.). And that is why having some way for people to prove their identity online has become so important, so transactions and interactions between citizens and government gain legal validity. For that some governments have developed an electronic identification system ingrained in the physical ID: the e-ID (Arora, 2008). This consists on a set of information available in a chip located in the ID card that would allow citizens to identify themselves as they would in person to request public services such as benefits, grants, pensions or to fill the tax return (Arora, 2008; Servicio Público de Empleo Estatal, n.d.; Thales Group, 2021; White et al., 2019). Besides, The World Bank (2019) believes that e-ID can help to bridge the identification gap and unlock both economical and non-economical value for certain emerging economies.

The problem is that e-ID implementation and uptake has not been as smooth as expected in some cases (Domeyer et al., 2020; Quest et al., 2021). Countries like Italy, the United Kingdom or Japan have quite low adoption rates of their e-ID schemes and most European countries do not seem to count with a mature (as in active and with more than 40% of adoption) e-ID scheme (Domeyer et al., 2020; Quest et al., 2021). And yet there are not that many studies that focus on analysing the causes for which citizens seem to not be willing to use such technology, which is not convenient since public acceptance is quite a relevant aspect of policy success (Alzahrani et al., 2017; Ejelöv & Nilsson, 2020; Paulson & Büchs, 2022; Tsap et al., 2020). If there is a high amount of people that do not support the use of e-ID, whatever the reason, it may make decision-makers reconsider the implementation of the technology, which could put a halt to the public sector's digital transformation (Ejelöv & Nilsson, 2020). Therefore, it seems essential to try to understand why people have a negative opinion of e-ID and why they do not feel incentivised to use it. That leads toward the following question: what are the factors that affect e-ID public acceptance?

To study this the thesis focuses on the case of Spain. This country presents an intriguing paradox: while its digitalization level is quite high as can be seen by its top 5 positioning at the Digital Economy and Society Index (DESI) or its top 10 rank at the OECD Digital Government Index, the success of electronic identification in the public sector is quite low, with barely 5% of the

population using e-ID by 2010 (European Commission, 2022a; INE, 2010; OECD, 2020). Even if numbers may have increased it is still not a widespread technology among the citizens. And this poses a barrier to the interactions between government and citizens: the latter will lose time in travelling to a physical office and public servants will have to check the personal information and approve the transaction by hand. This hinders such interactions, which would be streamlined if citizens adopted the electronic technology at hand. That is why it is important to understand what makes citizens want to use e-ID. To carry out such research, data from the survey on the use of Information and Communication Technologies (ICT) in households and by individuals collected by the Spanish National Statistics Institute yearly has been used. Concretely, the database consists of observations from six consecutive waves, from 2016 until 2021, which coincides with the timeframe when the 3.0 e-ID (the latest implementation of e-ID in the Spanish public sector as an attempt to overcome the acceptance problems) was being issued. It is important that the study is a longitudinal one to get the full picture of the effects, since e-ID implementation and adoption is a process that takes time, so if only one year would be study the results would lose reliability. To analyse this a Conditional Fixed-Effects Logistic Regression will be used.

Between all the technology acceptance theories, the Technology Acceptance Model (in its third revision) has been the one chosen to perform this analysis. That is because it is the most developed version of the Technology Acceptance Model (TAM), a model based on how easy and how useful the system is to users which has become the most used theory to analyse the reasons behind technology uptake (Alotaibi & Wald, 2013; Momani, 2020). It must be acknowledged though that the three versions of TAM have been criticized by various authors (Lunceford, 2009; Malatji et al., 2020). Some of that criticism centres in leaving out other aspects like financial ones or societal rule, which is why to study the public acceptance of e-ID two additional variables related to external costs and Internet trust dimensions have been added. Besides, to complete this study a spatial analysis was performed to test if province size, which is related to government size, affects the use of such technology. This type of analysis seems to be something unexplored so far in the literature of adoption of e-ID but can have interesting implications related to the degree of digitalization of IT resources each province holds and even to the technological spill over in the public sector between provinces.

With the addition of the spatial analysis and new variables not contemplated by the TAM 3 this thesis will therefore pose a theoretical contribution to both the existing literature about adoption of electronic e-ID and to the theoretical framework used. Besides, it can have some practical contributions too since the results can be used to understand why people seem so reticent to use the e-ID. This knowledge can be used by public servants to create strategies which can improve the actual schemes to make them more attractive to citizens, which would lead toward an increase in uptake. Due to the results this are mainly related to the design of a scheme that will allow

citizens to feel like they have the control of the situation and the improvement of the transparency and help offered for the process. Furthermore, as the data used is the one of Spain, the results showcase inherent barriers to that scheme, which means some recommendations to the country can be proposed too. This are mainly related to the future strategies that can be made due to the results of the geographical analysis, the result of which shows that there should be a bigger focus on promoting e-ID in smaller provinces.

The thesis is divided as follows. Section 2 counts with a literature review where the importance of the e-ID technology is explained more thoroughly, and a revision of international literature is made. Besides, in that section the case of Spain is presented. The theoretical framework that will be used in the analysis is presented in Section 3, with an overview of technology acceptance models and an explanation of the theoretical relevance of other variables not included in the original models. Section 4 presents the data used to perform the analysis, as well as the operationalization of the variables included in the several models and the methods used for both the longitudinal and spatial analysis. The results that have been estimated through those models will be presented in Section 5. Finally, Section 6 holds the discussion of the results considering the different hypothesis and literature reviewed.

2. Literature review

In this section the literature review will be carried out. The concept of e-ID will be presented in the first subsection, with a more extended explanation of both its societal and academical importance. Afterwards, a revision of the current literature centred on the electronic identity from the citizen's point of view will be made. That means that the second subsection will include a review of the factors that up until now have been related to the public acceptance of e-ID. Lastly, the Spanish case will be introduced in the third subsection, which will include a brief historical review and an explanation of the paradox that it represents.

2.1. Importance of e-ID

The need to identify people begun back in time when people started trading for goods in complex societies. This identification "was made on an ad-hoc basis, including physical recognition of the person, status and power representations […], or co-optation" (Deloitte, 2018, p. 6) but it was not until last century that physical proof of identity started being issued in order to reinforce the state authority and prevent non-controlled immigration and fraud (Deloitte, 2018). Now, with the current rise of digitalised economies, new forms of identification are necessary to combat online anonymity which has "made the risks of fraud and identity theft increase considerably" (Deloitte, 2018, p. 6). And this is precisely what showcases the societal importance of e-ID the best since an electronic ID represents a set of information that contains your personal data so you can prove your identity online in order to gain access to electronic services (Thales Group, 2021; Tsap *et*

al., 2019). With it, citizens can have access to "banking, government benefits, education, and many other critical services" (White et al., 2019, p. vi), which should ease the interaction between citizens and government (Domeyer et al., 2020).

Because of this the e-ID has become quite a widespread tool. Up to August 2020 there were 165 countries who had launched an at least partially electronic ID scheme, and the European Union has created a regulation (eIDAS[1]) which aims to allow European citizens to use their electronic identification in all member countries independently of the country that issued their ID (Domeyer et al., 2020; European Commission, 2022c). Besides, the European Commission not only is trying to create a unified electronic identity system but has included the use of this technology in one of its digital targets for 2030, aiming for 80% user rate (European Commission, n.d.).

But not only that. The e-ID scheme could prove to be essential for cases where the need to identify people is not being met or is proven difficult. There are close to 1 billion citizens around the globe with no basic ID credentials and 3.4 billion citizens who have an ID but limited access to their electronic identity (The World Bank, 2019). That is why The World Bank (2019) proposes the electronic ID as a way to facilitate the identification of citizens worldwide to bridge the identification gap, which could in fact "unlock 50 to 70 percent of the full economic potential" (White et al., 2019, p. 13) of certain emerging economies as well as "unlock noneconomic value, potentially furthering progress toward […] inclusion, rights protection, and transparency" (White et al., 2019, p. 66).

Therefore, an efficient and effective electronic ID could prove to have plenty of benefits for the population and their interaction with governments and businesses. But, despite all of this, not all countries have succeeded in getting their citizens to have a positive opinion about electronic ID, a factor that is quite important to achieve a successful implementation of this type of schemes (Domeyer et al., 2020; Tsap et al., 2019). That is because public acceptance is one of the key factors of the implementation of public policies: if citizens have a negative opinion of a policy proposed by the public administration in democratic countries, it will affect the degree of success and enforcement it has (Burstein, 2003; Ejelöv & Nilsson, 2020; Paulson & Büchs, 2022; Sharp et al., 2020). In spite of this, there seems to be a lack of articles whose main purpose is that of studying the citizen's perception of this type of schemes (Tsap et al., 2020). Even though the topic of electronic ID's seems to have been extensively researched in the academic world, it seems

[1] The eIDAS Regulation seeks to increment the trust in electronic transactions by providing a common secure environment for citizens, businesses, and public authorities to conduct such transactions. Its main objective is that of eliminating the electronic barrier that EU citizens face since they cannot use their e-ID in other Member States besides their own. Therefore, the eIDAS Regulation aims to create a legal framework that allows EU citizens to use their electronic identification in cross-border public services. EUR-Lex - 32014R0910 - EN - EUR-Lex (europa.eu).

that most of the papers centre around its technology, regulations, implementation, and adoption instead of around the topic of public acceptance (Axelsson & Melin, 2012; Chauhan & Kaushik, 2016; Tsap et al., 2019, 2020).

This is why this thesis will be focused precisely on the citizen's side of the government-citizen interaction and will try to understand what factors affect the public acceptance of electronic ID, which is one of the pillars of a successful national electronic ID implementation (Axelsson & Melin, 2012; Tsap et al., 2019). Concretely, it will focus on the case of Spain, a country which is deeply advanced in e-governance but counts with a seemingly unsuccessful e-ID scheme (if the low user rate is taken as measurement of success).

2.2. Studying e-ID acceptance across citizenship

As mentioned above, most of the literature that have studied the electronic ID have focused on the technical aspects of its creation and implementation (Tsap et al., 2020). Therefore, it is more complicated to find papers with a citizen-oriented perspective, both from the general e-government topic (Kolsaker & Lee-Kelley, 2008; Mossberger et al., 2007; Nam, 2016) as from the concrete e-ID topic (Alzahrani et al., 2017; Tsap et al., 2020). In fact, by 2019 there was still a lack of "comprehensive study of factors that influence the user acceptance of national eID" (Tsap et al., 2019, p. 1). Still, even if limited, there is some literature available that indeed analyses e-government adoption, as well as e-ID adoption (Alzahrani et al., 2017; Jacob et al., 2019; Tsap et al., 2020).

Tsap et al. (2019) carried out a revision of existing literature with the aim of collecting information of possible factors that could affect citizen's acceptance of electronic ID. For that they looked at several databases to search for papers related to the topic, finding a total of 146 sources. Out of those, only 39 articles were deemed suitable for the study (Tsap et al., 2019). Out of all the concepts mentioned in those documents as factors that affected e-ID public acceptance direct or indirectly, Tsap et al. (2019) established 12 different groups: (1) complexity; (2) ease of use; (3) functionality; (4) awareness; (5) trust; (6) privacy concerns; (7) security; (8) control and empowerment; (9) transparency; (10) path dependency; (11) cultural and historical factors; (12) other. In this last one, the authors included concepts such as costs, the possibility of receiving technical assistance, age, gender, and level of studies. To end the review, Tsap et al. (2019) tried to see if this factors where barriers to the citizen's acceptance of the e-ID or if they affected it positively, but no conclusions were reached since the results presented in the analysed documents were mixed.

Based on the concepts named in this article, Tsap et al. (2020) performed a qualitative analysis to find out which of these factors affected public acceptance of authentication options in Estonia. Path dependency and cultural and historical factors were left out of the study as the authors

decided they were irrelevant considering the context of the study. What was found was that ease of use was the most relevant factor when it comes to gaining the acceptance of the population concerning online authentication methods, followed by functionality and security (Tsap et al., 2020). This did not come as a surprise to the authors since ease of use is a concept that is mentioned in multiple technology acceptance theories(Tsap et al., 2020). Apart from those three, trust and awareness were also quite important regarding public acceptance, but they linked these two factors as strengths from the Estonian case, since generally they are seen as weaknesses from e-ID schemes (Tsap et al., 2020)

Precisely, trust in the e-ID scheme was hypothesized as an aspect that affects positively the perceived usefulness and the user's attitude of use by Chauhan & Kaushik (2016), who studied the acceptance of the Indian e-ID (UID) using TAM. The results of the study show that trust affected the attitude toward using the technology, which in turn affected the behavioural intention to use UID, asserting the importance for governments to convince its citizens that the online authentication scheme is trustworthy. Besides, the analysis determined that perceived ease of use affected perceived usefulness which in turn affected the attitude toward using the technology. The authors state that the government needs to make sure that there are plenty of public services available where the electronic identification is accepted as an authentication method for UID to achieve public acceptance, and that the intricacy of "enrolling and lack of awareness might instil the perception that the system is complex" (Chauhan & Kaushik, 2016, p. 237).

How lack of awareness affected negatively the intention to use e-ID was too one of the main points of focus of the study of Harbach et al. (2013) who decided to study the German e-ID scheme, which was the first authentication scheme to work without the necessity of having a password. For that the authors used focus groups to conduct a qualitative analysis, from which they found out that the ID functionality of online authentication was mostly unknown to the citizens and that they were "struggled to judge the mechanism because they did not know anyone using it" (Harbach et al., 2013, p. 11). That and the fact that at that point they did not know of any online services where they could use the e-ID to identify themselves proved to be a demotivating factor for citizens, who had concerns too about its complexity and the lack of information and control they seemed to have. Besides, this scheme needed of an e-ID reader and a special software to work, and that proved to be a public acceptance barrier too since citizens thought of the device as costly and with little added value; and of the process as uncomfortable compared to just using a password (Harbach et al., 2013). As additional considerations, the authors mention that participants of the focus groups added their lack of confidence in the Internet as a fully secure space as a barrier to e-ID adoption.

But the paper of Harbach et al. (2013) is not the only one where the lack of security provided by Internet is mentioned as an important determinant of citizen's attitudes toward the use of e-ID. Joinson (2009) decided to analyse "the links between privacy concerns, trust in the Government and compulsion" (p. 1) in relation to public opinion of e-ID in the UK. What he could find is that all three factors indeed were proven important to predict the population's attitude toward the electronic authentication technology. Not only that, but the author found out that there was a relation between trust in government and privacy: the level of trust in the government was not that crucial if citizens thought that having an e-ID presented a high thread to their privacy, but if they did not give that much importance to the possible thread to their privacy then trust in the government became key in understanding citizen's attitude toward e-ID. Besides this relation, Joinson found too that people's feelings of control were affected by what he called an "affective component" (Joinson, 2009, p. 8), which meant that the government should seek to implement this type of technology in a way that made people feel like they had control over the process and the technology.

A related aspect to the lack of control noted by both Harbach et al. (2013) and Joinson (2009) as a hindrance to e-ID adoption is mentioned too in the essay of Lips et al. (2020), which focuses on the possible adoption barriers of the eIDAS implementation in Estonia and the Netherlands. The fact that citizens would not know who to contact to get information or help in case of error while trying to use e-ID was seen by Lips et al. as a challenge for cross-border electronic authentication. Moreover, the lack of end-user support division was seen by the authors not only as a problem regarding the technical aspects of the technology but as a problem regarding the semantic aspects of the technology too. If a citizen does not speak the language in which the site is written, then it could prove difficult for them to interact with public services (Linos et al., 2022). This constrain is mentioned too in Kemppainen et al. (2023), a paper in which the authors focus on the sociocultural barriers of having access to e-ID. The results of that study showed that having a poor command of the local language, an advanced age and limited economic resources "were associated with a higher risk of not having an e-ID" (Kemppainen et al., 2023, p. 45). These results accentuate the need to control for socioeconomic factors when trying to understand the results of electronic authentication uptake, which something that has been mostly neglected in the other papers mentioned so far. Going back to Lips et al. (2020) study, accessibility, ease of use and security where again highlighted as important obstacles for cross-border identification. The need of homogeneous service portals and schemes, and the need to create awareness related to the security that this technology would provide where seen as necessary factors for the public acceptance of the eIDAS system (Lips et al., 2020).

But security does not always come up as a negative aspect regarding public acceptance. At the paper of Goodstadt et al. (2015), who analyses why the Hong-Kong e-ID has been more successful

than other e-IDs, the authors were surprised to find that the fact that having an e-ID represented an added threat to privacy did not seem to have an effect on the uptake of the technology in Hong-Kong, despite the historical context suggesting otherwise. Goodstadt et al. (2015) found out that from a technology acceptance model point of view the Hong-Kong electronic identification, which was voluntary, was seen as both easy to use and useful. But the authors determined that was not sufficient to explain why that e-ID card had been more successful than others since other schemes who had failed to gain the public's acceptance presented both of those qualities too. What they observed is that apart from those two factors, trust in the government was present too, apart from some sort of "historical path dependence and political culture" (Goodstadt et al., 2015, p. 78) which proved to be the most critical aspects to explain why this technology had been as successful in that city in particular. Hongkongers supported the use of e-ID since it allowed them to better control tourism and immigration, thereby providing citizens with a sense of distinction from Mainland Chinese and a superior status when requesting public services.

The acceptance of the e-ID in Hong-Kong is analysed too in the paper of Chan et al. (2010), but with a different method from the one used by Goodstadt et al. (2015). For their study, Chan et al. use the main factors of the Unified Theory of Acceptance and Use of Technology (UTAUT) together with citizen's satisfaction to explore the compulsory adoption of e-government technologies. The main results showed that out of "the four core technology adoption beliefs, performance expectancy, effort expectancy, and facilitating conditions were significant determinants of satisfaction" (Chan et al., 2010, p. 533) regarding the compulsory adoption of the electronic identification scheme. Apart from those variables, the authors added some external variables that could affect the core ones. What they found out is that performance expectancy in turn was affected by "compatibility, flexibility, avoidance of personal interaction, and trust" (Chan et al., 2010, p. 533) and that effort expectancy and facilitating conditions were in turn affected by "self-efficacy, convenience and assistance" (Chan et al., 2010, p. 533). Out of those external variables though there were two that Chan et al. reported as the strongest determinants: trust and convenience.

Another example of how convenience affected negatively the public acceptance of e-ID was mentioned by Harbach et al. (2013), who touched upon the problem that card readers presented to the motivation of using e-ID in Germany (Harbach et al., 2013). Yeow et al. (2007) mention this factor too as an adoption barrier in their study about acceptance of electronic ID cards in Malaysia (NIC) where they integrated the TAM with other technology acceptance theories. The authors consider that having to dispose of a card reader every time someone needs to use the e-ID card could negatively affect the convenience and ease of use of the technology. Apart from that, the paper to find out that "privacy, civil liberty, fines, and the cost of upgrading, and durability when adopting the NIC application" (Yeow et al., 2007, p. 44) were all obstacles faced

by the electronic authentication scheme, and that they were probably caused by the lack of knowledge the population had about the system.

Overall, it seems that more digitalized countries have more chances at accomplishing a successful adoption of e-ID schemes. To create a useful scheme the nation needs to be able to provide plenty of online public services for which citizens can use the digital authentication and for that there needs to be a high degree of digitalization, which is needed as well to create a system that is easy to use and not too complex. There are some real-life examples that proof this, like the Estonian case or the Northern countries one. Estonia is positioned first in the ranking of Digital Public Services that is part of the Digital Economy and Society Index (DESI) in 2022. By 2021 the country held a 99% e-ID user rate (Quest et al., 2021). In the case of the Northern Countries, they are all positioned in the top 15 of the IMD World Competitiveness ranking and by 2021 held a combined BankID usage rate of 78% (Quest et al., 2021). But there is one case that deviates from this. Spain is a country that counts with a very high level of digitalization, but the user rates of its electronic identification scheme have been very low ever since its implementation (European Commission, 2022a; INE, 2009, 2010; OECD, 2020). This is why the Spanish case is a compelling one for the theme of this thesis.

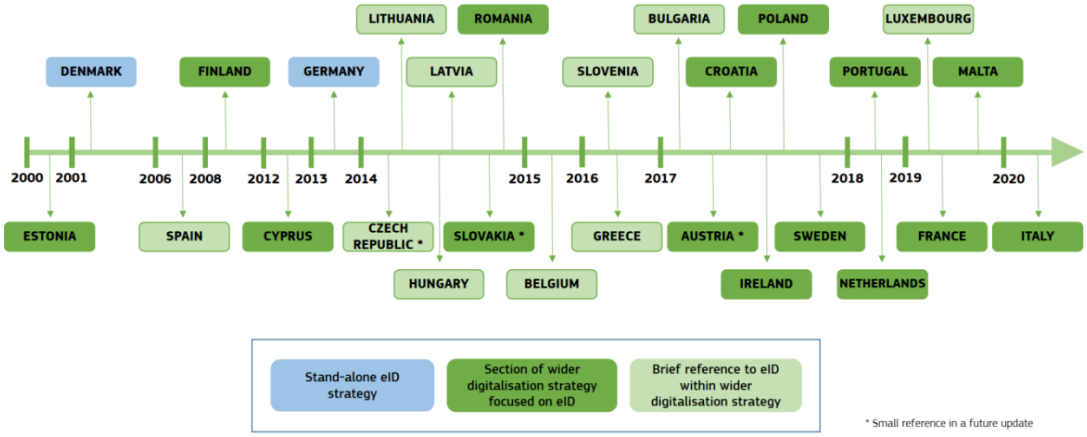
2.3. The Spanish case

The first Spanish e-ID was issued in 2006. Since then, it has become quite widespread, with most citizens holding an electronic identity card, which represents a well implementation of the supply-side (Arteaga & Criado, 2011). But that success does not seem to be reflected on the "demand side" of the implementation (Arteaga & Criado, 2011), that is, on the actual utilization of the identification capabilities of the e-ID. This creates a paradox that turns the Spanish case into a very interesting case to study. But that is not the only paradox present. As mentioned above, there is a link between country's having a high degree of digitalization and the population's use of e-ID, but this is something that is not present in Spain.

2.3.1.History of e-ID

Spain was one of the first European countries to adopt an electronic e-ID scheme, as can be seen in Figure 1. The identity card is issued by the Police General Directorate, a governing body under the Ministry of Interior, and it is compulsory for all Spanish citizens who are over 14 years old (Heichlinger & Gallego, 2010). The e-ID allows its holder to connect electronically with the Public Administration in order to sign documents virtually as stated by the Spanish Tax Agency (Agencia Tributaria, n.d.).

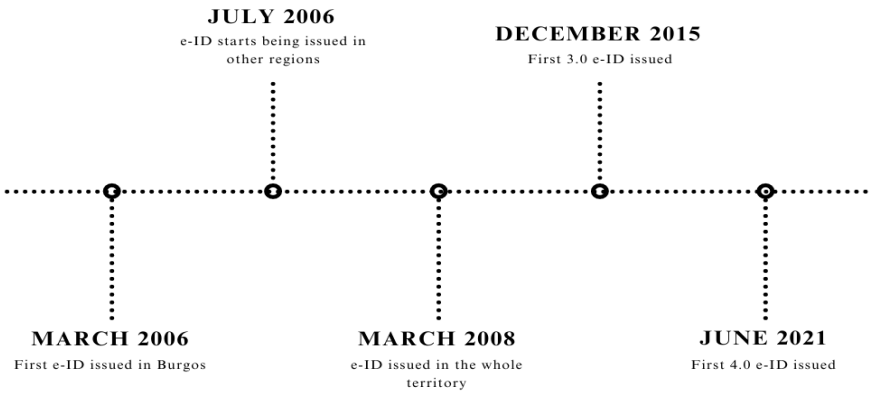
Figure 1: e-ID Strategies Roadmap



Source: from *Trends in electronic identification - An overview*, by Deloitte, 2018, European Commission.

The first card was issued in Burgos as part of a trial run in March of 2006 before starting being issued in other regions of Spain (Heichlinger & Gallego, 2010). This innovation became increasingly popular: the amount of issuances went from 120.000 in 2006 to 23.000.000 in 2011 (Arteaga & Criado, 2011). But, even if people were asking for e-IDs, it did not seem as if its use was being as elevated which, as Heichlinger and Gallego (2010) explain, could be due to: (1) "technological difficulties" (p. 59); (2) the lack of digital knowledge among the population.

Figure 2: Timeline of Spanish e-ID



Source: own elaboration.

Since its enactment back in 2006, the Spanish e-ID scheme has had two updates:

- From 2006 until 2015: first ID that incorporates a chip, which allows citizens to interact online with the public administration by using a card reader connected to a computer (Cuerpo Nacional de Policía, n.d.-b).
- From 2016 until 2021: the 3.0 e-ID changed the chip to a more advanced one, a Dual Interface chip, which allows citizens to connect to electronic services by using a card reader or by using devices with Near Field Communication (NFC) technology together with an app (Cuerpo Nacional de Policía, n.d.-b).

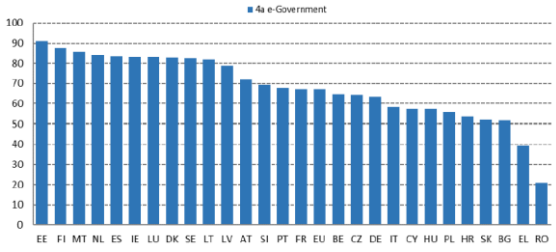
- From 2021 until present: the 4.0 e-ID was created in order to comply with the European Parliament and European Council regulation on strengthening the security of identity documents (Cuerpo Nacional de Policía, n.d.-a). Since its implementation is quite recent, there is still not enough data for this thesis to focus on this version.

The personal information is contained in the microchip incorporated in the physical e-ID card, which means that the only way for citizens to access their data is through the use of the e-ID together with an external device (Heichlinger & Gallego, 2010). It must be mentioned that an alternative to avoid this process does exist: registering on Cl@ve, a system which purpose is that of unifying the access to e-governance services (Gobierno de Cantabria, n.d.). Still, the Spanish government presents this system as an alternative to e-ID rather than as a linked application (Gobierno de Cantabria, n.d.).

2.3.2.Relevancy of the case

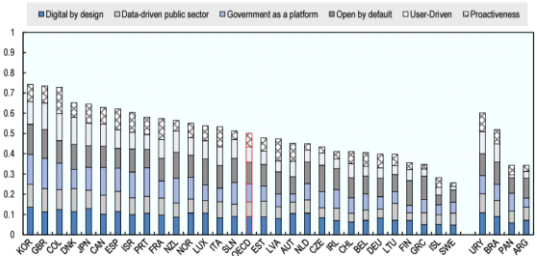
Spain was 5th in the ranking of Digital Public Services that is part of the Digital Economy and Society Index (DESI) in 2022. This index "describes the demand and supply of e-government as well as open data policies" (European Commission, 2022a, p. 82). Spain's positioning is not something new, since the country has always been on the top positions of this ranking (European Commission, 2022b). Besides, the country was 7th in the Digital Government Index published by the OECD in 2019, an index which evaluates digital government policies and reforms. That means that even including non-European countries Spain identifies as a country with quite advanced digital services and with a quite developed e-government.

Figure 3: Digital Economy and Society Index (DESI) 2022, Digital public services



Source: from *Digital Economy and Society Index (DESI) 2022* by European Commission, 2022 (https://digital-strategy.ec.europa.eu/en/library/digital-economy-and-society-index-desi-2022)

Figure 4: The OECD Digital Government Index Composite Results

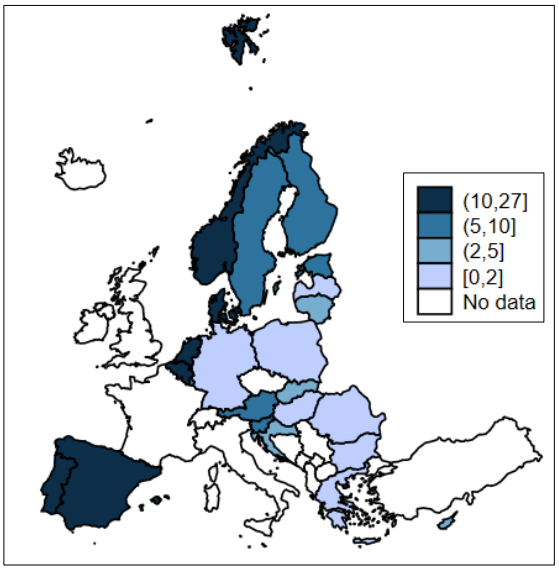


Source: from *Digital Government Index: 2019 results* by OECD, 2019 (https://www.oecd-ilibrary.org/governance/digital-government-index_4de9f5bb-en)

This discourse changes if the focus shifts to the Spanish e-ID scheme. From the point of view of citizen's use, this area does not seem to be part of the group of the country's strong digital services. Observing the Figure 5, out of all the European Union member states the country holds one of the highest percentages of people that had some trouble while using the e-ID to send forms. This fact

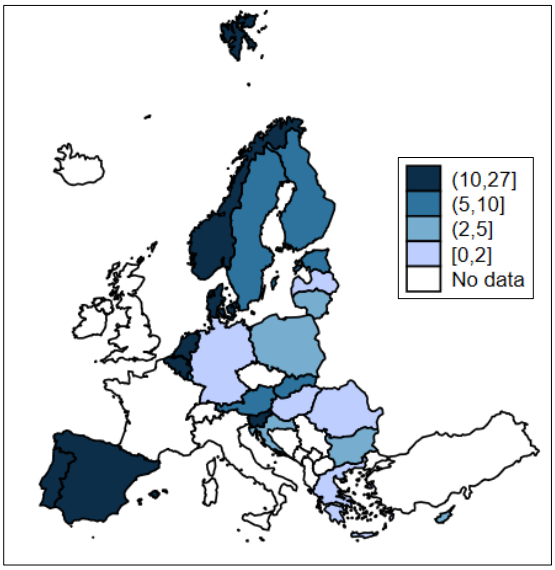
does not alter if the focus changes from the rate of problems per citizen to the rate of problems per Internet user, Spain is still one of the countries with the highest percentage of trouble experienced.

Figure 5: Problems using electronic signature or identification (% of individuals)



Source: own elaboration with data from Problems experienced when using e-government websites (2022) by Eurostat.

Figure 6: Problems using electronic signature or identification (% of internet users)



Source: own elaboration with data from Problems experienced when using e-government websites (2022) by Eurostat.

Observing the rate of use of the e-ID, the data does not disclose better results. In 2009 only 3,4% of the population used this technology to interact with the Public Administration (INE, 2009). Numbers did not increase much in 2010 despite the new regulation that made it mandatory for all public services to be available online, with only 4,6% of the population using it (Heichlinger & Gallego, 2010; INE, 2010). Currently there is a lack of data regarding the exact amount of users of this scheme, but if the amount of users who used an electronic certificate to sign up to Cl@ve is observed, only 2,5% of citizens used the e-ID in 2023 (Cl@ve, n.d.; INE, 2022; Secretaría General de Administración Digital, 2023).

It is precisely this mix of good global positioning in the field of digital public services and e-governance and low use rates that makes Spain an interesting case to study. As mentioned before, normally countries which experience a good performance in electronic Public Administration, like Estonia or the Northern countries, count too with a high usage rate of electronic ID but the Spanish case is quite the contrary. Besides, despite the country's high digitalization, it seems like the e-ID scheme is quite rudimentary, with citizens needing to use external devices to be able to access to the certificates inside it. This makes the scheme look somewhat technologically behind compared to the schemes of other countries like the Netherlands' DigiD or Malta's e-ID account,

which represent a profile that stores the citizen's electronic identity and which they can use to connect with online public services (Government of the Netherlands, n.d.; Identity Malta Agency, 2019). This all shows how the Spanish case deviates from what is expected creating a paradox and turning this into a relevant case to analyse what is it that makes citizens accept the electronic identification.

3. Theoretical framework

In this section the theoretical framework of the thesis is presented. The theory that serves as basis for the study is the Technology Acceptance Model (TAM). But that one is not the only existent technology acceptance theory (Momani, 2020). That is why the first subsection will briefly present the evolution of the technology acceptance theories and will expose why TAM-3 is the most fit theory for this thesis. The second subsection will therefore revolve around TAM and its extensions, where the model will be presented together with some initial hypothesis. The last subsection will focus on additional variables that are not considered in the original TAM model nor its extensions but that should be contemplated when studying public acceptance of the electronic ID, and it will present some additional hypothesis that stemmed from those variables.

3.1. Evolution of technology acceptance theories

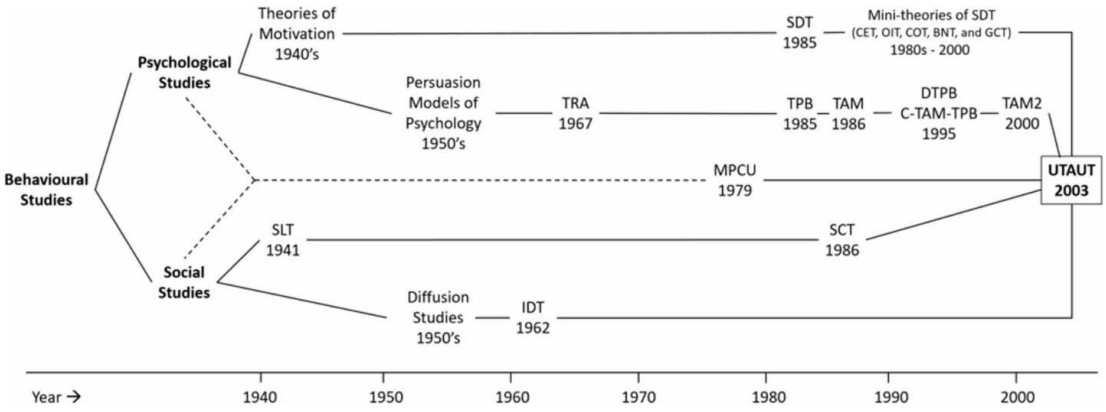
The Cambridge Business English Dictionary (n.d.) defines acceptance as the "willingness of people to use a new product or service or to believe a new idea". In the case of public administration this concept focuses on people's opinions and assessment of policies (PytlikZillig et al., 2018). Therefore, in this paper public acceptance would be describe as the general willingness of the population of a state to use the electronic ID to interact online with public services based in their personal experience with the adoption of the technology. But with this definition, the concept sounds qualitative rather than numerically computable, so how can public acceptance be quantitatively analysed?

The technology acceptance theories and models were created to study people's opinion on the implementation of new technologies by analysing several variables that could affect the decision-making process of new users (Momani & Jamous, 2017). By gaining comprehension about that process, the people that implement new technology should be able to create, gauge and predict in a better way how users are going to respond to their innovation (Taherdoost, 2018). Since their creation, several theories and models have been developed (Momani, 2020):

The first technology acceptance theory, the Theory of Reasoned Action (TRA), was derived from the field of psychology and it is based on the fact that people are rational and use all the available data to think about the potential consequences before acting (Alotaibi & Wald, 2013; Taherdoost, 2018). As an extension the Theory of Planned Behavior (TPB) was suggested to touch upon "the subconscious aspect of behaviours" (Alotaibi & Wald, 2013, p. 3), and this was in turn extended

in the Decomposed Theory of Planned Behavior (DTPB), which ended up being the better out of the three at explaining people's behaviour (Momani & Jamous, 2017). The other theory that derived from psychological studies is the Motivational Model (MM). From the field of social studies we can find two main theories: the Social Cognitive Theory (SCT), developed from the "idea that cognitive, environmental and personal factors, in addition to behaviour, are determined mutually" (Alotaibi & Wald, 2013, p. 6); and the Innovation Diffusion Theory (IDT), proposed as a conclusion of several innovation studies that had taken place in the 1950s (Momani & Jamous, 2017). Besides, the Model of PC Utilization (MPCU) was proposed as a model that stemmed from both psychological and social studies with the aim of assessing the "individual acceptance and personal computer (PC) utilization" (Taherdoost, 2018, p. 964).

Figure 7: Evolution of technology acceptance theories



Source: from "The Unified Theory of Acceptance and Use of Technology: A New Approach in Technology Acceptance" (p. 81) by A. M. Momani, 2020, *International Journal of Sociotechnology and Knowledge Development, 12* (3).

After comparing these previous technology acceptance theories, the Unified Theory of Acceptance and Use of Technology (UTAUT) was developed by Morris Venkatesh (Alotaibi & Wald, 2013; Taherdoost, 2018). It proposes that behaviour is affected by four main aspects which are effort expectancy, performance expectancy, social influence, and facilitating conditions, and four mediating variables which are gender, experience, age, and voluntariness of use (Alotaibi & Wald, 2013; Taherdoost, 2018). Because it unifies all technology acceptance theories, this model has become the most advance out of them all, and has been extended in 2012 to include hedonic motivation, price value, and habit as determinants of behaviour (Momani, 2020).

But the most used theory when studying "the level of acceptance and usage by a user" (Alotaibi & Wald, 2013, p. 4) is the Technology Acceptance Model (TAM). Proposed by Fred D. Davis as another extension of the TRA, this model focuses on two different dimensions: perceived usefulness and perceived ease of use (Momani & Jamous, 2017). This model has had two extensions since its creation: TAM-2, which focuses on the factors that affect perceived

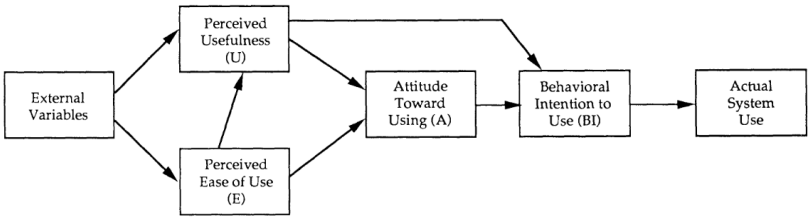
usefulness; and TAM-3, which focuses on the factors that affect perceived ease of use (Alotaibi & Wald, 2013; Venkatesh & Bala, 2008).

As presented above, the most used and recent technology acceptance theories are TAM and UTAUT. Due to the available data and the topic of the study, out of those two models the one that suits this thesis best is the TAM. That is because the UTAUT is more focused on expectations and social influence while TAM takes into consideration variables that are more related to the user's experience and personal characteristics. Due to the nature of the research question, this last aspect is the most appropriate to analyse what are the main factors that affect e-ID public acceptance. And out of the three versions of TAM, TAM-3 was chosen to perform the analysis as it is the most developed version of the theory.

3.2. Technology Acceptance Model (TAM)

As mentioned above, the TAM was proposed by Davis in 1986 as an extension of TRA based in the technology field and it has become the most recurrent when studying the user's acceptance of a technology (Alotaibi & Wald, 2013; Momani, 2020). It is based on the premise that there are two main factors that determine someone's technology acceptance: perceived usefulness and perceived ease of use.

Figure 8: Technology Acceptance Model (TAM)



Source: from "User Acceptance of Computer Technology: A Comparison of Two Theoretical Models" (p. 985) by F. D. Davis et al., 1986, *Management Science, 35* (8).

This model is considered quite simple, which is part of the reason for its popularity (Malatji et al., 2020). But in spite of this, the model has proven to be flawed (Malatji et al., 2020). The fact that the TAM only took into consideration usefulness and ease of use of a technology meant it left out other aspects like financial aspects or societal rules, which can play an important role in individual's decision making when it comes to adopting a technology or thinking about it as necessary (Lunceford, 2009). Besides, it has been proven that depending on the technology being analysed it is possible that ease of use is not a significant determinant of attitude toward using and behavioural intention to use, which shows that the model is not perfect when it comes to predict users' acceptance of a technology (Malatji et al., 2020). Besides, the TAM did not provide a way of identifying those external values that affected usefulness nor ease of use, so Venkatesh & Davis (2000) decided to extend the model and proposed the TAM-2 and further on Venkatesh & Bala

(2008) extended the model one more time to propose TAM-3. That led to five new determinants of perceived usefulness added to the original TAM:

- Subjective Norm: perception about how your inner circle think you should behave (Venkatesh & Davis, 2000).
- Image: the degree to which a person believes that using an innovation will improve their social status (Venkatesh & Davis, 2000).
- Job relevance: "an individual's perception regarding the degree to which the target system is applicable to his or her job" (Venkatesh & Davis, 2000, p. 191).
- Output quality: Venkatesh & Davis (2000) describe it as "how well the system performs those tasks" (p. 191) that comprise the job relevance.
- Result demonstrability: as cited in Venkatesh & Davis (2000), Moore and Benbasat (1991) describe it as the "tangibility of the results of using the innovation" (p. 192).

These determinants are necessary to provide more information about the reasons behind someone finding an innovation useful (Chuttur, 2009). And this is quite important to understand why people support the use of an innovation since citizens tend to do that if they "see the features and uses of the information system" (Musyaffi et al., 2021, p. 13). This concept comes from the motivation theory, which states that "if an individual perceives an activity to be instrumental for achieving valued outcomes, he or she will be more likely to accept the new technology" (Igbaria et al., 1994, p. 351). Therefore, the following hypothesis is proposed:

H1: Perceived usefulness has a positive effect on the probability of using e-ID.

Besides, in TAM-3 four new determinants of perceived ease of use were added:

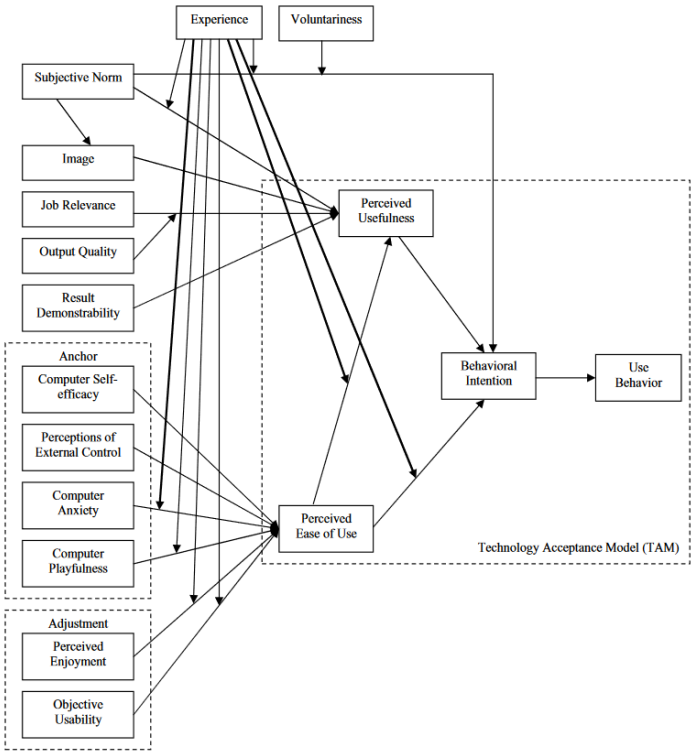
- Computer self-efficacy: it "refers to individuals' control beliefs regarding his or her personal ability to use a system" (Venkatesh & Bala, 2008, p. 278).
- Computer anxiety: described by Venkatesh (2000) as the extend of apprehension or fear a person experiences when they may have to use computers.
- Computer playfulness: "represents the intrinsic motivation associated with using any new system" (Venkatesh & Bala, 2008, p. 278).
- Perceptions of external control: the "degree to which an individual believes that organizational and technical resources exist to support the use of the system" (Venkatesh & Bala, 2008, p. 279).

These determinants helped to present "a complete nomological network of the determinants that predict user information technology adoption" (Nikolopoulos & Likothanassis, 2018, p. 290). And it brought a better understanding to the reasons that make people find a technology easy to use, which tends to affect public acceptance since it tends to affect adoption in a significant

manner (Chen & Aklikokou, 2020). "If a system is relatively easy to use, individuals will be more willing to learn about its features and finally intend to continue using it" (Hamid et al., 2016, p. 646). This leads to the proposal of the following hypothesis:

H2: Perceived ease of use has a positive effect on the probability of using e-ID

Figure 9: Technology Acceptance Model 3 (TAM-3)



Source: from "Technology Acceptance Model 3 and a Research Agenda on Interventions" (p. 280) by V. Venkatesh & H. Bala, 2008, *Decision Sciences, 39* (2).

3.3. Additional variables that can affect technology acceptance

The Technology Acceptance Model and all its extensions are based on aspects which are related to a person's behaviour and to the effectiveness of the technology studied. Yet, despite the two extensions the model has gone through, there are some factors which still have not been considered in this theory. This is the case of characteristics that do not necessarily need to be related intrinsically to the user's attitude and experience but could still affect his opinion on the technology.

Precisely, one of the many critiques TAM has experience is related to the lack of consideration toward the cost-benefit aspect of the use of a new technology (Lunceford, 2009). The decision to adopt or not a new technology tends to include the consideration of the trade-off between the necessary investment costs and the future benefits it will bring (De Groote & Verboven, 2019). Therefore, if the adoption of a technology is not cost-free and user's do not think it will pay off in the future, the intention to use that innovation will be negatively affected. Besides, if a

technology is so expensive that people cannot afford it, then it does not matter if it is easy to use or useful since people will not able to adopt it anyway, and that will affect acceptance in a negative way (Lunceford, 2009). Because of that, this variable has been mainly taken into consideration in online transaction studies (Özbek et al., 2015). As Wu & Wang (2005) mentioned, the cost-benefit analysis was already considered in behavioural decision theory as determinants of both perceived ease of use and perceived usefulness and it should affect behavioural intention to use since higher adoption costs discourage users from switching to new technologies. Those costs include "equipments costs, access cost, and transaction fees" (Wu & Wang, 2005, p. 723). Because of this, it can be hypothesized that:

> H3: The more costly it is for someone to use digital devices, the less probability they will have of using e-ID.

Another variable that is not considered by the TAM but can affect the intention to adopt a technology is trust. "Many researchers maintain that trust is essential for understanding interpersonal behavior and economic exchanges" (Pavlou, 2003, p. 102). Furthermore, trust is seen as key to decrease uncertainty and insecurity (Ha & Stoel, 2009). And precisely the degree of uncertainty and insecurity is way higher in the online setting than offline, which explains why trust has gained plenty of importance in the technology field and why it can affect people's perceptions about innovations and therefore their intention to use them (Al-Ajam & Nor, 2013; Ha & Stoel, 2009). Citizens want to make sure that they can perform transactions through the Internet and that the businesses they are interacting with will be able to safeguard their personal data (McCloskey, 2006). But when performing transactions through the Internet the user may come across several security threads, such as indirect data collection or unauthorised data transfers, which are unique to the online environment (Beldad et al., 2011). With the world becoming more and more digitalized and with importance of the information available and shared on the Internet increasing, the privacy concerns grow and that will affect the user's willingness to disclose personal information (Kim et al., 2019). Therefore, the following hypothesis is proposed:

> H4: The more trust in the Internet the citizens have, the more probability they will have of using e-ID.

Finally, another concept that can influence technology acceptance and usage but is not contemplated in the TAM is the geographical one. The spatial characteristics were ignored when performing empirical models up until the 80s and 90s when spatial econometrics gained traction (Vayá & Moreno, 2002). That would explain why it is does not seem common to include the size of the territorial organization where the technology is being implemented as a variable that can affect intention to use in the technology acceptance theories. Despite this, size is normally taken into account in innovation adoption studies as an organizational characteristic or as a proxy for

an environmental framework variable (Moon & Norris, 2005). This is because the size of the territorial organization (be it city, province or municipality) is related to the size of the government and therefore to the size of the "level of resources and public services" (Moon & Norris, 2005, p. 48). That means that "larger cities are under greater pressure to find alternative ways to provide public services; larger cities also have more resources (including more and better trained staff, a larger budget and often a formal and well-established IT department) to pursue alternatives" (Moon & Norris, 2005, p. 48). It is true that it is believed that small governments, and therefore small cities, have a better understanding of the citizen's preferences while bigger ones are more bureaucratic and consequently less likely to meet the population's demands (Avellaneda & Gomes, 2015). But in the end that tends to depend on the type of activity studied (Avellaneda & Gomes, 2015). This leads to the proposal of the following hypothesis:

H5: The province size has a positive effect on the probability of using e-ID.

4. Methodology

In this section there will be a thorough explanation about the data and methods used to research which are the factors that affect public acceptance of e-ID. The first subsection will revolve around the database used for this purpose and the time-period selected. Then, in the second subsection it will be explained which variables were chosen to perform the quantitative analysis and how they were operationalized. Finally, the last two subsections will be focused on the explanation of the methods used with the third subsection revolving around the longitudinal analysis that will be made using the TAM-3 as base, and the fourth one focusing on the spatial analysis that will be performed to check if geography has any relationship with the public acceptance of e-ID.

4.1. Sample selection and data collection

The database used to perform the quantitative analysis in this thesis comes from the EU survey on the use of Information and Communication Technologies (ICT) in households and by individuals[2], which is a survey that has been conducted annually ever since 2002 by the National Statistics Institutes following the questionnaire designed by Eurostat (Eurostat, n.d.). In between the topics this survey covers it is included the "use of ICT by individuals to exchange information and services with governments and public administrations" (Eurostat, n.d.). Because of data access constraints and the relevance of the case, the chosen microdata concretely comes from the survey conducted by the Spanish National Statistics Institute (INE)[3] in six consecutive waves, from 2016 until 2021. This timeframe has been chosen because it corresponds to the timeframe when the 3.0 e-ID was being issued.

[2] ec.europa.eu
[3] www.ine.es

4.2. Operationalization of variables

The dependant variable of this study is the use of e-ID in households. The ICT usage survey includes the question "What were the reasons why you did not send completed forms to public administrations via the Internet in the last 12 months?" (INE, n.d.) to measure how many people has had the necessity to submit forms to the public administration but could not do it. In between the reasons given, the following one can be found: "For not having an electronic signature or certificate or for having problems with them" (INE, n.d.). Based on the answers for that reason a dummy variable was created. The dummy equals 0 for those people that answered no (which meant their problem was not related to e-ID and therefore they probably did not have to use it) and for those that did not have to send any completed forms online to the public administration (which means they did not have to use e-ID at all) and 1 for those who answered yes (they had to use it but experienced trouble while doing so, which affected the completion of the task).

Job relevance and output quality were the variables integrated in this study as the independent variables that represent the perceived usefulness dimension. Subjective norm and image were not included since the use of e-ID to interact with online public service is compulsory. If someone must use it to send complete forms they do not have another option but to do so, which means they will not be influenced by someone else's opinion on whether they should use it or not and their social status will not change. Results demonstrability has not been added to the model either since the closest thing to tangible results of using e-ID would be successfully sending the necessary completed forms to the public administration, and that has already been operationalized as part of output quality in the form of a dummy variable. This dummy was created out of the answer to the question "Could you tell me which of the following forms of contact or interaction with public administrations or services via the Internet have you used, for private reasons, in the last 12 months? Excluding the use of e-mail" (INE, n.d.). If citizens ticked the yes box for "Sending completed forms" the dummy equals 1, if not 0. Besides, citizens who ticked the no box for "Sending completed forms" had then to answer the following question: "But have you had to submit any official forms to public administrations in the last 12 months?" (INE, n.d.). This question was used to operationalize job relevance as a dummy variable that took the value of 1 if the answer was yes and 0 if the answer was no.

For the dimension of perceived ease of use, computer self-efficacy, perceived external control and computer anxiety were added to the model. Computer playfulness was excluded from the model for the same reason as subjective norm and image. The use of e-ID to send completed forms is compulsory if the service with which the citizen is interacting with deems it so. That means that users will not have an intrinsic motivation to use this technology, but rather only an extrinsic motivation to do so. Perceived external control was added to the model as a dummy variable created from the responses to the question "Could you tell me which of the following

forms of contact or interaction with public administrations or services via the Internet you have used, for private reasons, in the last 12 months? Excluding the use of e-mail" (INE, n.d.). Responders could answer "Obtaining information from government websites or apps", which was used as a proxy to operationalize perceived external control. The dummy took the value 1 if the responded ticked the yes box and the value 0 otherwise. To operationalize computer self-efficacy and computer anxiety the answers to the question "What were the reasons why you did not send completed forms to public administrations via the Internet in the last 12 months?" (INE, n.d.) were used. Computer self-efficacy was added as a dummy variable which equals 1 if the respondent ticked the yes box for the answer "Lack of skills or knowledge" and 0 otherwise. Computer anxiety was added as a proxy dummy variable which equals 1 if the respondent ticked the yes box for the answer "Being concerned about the protection and security of personal data" since the concept of experiencing concern for personal data while using the e-ID was related to the feeling of apprehension for using e-ID. Because of the way these two last variables were operationalized, they are expected to hold the opposite sign to perceived external control.

Apart from the variables present at TAM-3, two other variables were added to the model as a contribution: trust on Internet and costs. Trust on Internet was operationalized as an ordinal variable that goes on a scale from 1 to 3, depending on if the respondent answered "Little or nothing", "Quite a lot" or "A lot" to the question "Please indicate your level of confidence in the Internet" (INE, n.d.). The costs were operationalized as a dummy variable depending on the answer to the question "For which of the following reasons does your home not have Internet access?". If respondents marked the yes box for "Equipment costs or connection costs are too high" (INE, n.d.) then the dummy variable equals 1, if not it equals 0. In 2018 that question was omitted in the questionary, so the data was inferred from the 2017. In 2020 the question varied minimally, turning out to be the following: "For which of the following reasons have you not used Internet-connected devices or systems for private purposes?" (INE, n.d.). Still, the main aspect measured remained constant, since one of the answers was "Too high costs", which is the one that has been used to operationalize the variable costs for 2020.

Finally, some control variables were added to the model. It is important to consider age, gender and level of studies of the respondents of the survey since those are characteristics that can affect how people deal with technology. All respondents need to indicate their age and gender at the beginning of the survey, so the variables are drawn from there Age is collected as an ordinal variable and gender takes the value 1 for male and 6 for female. Level of studies is operationalized as an ordinal variable following the question "What is your highest level of education?" (INE, n.d.). The responses are coded from 0 to 8 according to the 2014 National Education Rankings (CNED-2014) with "Illiterate and incomplete primary education" as the lowest level and "PhD" as the highest.

Table 1
Summary of the variables' operationalization.

Variables	Question	Operationalization
Dependant variable		
Use of e-ID	What were the reasons why you did not send completed forms to public administrations via the Internet in the last 12 months? - Not having an electronic signature or certificate or for having problems with them.	Binary scale 0-1
Independent variables		
Job relevance	But have you had to submit any official forms to public administrations in the last 12 months?	Binary scale 0-1
Output quality	Could you tell me which of the following forms of contact or interaction with public administrations or services via the Internet you have used, for private reasons, in the last 12 months? Excluding the use of e-mail - Sending completed forms.	Binary scale 0-1
Computer Self-Efficacy	What were the reasons why you did not send completed forms to public administrations via the Internet in the last 12 months? - Lack of skills or knowledge.	Binary scale 0-1
Perceived external control	Could you tell me which of the following forms of contact or interaction with public administrations or services via the Internet you have used, for private reasons, in the last 12 months? Excluding the use of e-mail - Obtaining information from government websites or apps.	Binary scale 0-1
Computer anxiety	What were the reasons why you did not send completed forms to public administrations via the Internet in the last 12 months? - Being concerned about the protection and security of personal data.	Binary scale 0-1
Trust on the Internet	Please indicate your level of confidence in the Internet	Ordinal scale 1-3
Costs	For which of the following reasons have you not used Internet-connected devices or systems for private purposes? - Equipment costs or connection costs are too high.	Binary scale 0-1

Source: own elaboration.

4.3. Longitudinal analysis

As it was mentioned in the history section of Spanish e-ID, the implementation of this type of schemes is not finished in just one year. It is a process that takes time. Same happens with the uptake, and public acceptance. Citizens need to go through a situation where they need to interact online with the public administration, but that may not be a common occurrence. Therefore, the public acceptance of e-ID cannot be analysed selecting only one year. To get the full picture it is needed to analyse a longer period. To do that, the better quantitative method is a longitudinal analysis, since it is the one used to measure change over a particular spam of time (Gayle & Lambert, 2020; Menard, 2007; Rajulton, 2001).

The method used for the analysis is the Conditional Fixed-Effects Logistic Regression. Fixed-Effect models are one of the main methods used to analyse panel data (Baltagi, 2008). This type of data consists of a recompilation observations over several years on the same units, be it individuals, households, countries… (Wooldridge, 2012). The final database consists of microdata of the same survey collected during six consecutive years, which means that can therefore be qualified as panel data. But due to the nature of the data (which is anonymised and survey-based) and to the nature of the dependant variable (which is a dummy) it is more convenient to perform a conditional logistic analysis rather than a regular fixed-effects one, which means that the model will be estimated by maximum likelihood. "Conditional logistic analysis differs from regular logistic regression in that the data are grouped and the likelihood is calculated relative to each group" (StataCorp, 2019, p. 253). In this case, the data is group by province, which means that results will be estimated based on geographic differences.

4.4. Spatial analysis

The database used to analyse how does the province size affect the public acceptance of e-ID comes too from the EU survey on the use of Information and Communication Technologies (ICT) in households and by individuals. The surveyor has to indicate the province where the survey was conducted. The province is then coded with a number from 1 to 52 following an alphabetical order. That means that Álava would be coded as 1, Albacete as 2, Alicante as 3 and so on. Ceuta and Melilla are the exceptions, holding the last two numbers, 51 and 52 respectively. To operationalize the number of people who used e-ID per province, the number of people who ticked the yes box for the answer "For not having an electronic signature or certificate or for having problems with them" to the question "What were the reasons why you did not send completed forms to public administrations via the Internet in the last 12 months?" (INE, n.d.) was added up.

The spatial analysis is performed using Exploratory Spatial Data Analysis for each year separately. This is motivated by the fact that the Conditional Fixed-Effects Logistic Regression estimates the coefficients by comparing between groups. In this study concretely the data was

grouped by province, which showcases the fact that differences depending on the territory exists. The resulting map is analysed according to province size. This aspect is measured by the population density of the province in question, which was calculated by diving the number of residents between the province surface. Population data was acquired from the population figures and demographic censuses that Spanish National Statistics Institute make available (INE, 2022). The database is based on the provisional results for the 1st of July of 2022. The surface data was acquired from the basic statistics made available by the Ministry for Ecological Transition and the Demographic Challenge (Ministerio para la Transición Ecológica y el Reto Demográfico, n.d.). The data is showcased at Appendix 1.

5. Results

The e-ID system is key to defy anonymity on the Internet. That is why it is important that the system is approved by the citizens, who should be willing to use it to identify themselves to complete public administration related tasks online. Looking first at the variables that compose the analysis, apart from perceived external control, age and sex the rest of the variables tend to be skewed to the left, which means most of the results are closer to the minimum than to the maximum. That could represent extreme opinions of the respondents on the e-ID and e-governance topic, even though the average from most variables does not seem to be very representative due to how much they differ compared to their standard deviation. This means that the sample is quite heterogeneous. Besides the descriptive statistics, the variation influence factor (VIF) of the independent variables is added to the table. This is used to control for multicollinearity, since it can influence the variable's coefficients in a way that would prevent the results from showing the real effect (Peters et al., 2021). "As a general rule, a VIF above 5-10 is an indicator for potential collinearity" (Peters et al., 2021, app. B). In this case only trust on Internet and age are above 5, but still under 10, so the collinearity might not be that worrisome.

Table 2
Variables descriptive statistics.

	Observations	Mean	Standard deviation	Min	Max	VIF
Use of e-ID	98.932	0,03	0,17	0	1	
Job relevance	98.932	0,11	0,32	0	1	1,99
Output quality	98.932	0,34	0,47	0	1	3,35
C. Self-Efficacy	98.932	0,04	0,19	0	1	1,62
P. External Control	98.932	0,41	0,49	0	1	3,44
C. Anxiety	98.932	0,02	0,14	0	1	1,3
Trust on Internet	73.406	1,69	0,58	1	3	7,04
Costs	98.932	0,06	0,24	0	1	1,17
Age	98.932	54,50	18,65	16	115	7,07
Sex	98.932	3,75	2,49	1	6	2,96
Level of education	98.932	3,13	2,24	0	9	4,91

Source: own elaboration. Estimation performed with the statistical software package Stata.

Four models are presented for the purpose of analysing public acceptance of e-ID in Spain. The first two follow the TAM-3 model, excluding some variables due to the compulsory nature of the subject studied. The last two have some additional variables that are not contemplated in the original TAM-3. This way it can be checked separately if the TAM-3 model does present results representative enough to explain which aspects have an effect of e-ID use and if the additional variables do add significance to the result. Besides, the main difference between the first and second model and between the third and fourth model is the addition of the control variables. This way it is easy to check the robustness of the models.

The first surprising results are those of the variables that determine Perceived Usefulness: neither variable is statistically significant. That could be due to the compulsory nature mentioned previously of the Spanish e-ID. Having an e-ID is compulsory in the country and people that need to use it to interact online with the public administration tend to not have any other option but to do so, so it makes sense that in this case usefulness does not affect the probability of intending to use the electronic identity.

When looking at the factors that determine perceived ease of use, the three variables affect positively the probability of using e-ID. As predicted, the more perception of external control a citizen has when using his electronic identity, the more probability that citizen has of intending to use the technology. That means that governmental pages should provide as much information as possible about the system and about how to use it. Besides, there should be an active assistance system for people who are experiencing trouble or want to know more. But again, the results are unexpected for computer self-efficacy and computer anxiety.

Due to the operationalization of those variables, the results should hold a negative sign, yet they too affect positively the probability of using e-ID. Those results could be related to the fact that the dependant variable measures the citizens who intended to use e-ID to perform a task but were unable to complete it due to problems with the system. So, it can be understood that if someone does not understand correctly how to perform the process or does not trust it, he will have more trouble using e-ID. And that means that computer self-efficacy and computer anxiety are affecting the probability of having trouble while using e-ID rather than simply the probability of intending to use it. At the same time, it can be inferred that if the probability of experiencing problems grow, that means that the probability of intending to use e-ID has grown too, even if it is not necessarily because more people intend to use it but because those citizens who do not feel comfortable using it keep trying more than once. That would indicate that there has probably been an increase in acceptance of unskilled people.

Table 3
Results of the regressions.

Determinants of probability	**(Model 1) Use of e-ID**	**(Model 2)**	**(Model 3)**	**(Model 4)**
Perceived Usefulness				
Job relevance	22,021551 (699,6086)	23,136954 (1363,101)	22,341924 (1037,13)	21,6488 (758,2756)
Output quality	-0,00579608 (950,3869)	-0,00889801 (1741,453)	-0,00905827 (1275,108)	-0,00760658 (912,6311)
Perceived Ease of Use				
Computer Self-Efficacy	1,0798665*** (0,0518743)	1,2779851*** (0,0555922)	1,0829723*** (0,0523445)	1,2645441*** (0,0559251)
Perception of External Control	0,83408852*** (0,0510666)	0,67023754*** (0,0530274)	0,80989432*** (0,0514467)	0,66400263*** (0,0532383)
Computer anxiety	1,3674816*** (0,0570455)	1,355145*** (0,0574486)	1,3939884*** (0,0578063)	1,3754488*** (0,0581622)
Trust on Internet			0,20536213*** (0,0433149)	0,15604053*** (0,0438807)
Devices/Internet costs			0,49824138*** (0,1185476)	0,46365689*** (0,1198108)
2017	0,80453733*** (0,0839833)	0,8214479*** (0,084526)	0,8036497*** (0,0841433)	0,82011377*** (0,0846155)
2018	0,77760007*** (0,0878128)	0,81607194*** (0,0883042)	0,80278759*** (0,0879804)	0,83432786*** (0,088411)
2019	0,79818543*** (0,0917931)	0,85962255*** (0,0925265)	0,83131506*** (0,091988)	0,881621*** (0,0926293)
2020	1,0868223*** (0,0898728)	1,1588804*** (0,0908449)	1,0420456*** (0,092927)	1,1032896*** (0,0939335)
2021	1,1071581*** (0,093274)	1,2149553*** (0,0943459)	1,1708705*** (0,0940838)	1,2552839*** (0,0949103)
Age		-0,01119681*** (0,0016575)		-0,00992534*** (0,0016718)
Gender		-0,00315762 (0,0098422)		-0,0014323 (0,009872)
Level of education		0,12330362*** (0,0127776)		0,11889951*** (0,0128342)
Pseudo R-squared	0,5847	0,5903	0,5573	0,5625
Log likelihood	-5185,0761	-5115,5526	-5146,5987	-5086,3689
Wald F-statistic	14600,06***	14739,11***	12958,56***	13079,02***
Observations	98,932	98,932	73,406	73,406

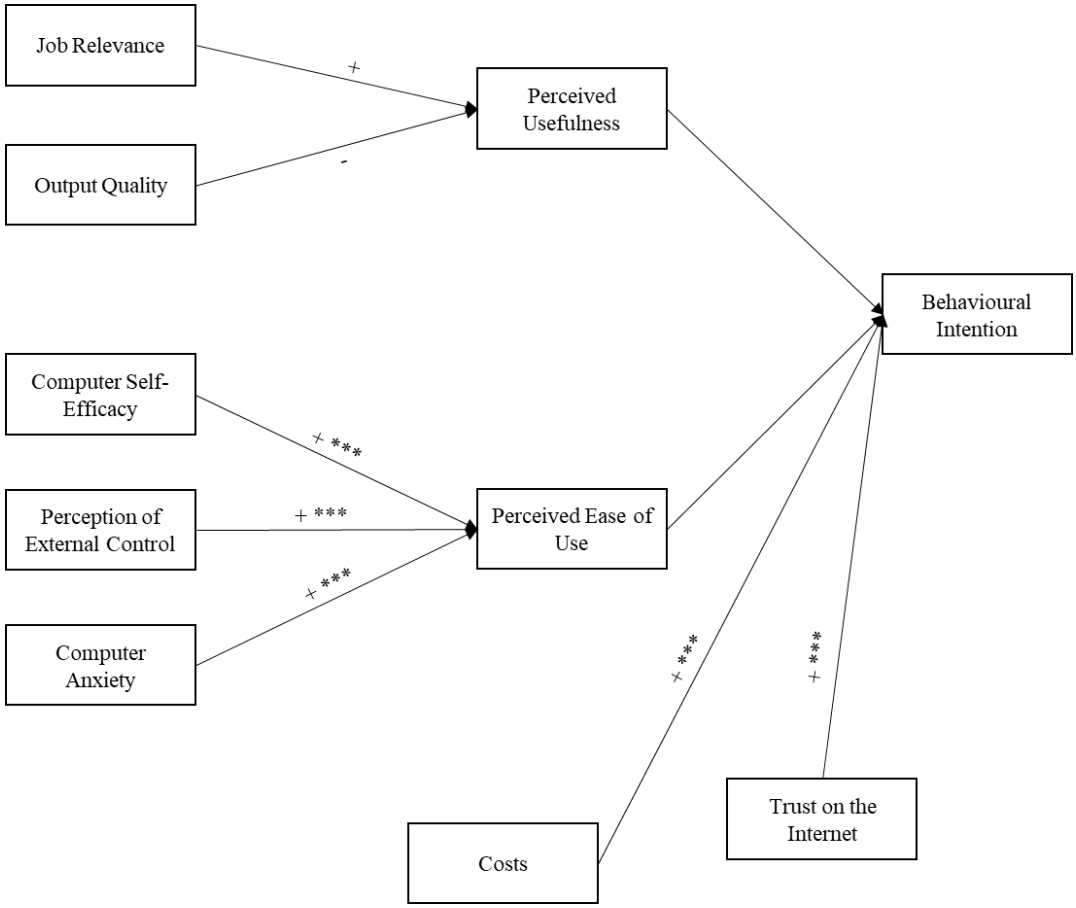
Source: own elaboration. Estimation performed with the statistical software package Stata. Standard deviation in brackets. * p<0,1; ** p<0,05; *** p<0,001. From 2016 until 2021.

Cost is another variable which affects the probability of using e-ID in the opposite way than was expected. The more costly it is for someone to use e-ID, the more probable it is that they intend to use it. As before, it can be understood that in truth costs affect the probability of having problems while trying to use e-ID, and that from there it can be inferred that the probability of intending to use increases too. The more costly it is for someone to have the gadgets needed to use e-ID, the more probable they will experience trouble while trying to use it, be it because they cannot afford to have a computer or internet connection to perform the necessary procedure online, or because they do dispose of an electronic ID reader, but that would mean that still those people with less resources would be trying to use the electronic ID. That would indicate that there has probably been an increase in acceptance of citizens with limited resources. The result of confidence on Internet, as expected, is positive. That means that the probability of using e-ID increases with the more trust citizens have on the Internet. If people confide in the information, they find online and in the processes they can carry out through Internet, then it will be more probable that they decide to hand in forms through Internet using their e-ID.

The year dummies are all statistically significant and positive which means that compared to 2016, which is the baseline year, the probability of using e-ID increased for time-specific reasons. For example, the National Police estimated that "normal" IDs would persist up until 2017, but from that year onwards only e-IDs would be valid (Europa Press, 2009b). Apart from that, the COVID-19 pandemic in 2020 that caused Social Security offices to shut down, which meant that public sector procedures could not be done in person (La Moncloa, 2020), or the establishment of an "appointment" to go to public service offices after COVID-19, which reduced the capacity of people that could carry out procedures in person (Revista Seguridad Social, 2020). Events like these can have increased the probability of intending to use the e-ID along the years.

Results hold when control variables are included. Gender is not statistically significant, which means it does not affect the probability of using e-ID. That could be caused again for the compulsory nature of the technology, which means everyone, whether they are male or female will not have another option but to use it if they need it to interact online with the public administration. Age negatively affects the probability of using e-ID, which means that the older the citizen is, the less probability he will have of intending to use this technology. Level of studies affects positively the probability of using e-ID, which means that the more educated the citizen is, the more probable it is that he intends to use this technology.

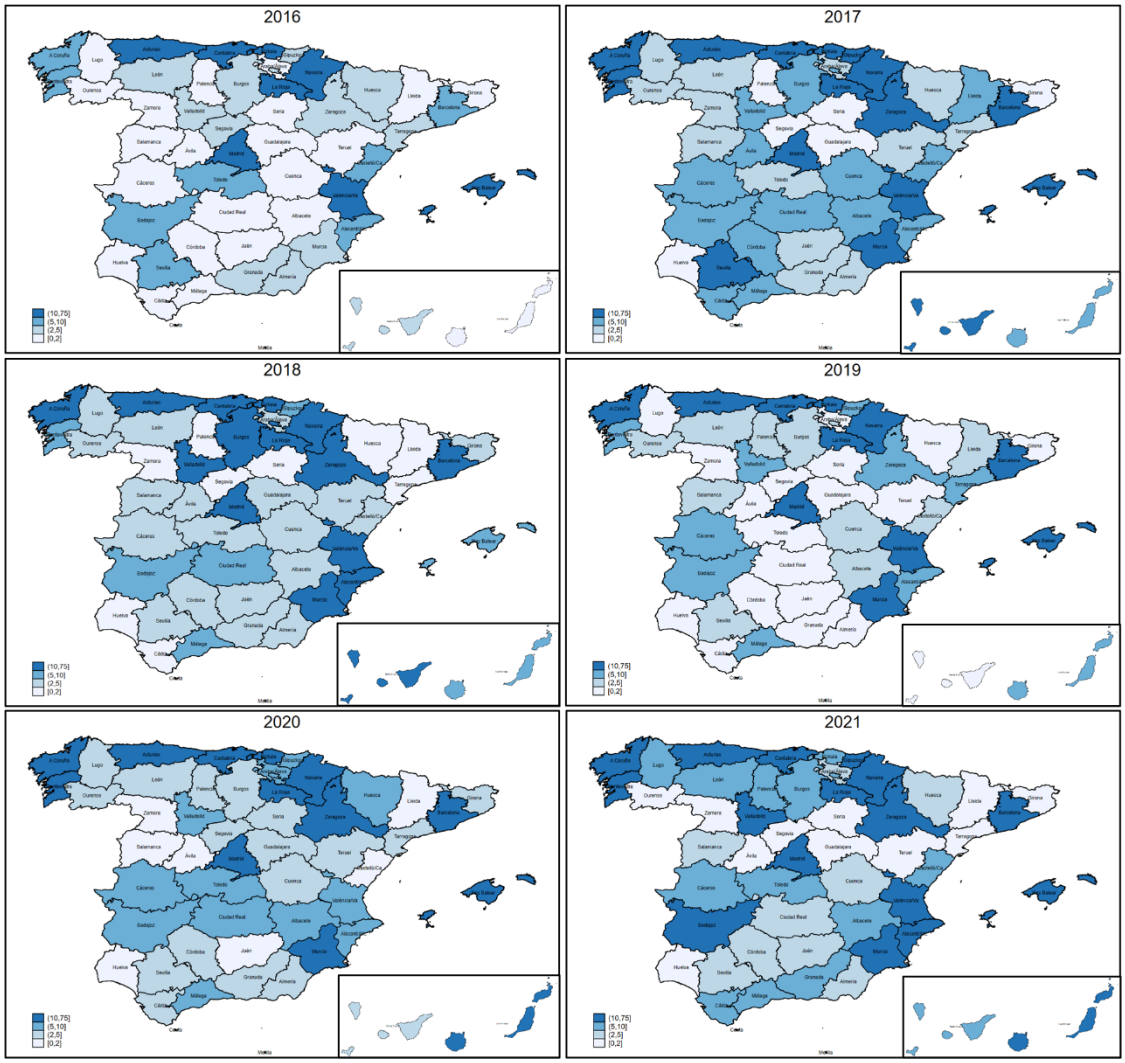
Figure 10: Model used to perform the analysis with effect results.



Source: own elaboration

But the use of e-ID might be affected too by geographical factors. The size of the province could determine the number of resources that the public sector has available to offer better IT services. Therefore, province size can affect the public acceptance of e-ID. For that a spatial analysis of the use of e-ID per year has been carried out. In the results the provinces with the highest number of citizens who intend to use the electronic identity tends to remain mostly constant. There are more changes between the provinces with the least number of citizens who intend to use the electronic identity, though still there are some provinces like Girona, Zamora, Ávila or Soria that appear constantly as some of the provinces with the less intention to use. Another interesting trend to observe is how the use of e-ID seemed to accelerate from 2016 to 2017, but from there until 2019 there was a steady decline instead of a continuation of growth. That trend reversed again at the start of 2020. This could be due to the breach in security that was detected in at the end of 2017 and that caused the National Police to deactivate the electronic identification system, which could have caused people to lose confidence in the technology and therefore to reduce the use of e-ID up until 2020 when the COVID-19 pandemic started (Expansión.com/EFE, 2017). As mentioned before, due to the pandemic the Social Security offices closed, which meant citizens could only contact the public administration online. For that they needed to identify themselves with the e-ID, which again would increase its use (La Moncloa, 2020).

Figure 11: use of e-ID by province (2016-2021)



Source: own elaboration. Estimation performed with the statistical software package Stata.

Observing the graphs, it seems indeed like provinces with most inhabitants per km^2 like Madrid, Barcelona, Bizkaia, Gipuzkoa or Alicante are the provinces with the highest use of e-ID. On the other hand, the smallest provinces like Soria, Zamora or Ávila are the ones with the lowest use of e-ID. The rule not always apply though, as it can be seen with the cases of Girona which has been always between the list of provinces with the less use of e-ID or Cádiz and Sevilla, which during a couple of years were part of the provinces with the highest use of e-ID (2017 and 2018 for the former; 2016 and 2017 for the latter). Despite this, it can be said that it cannot be discarded that province side effects intention to use electronic identification, and this could be due to the fact that bigger provinces are the ones that tend to be more industrialized and more populated while the smaller provinces tend to be more rural, which then affects the degree of digitalization of the province and the IT resources available to the public sector.

6. Discussion

The results obtained in the analysis show that Perceived Usefulness does not affect the probability of intending to use e-ID, but perceived ease of use does increase such probability. Both costs and trust on Internet affect positively the probability of using the technology too, as well as province size. However, these results do not always coincide with what was hypothesized.

Firstly, in the literature it is mentioned how normally the significance problem comes from ease of use rather than usefulness. Malatji et al. (2020) mention how one of the most important critiques toward the TAM model was that the former variable did not always turn out to be statistically significant when studying intention to use. But in the results of the study of the probability of use of e-ID in Spain the opposite applies, which contradicts the first hypothesis of the study which predicts that perceived usefulness has a positive effect on the probability of using e-ID. That could denote some differences between compulsory technology and elective one, since in the study of Tsap et al. (2020), where the acceptance of Estonian e-ID was analysed (which is compulsory too), showed that ease of use was the most important determinant of opinion. If someone chooses to use a technology but has the option not to, it makes sense that usefulness plays an important role in determining the acceptance. And it makes sense that its effect will be bigger than the one of ease of use. Even if a technology seems complicated to use, people can learn how to use it if they are interested in it, but if it is not useful, people will disregard it from the beginning. But this changes if people have no other option but to use a certain technology to an end. Usefulness will then not be as important as expected, and the main factors that will determine if people have a positive opinion of the technology or not depends on how much effort they need to invest in using it.

The second hypothesis of the study, which predicts that perceived ease of use has a positive effect on the probability of using e-ID, seems to hold since all factors determining ease of use affect positively the probability of using such technology. But there is a nuance. When operationalizing the variables, it was mentioned that Computer Self-Efficacy and Computer Anxiety were coded in the reverse way than expected, which means they should affect the probability of using e-ID in the opposite way. This means that H2 cannot be fully accepted, only for Perception of External Self-Control. This may seem surprising, but if the literature review is analysed some precedents can be found for the results of Computer Anxiety. In this study, security concerns were used as a proxy for this variable. Even if most papers state how security is one of the most important variables affecting acceptance, with opinions turning negative if it jeopardized, Goodstadt et al. (2015) already mentioned how in their study of e-ID in Hong-Kong how the thread to privacy that the technology represented seemed to not affect intention to use. Still, Goodstadt et al. (2015) described this result as a consequence of Hong-Kong historic past and related it to the fact that e-ID had not been heavily promoted by the government. This clashes with the Spanish case, were

the government even created a marketing campaign to promote its use back in the late 2000s (EFE, 2010; Europa Press, 2009a). As mentioned above, the result could maybe be affected by the measurement of the dependant variable, that was determined in base of the people who had trouble while using e-ID, so maybe the increase of computer anxiety affected the probability of having trouble rather than the probability of intending to use, which would be a result more understandable.

Computer Self-Efficacy was not given much important in the papers analysed. Only Chan et al. (2010) touched briefly upon it, pointing it out as a determinant of effort expectancy and facilitating conditions. Therefore, it is difficult to say if the result is exclusive of this study or if there have been other instances when feeling like lacking knowledge to use a technology was seen as a factor increasing the intention to use. As mentioned above, it could be the same case as for Computer Anxiety, with the variable affecting the probability of having trouble while using e-ID rather than the probability of using such technology. But again, it could be a result influenced by the mandatory nature of the electronic identification. If people are obliged to use it but they do not have the endowments to do so, they may be interesting in incrementing their e-ID use to master the process for the time when they actually need to use it to interact with the public administration for important tasks such as asking for benefits or grants.

Perception of External Self-Control is the only variable of ease of use that affects the probability of using e-ID as expected. Besides, this result is heavily backed by the existing literature. Harbach et al. (2013) mentioned how in Germany the fact that people did not have a set idea of where to use e-ID was proving to be detrimental to the citizen's opinion of the technology. And Chauhan & Kaushik (2016) pointed out how the intricacy of enrolling for Indian e-ID was affecting the acceptance of such technology. Besides, Joinson (2009) pointed out too how the government should aim to design technology in a way that allowed people to feel like they had the control of the technology and process, and Lips et al. (2020) mentioned how the lack of a set assistance service contact point was detrimental for the eIDAS scheme. Therefore, it seems clear that the government should make sure to present the e-ID scheme as transparently as possible and to make available an assistance service to help people who are struggling. For this last point, the Spanish National Police offers a phone or email service to help with "any type of incident relating to the DNI" (Cuerpo Nacional de Policía, n.d.-c), which seems to be a point in favour of the e-ID scheme.

As a contribution, costs and trust on the Internet were added to the original TAM-3 model as variables that could affect behavioural intention to use e-ID. The results on costs contradict the third hypothesis, which predicts that the more costly it is for someone to use digital devices the less probability they will have of using e-ID, since the results show that costs affect positively the

probability of using e-ID, which would mean that the higher the costs the higher the probability of use. That once again goes against what was found in the literature review. Harbach et al. (2013) mentioned how the e-ID lector prevented people from wanting to uptake the technology, since citizens thought its cost was higher than its added value. The Spanish case should be similar, since to use the e-ID one of the requisites is to have an e-ID lector. But the difference may reside in the fact that with the 3.0 e-ID the lector can be exchanged by an NFC-enabled device. This are more costly, but at the same time can have more added value, since these devices are usually mobile phones or tablets, so they can be used for more tasks than just using the electronic identification. It is true though that Yeow et al. (2007) identified the cost of upgrading as a barrier for e-ID, but in this case there is too one important difference with this study. Yeow et al. (2007) analysed barriers for this technology in Malasya, which is a developing country, back in the late 2000s. That means that the cost of upgrading was probably higher than it is in Spain in the late 2010s, which then could change the results obtained. For trust on the Internet, the hypothesis which predicts that the more trust on the Internet the citizens have the more probability they will have of using e-ID is accepted. This result coincides with the results of most studies, with Tsap et al. (2020), Harbach et al. (2013), Chauhan & Kaushik (2016), Chan et al. (2010) all pointing out toward the importance of trust for citizen's acceptance of e-ID.

Finally, the last contribution made in this study was the spatial analysis of use of e-ID in the provinces of Spain along the years to test the hypothesis that province size has a positive effect on the probability of using such technology. Except in some cases, generally the last hypothesis made is accepted, since it seems that indeed the largest provinces (with size measured by population density) are the ones where the technology has been used the most. It is true that during the years the evolution of intention to use has not been steady. A negative trend can be observed from 2017 to 2019 and again from 2020 to 2021, but that does not change the fact the highest use of e-ID happened at the largest provinces. If we look at the five largest provinces (excluding Ceuta and Melilla, whose population density is a bit distorted due to their minimal surface) Madrid, Barcelona, Bizkaia, Gipuzkoa and Alicante are always in the top categories of use of e-ID. This territorial study of the use of electronic identification is a new approach which has not been touched upon in the revised literature, but it brings on an interesting aspect to bear in mind in technology acceptance studies.

After observing the results, it can be said that this thesis can pose a practical contribution to the public sector. As it was mentioned at the beginning, Internet can be an unsafe environment. This is something that not only affects the public administration, that needs to find a way to identify who they are interacting with, but that affects users too. The results show that citizens will be persuaded to use e-ID if they do not trust enough the online transaction channel that the electronic ID provides. That means that civil servants in charge of designing and implementing the

technology should focus on creating a scheme as secure as possible and of doing so with transparency so citizens can check what happens with their data and who has access to it. Besides, the scheme design should be as simple as possible, so citizens can feel like they know how to use the e-ID and what the process consists of, and there should be some assistance email or phone in case some doubts arise while citizens are using it. That should be useful to increase citizens' feelings of external self-control and trust, and as seen in the results that will lead toward an increase in public acceptance and therefore adoption.

And because this thesis focuses on the Spanish case, it can pose some practical contributions for the country as well. The results show that costs are not as significant a barrier as expected, which means the current lack of adoption seems to be less centred on the need to use external devices. That means that, despite a platform like Cl@ve can help the scheme to gain popularity if related to e-ID, it should not be the focus of the civil servants in charge of implementing the technology. But the result that holds the most important contribution for the country is that of the spatial analysis. Since it has been observed that bigger provinces have higher adoption, the public administration should focus on promoting e-ID in the smaller provinces. Since those tend to be more rural or have less resources Spanish public servants should take measures, such as implementing training courses or installing a physical assistance service area, to get the citizens of those provinces to comprehend better how to use the electronic identity. That could mean an improvement in ease of use, and, therefore, an increment of adoption.

7. Conclusions

Electronic identification is becoming an important tool in an increasingly digitalised world. It can help to defeat online anonymity, which is an essential aspect in order to contact the public administration through the Internet and streamline the application for subsidies and grants. That is why it is important for citizens to have a positive opinion of this technology and for them to be willing to use it. And this is why it is relevant to identify which factors affect citizen's opinion of e-ID, which leads toward the main research question of this thesis: what are the factors that affect public acceptance of e-ID?

To study this, the different technology acceptance theories have been reviewed in order to find the most fitting one to carry out this research. The elected model was TAM-3, since it is the most updated version of TAM, which currently is the most used theory out of all the examined models. Still, there is evidence that TAM-3 is not yet a perfect model and can be improved. Because of that, two variables were added to the original model: costs and trust. These variables appear mentioned in the literature related to factors that affect uptake and opinion of e-ID and have a theorical base which can explain why indeed they need to be taken into account when trying to understand what the public thinks of this technology. Besides, as a contribution to the study of

factors that can affect the use of e-ID a spatial analysis was performed, since there is evidence that bigger provinces have bigger governments, which leads to more technological resources available.

To perform the analysis, data from the Spanish National Statistics Institute was acquired. That is because Spain presents a unique case when it comes to the e-ID. While their level of public sector digitalization is quite high, placing the country quite high in various digitalization rankings, it does not seem that citizens are that attracted to the use of electronic identification. Even though there is a lack of data regarding uptake of e-ID during the 2010s, the data available from 2009 and 2010 makes it clear that the technology was implemented with little success. The timeframe of the study corresponds to the years when the 3.0 e-ID was being issued. That means that the database is formed by observations from 6 different waves, from 2016 until 2021 and that the analysis performed was a longitudinal one.

The results show that while perceived usefulness determinants seem to not influence intention to use, perceived ease of use determinants do. That highlights that it is more important for the technology to not be complex rather than useful, a conclusion which may be affected by the fact the e-ID is of compulsory use in Spain. Besides, the added variables are statistically significant too and have a positive effect on the probability of using the technology, which emphasizes the fact that TAM-3 can still be improved and does not take into account all variables that can determine technology acceptance. The spatial analysis also contributes to the research question, showing that the use of the technology is affected too by province size, something that had not been contemplated before in any e-ID implementation study.

These results can lead to some policy implications. The bodies in charge of implementing e-ID should invest in making this technology as secure as possible. This is something that is already being tackled with the eIDAS regulation, but it should still stay as one of the main priorities to get people to trust the technology, which will lead to a higher acceptance. Besides, as it has been mentioned before, it is important to create a simple system that allow citizens to feel like they have the control of the process rather than feeling lost, and to provide the user with an assistance service to help in the event that something goes wrong during the process or the citizen has doubts. This should lead toward the improvement of the system which should improve people's opinion on e-ID.

It must be said that this research is not without limitations. Some variables were omitted from the original TAM-3 model because they did not fit the framework of a compulsory technology, but it could still be interesting to see how the full model would turn out with those added variables. This could not be done in this study due to data limitations. Since the data comes from a survey designed by the European Union, there were some aspects of the TAM-3 that were not

contemplated in the questions and that limited the scope of the analysis. The variables, even the ones that were included in the model, needed to be selected in base of pre-existing data. That too includes limitations for measuring exactly how many of the respondents used e-ID in order to contact with the administration, being only to only count those who had problems while trying to use it. Besides, the data limitations go beyond the Spanish questionary, since it was not possible to obtain the datasets from other European countries that conduct the same survey. That put a limitation to the research since it did not make it possible to compare the Spanish results with other country's results to see if the results hold or were more heterogeneous.

Therefore, as future lines of research it would be interesting to replicate the study performing a cross-country analysis with the "ICT usage in households and by individuals" survey microdata. Furthermore, it would be interesting to then test those results with a more thorough analysis that would include all TAM-3 variables plus the added ones, to see if despite the technology seemingly not being affected by image or subjective norm or computer playfulness this determinant could have an impact on the outcome. As a final point, it would be interesting to replicate the spatial analysis across Europe, since it is a line of research that has not been much exploited in current research. That type of study would be useful to see if there is any existing correlation between countries' public acceptance of e-ID and if there any technological spill over effects.

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Appendix 1

Table 1:
Province size measured by surface, number of inhabitants and population density.

Province	Surface (km^2)	Number of inhabitants	Population density (People/km^2)
Melilla	13	82.810	6370,01
Ceuta	19	82.147	4323,53
Madrid	8.028	6.825.005	850,15
Barcelona	7.728	5.658.399	732,19
Bizkaia	2.217	1.135.269	512,07
Gipuzkoa	1.980	714.907	361,06
Alicante/Alacant	5.817	1.923.000	330,58
Santa Cruz de Tenerife	3.381	1.102.341	326,04
Palmas, Las	4.066	1.159.314	285,12
Balears, Illes	4.992	1.232.270	246,85
Valencia/València	10.776	2.600.794	241,35
Málaga	7.308	1.722.389	235,69
Pontevedra	4.495	943.474	209,89
Cádiz	7.436	1.260.204	169,47
Coruña, A	7.950	1.122.033	141,14
Sevilla	14.036	1.963.000	139,85
Murcia	11.313	1.531.141	135,34
Girona	5.910	783.420	132,56
Tarragona	6.303	828.810	131,49
Cantabria	5.321	585.222	109,98
Araba/Álava	3.037	331.103	109,02
Asturias	10.604	1.005.397	94,81
Castellón/Castelló	6.662	582.435	87,43
Almería	8.775	729.201	83,10
Granada	12.647	932.249	73,71
Valladolid	8.110	518.950	63,99
Navarra	10.391	661.831	63,69
Rioja, La	5.045	316.806	62,80
Córdoba	13.771	776.582	56,39
Zaragoza	17.274	959.471	55,54
Huelva	10.128	533.989	52,72
Toledo	15.370	712.473	46,35
Jaén	13.496	620.763	46,00
Ourense	7.273	303.961	41,79
Lleida	12.173	439.507	36,11
Lugo	9.856	323.984	32,87
Badajoz	21.766	666.266	30,61
León	15.581	451.210	28,96
Salamanca	12.350	326.081	26,40
Albacete	14.926	387.969	25,99
Ciudad Real	19.813	489.755	24,72
Burgos	14.292	352.331	24,65

Segovia	6.921	153.994	22,25
Guadalajara	12.214	268.861	22,01
Ávila	8.050	159.318	19,79
Palencia	8.052	157.205	19,52
Cáceres	19.868	385.472	19,40
Zamora	10.561	167.363	15,85
Huesca	15.636	222.713	14,24
Cuenca	17.140	198.991	11,61
Teruel	14.810	133.338	9,00
Soria	10.306	89.519	8,69

Notes: the table is ordered from highest to lowest population density.
Source: own elaboration with data from "Población residente por fecha, sexo y edad" by INE (2022) and "Biodiversidad y Bosques - Estadísticas básicas" by Ministerio para la Transición Ecológica y el Reto Demográfico (n.d.).