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When citizens adopt the “e”: conditions for high usage rates of public e-services among the EU-27 national states

MA Thesis

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Authorship Declaration

I have prepared this thesis independently. All the views of other authors, as well as data from literary sources and elsewhere, have been cited.

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Abstract

Public e-services are generally considered to be rather on the later side of adoption in comparison to other digital innovations. However, their usage rates vary significantly across different national contexts. This study seeks to explain these substantial differences in public e-service usage rates among the EU-27 member states. Drawing on the diffusion of innovation theory, four main conditions (service accessibility and quality, digital literacy of citizens, perceived usefulness by citizens, and trust in public authorities) for high public e-service usage rates are identified. Utilizing a newly constructed dataset with data provided by the EU for 2021, a fuzzy-set Qualitative Comparative Analysis (fsQCA) is conducted. The results indicate that the identified set of conditions is highly sufficient for high public e-service usage rates to occur, demonstrating a strong and reliable model fit within the EU context.

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1. Introduction

"The Internet has been the most fundamental change during my lifetime and for hundreds of years" (Murdoch, 2010). This quote by the famous business magnate Rupert Murdoch, who can already look back on more than 90 years of life experience, is supported by decisions taken by billions of people every day. They send e-mails instead of letters, buy tickets online instead of at the counter, read news via the internet instead of in newspapers. The rapid digital transformation has reshaped not only individual behaviors but also entire industries and societal structures. E-commerce has revolutionized the retail landscape, making traditional shopping experiences almost obsolete for some, while online banking and digital payment systems have redefined financial transactions, enhancing convenience and accessibility. Educational institutions have embraced this shift as well by enabling remote access to instructions and resources via e-learning platforms, thereby allowing knowledge to spread across former social cleavages. However, this transition is not uniform as some former only analog activities which can now also be done online get adopted faster in its digital use than others.

Referring to this diffusion, public e-services have been witnessed to be rather on the later side of adoption (Distel, 2020). In 2021, only 44 percent of citizens of the European Union (EU) submitted official forms to public authorities via the internet during the last twelve months (Eurostat, 2024a), while 74 percent bought goods or ordered services for private use online in the same timeframe (Eurostat, 2024b). However, these usage rates of online form submission to public authorities differ significantly among the 27 EU member states. Whereas almost 80 percent of Swedish citizens used such services, less than nine percent of Romanian citizens did so (Eurostat, 2024a). Considering the common policy framework of the EU, highlighted in this context by the Single Digital Gateway (SGD), the question of why there is such high diffusion in the adoption rate across countries within the EU arises. In this thesis, I will try to give answers in addressing the research question:

How can differences in usage rates of public e-services
among the EU-27 countries be explained?

The vast majority of former research about determinants of the adoption of public e-services is conducted on a user-level and mostly in only a single jurisdiction, thus identifying why some citizens adopt the national public e-services while others do not. Identified factors in such works among the EU national states include sociodemographic factors such as age (Solvak et al., 2019) as well as individual skill factors like different levels of digital literacy (Delopoulos,

2010), and personal perceptions, such as perceived convenience (van de Walle et al., 2018), and trust in the services (Colesca, 2009).

Now, when trying to explain differences not on an individual but on a country-level, some of these factors are likely still relevant but additional ones must be added. In a country-level regression analysis among all the EU countries, Seri et al. (2014) identified broadband penetration, the education level, and the extent of corruption in a country as determining factors for the adoption rates of public e-services. Furthermore, by also applying a regression model, Stephany (2020) found that the levels of trust in the legal institutions and the population size of a country plays a distinctive role, while Yera et al. (2020) pointed out the significance of service availability and quality.

This work aims to enrich this existing literature by adding a new piece to the research puzzle through the application of a distinct conceptual framework based on the diffusion of innovation theory. In addition, a different methodological approach in the form of a Fuzzy-set Qualitative Comparative Analysis (fsQCA) will be used. This methodology combines qualitative and quantitative approaches to analyze complex causal relationships. In contrast to regression analysis, fsQCA therefore allows for the combination of conditions to evaluate if they are sufficient for the outcome to occur, rather than assessing the effect of each predictor independently. Hence, this approach entails greater flexibility in explaining why some countries have high usage rates of public e-services while others have low usage rates.

The following sections of this thesis will therefore proceed as follows. First, I will define and clarify what public e-services are and how they can be understood within the context of this study. To identify causal factors for the varying degrees of their use among European countries, I will then introduce the diffusion of innovation theory, originally established by the American sociologist Everett M. Rogers in 1962. Building on this theoretical foundation, two conceptual frameworks will be constructed to guide the subsequent fsQCA analysis.

The main steps to conduct such an analysis will then be explained, alongside a more in-depth description of how this methodology enables me to address the stated research question. This will also include a detailed explanation of the data collection process, the calibration of fuzzy-set scores, and the assessment of the output of a fsQCA analysis. Following this, the actual results from the fsQCA analysis will be presented and discussed in order to identify patterns that can explain differences in usage rates of public e-services among the EU-27 countries.

Finally, the discussion will highlight the theoretical and practical implications of the findings, offering insights into potential paths for future research. This will help to further enrich the understanding of the diffusion of public e-service adoption rates within the common EU framework. Through this comprehensive approach, this study seeks to contribute to the growing body of knowledge on digital transformation and public e-service adoption at the country level.

2. Conceptual and theoretical basis

In order to explain differences in the adoption rates of public e-services among EU member states, the following chapter will first discuss how public e-services can actually be defined in a conceptually robust way. The same also accounts for the concept of public e-service users which will not only be introduced and defined but also differentiated on the basis of two varying levels of maturity. After that, I will present and explain the core elements of the diffusion of innovation theory which will later on serve as the theoretical grounding for the identification of conditions that are assumed to have an effect on the usage rates of public e-services. Lastly, the two core conceptual frameworks derived from this chapter and applied in the later analysis will be introduced and explained.

2.1. Public e-services

Although most people might have a good general idea, defining what digital public services precisely are is all but simple. A first difficulty that occurs is embodied in the actual wording, as scholars use a variety of different terms for this concept. To only name a selection, the terms "online public service" (e.g., Van Deursen & Van Dijk, 2009), "e-government service" (e.g., Carter & Bélanger, 2005), public e-service (Axelsson et al., 2013), and "digital public service" (Bertot et al., 2016) are frequently used. Very commonly, academic scholars use these terms synonymously and in a self-evident way in their research. However, finding a clear definition of public e-services must be a seen as a very nuanced task on its own, especially in such a dynamically evolving academic field.

This lack of conceptual and terminological clarity in many studies about public e-services is also criticized by Lindgren & Jansson (2013), who refer to this based on findings by Sartori (1970) about comparative politics practices as "conceptual stretching" (p. 164). Deriving from this, the two scholars discuss the concept on the basis of a hermeneutic analysis, arguing for a clarifying multi-dimensional definition of public e-services. They identify three dimensions that characterize this concept: service, electronic, and public (Lindgren & Jansson, 2013, p. 163). In the following, the identified main characteristics of Lindgren & Jansson (2013) serve as the basis for our understanding of public e-services. Nevertheless, also potential conceptual weaknesses and feasibility issues that could derive from an unmodified use of these characteristics for the sake of this research are discussed in order to come up with the applied definition of public e-services in this work.

Unpacking the first dimension of service, Lindgren & Jansson (2013, p. 165f) expound that it is traditionally seen as an activity that assists or supplies a need. Services are therefore not the provision of objects but of performances that practically help the receiving side, making them "intangible" (ibid.). In line with other evaluations of definitions in the academic field of e-government like in a literature review conducted by Yildiz (2007, p. 651), they also clarify that it is very important to be aware about differences in the characteristics of services depending on the relationship between the costumer and supplier (Lindgren & Jansson, p. 165). This aspect will be especially crucial when I get to the user perspective.

Lindgren & Jansson (2013, p. 166) further argue that the main objective of the help offered must be the generation of additional value for the user in order to be understood as a service. Therefore, a service is essentially seen as a value-generating process for the user. However, I want to challenge this one-sided approach in the following as it might not be covering all the intentions of offering services sufficiently. Faulkner et al., (2019) point out that high adoption rates of public e-services can also result in an increased efficiency for the public authorities as fewer physical facilities and public servants might be needed than for the provision in an analog way. In this regard, the service provision would be value-generating for the supply side, too. Lindgren & Jansson argue themselves that through e-services "the relationship between government and citizens becomes an information based relationship" (p. 166). More generally you could say that there is an exchange of data happening when services are used in that way. Considering that data is perceived as "the new gold" (Shubladze, 2023) in the digital era, I argue that public e-services are processes that can generate value for the supply-side, too.

Now, the second dimension of public e-services is the "e", referring to the characteristic that the service is electronic. However, one might ask the question if service provision is nowadays not always electronic as computers are even used in still paper-based processes, for example for the purpose of printing forms. Lindgren & Jansson (2013) do not explicitly state that, but it can be assumed that they do not consider processes where users need to show up at a public office in order to let the public servant type their information into a computer as an e-service. In their definition the two scholars state that e-services are technical artifacts that require interaction and integration with other information systems which are "typically internet-based" (Lindgren & Jansson, p. 167). They do explicitly argue that e-services can possibly also be provided in non-online ways, for example via Short Message Service (SMS) (Lindgren & Jansson, 2013, p. 166).

However, it needs to be considered that their article was written a decade ago and as former highlighted, public e-services are part of a very dynamically evolving academic field. Stating that, internet-based messengers have largely replaced the SMS today (Rohloff et al., 2024). Therefore, I will opt for a narrower definition in this thesis, claiming that e-services are generally internet-based and can be accessed from everywhere. This definition is not only more precise but additionally ensures comparability across the observed cases in this work which will be explained later in chapter 3.1. about the measurements and data sources.

Finally, there is still the "public" dimension that needs to be unpacked before an all-encompassing definition of public e-services can be formulated. Lindgren & Jansson (2013) argue that public services are only those where public organizations act as the supplier, differentiating between "e-business" and "e-government" (p. 167). Public organizations in this regard are all decision-making and organizational bodies that enforce public administration, like ministries, municipalities, and other public authorities (ibid.). In contrast to the private sector, these institutions differ in that they have to follow other principles. They do not serve their own benefit, but the common good, which Lindgren & Jansson (2013) conceptualize as the "public ethos" (p. 167). Public organizations also have a monopoly on their services while private actors are usually competing over costumers (Lindgren & Jansson, 2013, p. 168). However, this also means that users not only cannot opt which service provider they want to use, but also have to make use of some services, for example in the case of taxes (ibid.). All these factors lead to a situation in which both sides are compulsory dependent on each other. Public services therefore entail a distinct legal framework and underlying principles in comparison to private services, affecting their provision.

Out of these considerations, I define "public e-services" in this work as *intangible acts of information exchange between public authorities and citizens over the internet in order to generate value.*

2.2. Public e-service users

Having public e-services now defined in this way, the users of public e-services are citizens. One might argue that public e-services potentially also address businesses. But although both, citizens as well as businesses, are users who might request to use public e-services, their needs and motivations to adopt them differ substantially (see e.g., Holgersson & Karlsson, 2014, p. 398). Hence, for the purpose of precision, this study focusses solely on public e-services in

which citizens act as users, which is also equivalent to the conceptualization by Lindgren & Jansson (2013, p. 163).

Now, according to the Cambridge Dictionary (2024), there are surprisingly many definitions of what a citizen actually means. The definitions usually differ based on if someone is holding the nationality of a country or if the person is living there. As the question of what entails citizenship should not be the focus of this work, I will define citizens as "individuals who live in a specific country and therefore have been given certain rights". This decision is based on the data used later on in this work (see chapter 3) in order to ensure that calculations which are based on population sizes like the usage rates of public e-services can be compared in a reliable way.

Besides the definition of citizens, another aspect I want to shed light on is derived from the former considerations about who receives value from the use of public e-services. I already made the case that besides citizens, also the public authorities as the supply side might benefit from the adoption of internet-based services. However, this benefit is heavily relying on whether the information exchange between public authorities and citizens is one-sided or two-sided. In a nutshell, public authorities only value substantially if citizens also submit information to them.

Therefore, it seems valuable to distinguish by two types of usage cases. In an empirical study about the adoption of public websites by citizens of Singapore, Teo et al. (2008, p. 100) conclude that their analysis differs depending on the dimension of usage, thus whether it is so-called "passive" use or a so-called "active" use. While citizens who only use these public websites for "browsing" and "downloading" are seen as passive users, active users also engage in "messaging" and "transacting" with the respective public authorities (Teo et al., 2008, p. 119). A passive user in this regard only retrieves information without submitting information to the public authorities on his own, while an active user is engaged in a two-sided exchange by also sending information. In the study by Teo et al. (2008), the relevance of certain independent variables, like trust in technology and information quality, differ significantly by these two distinguished types of user groups (p. 120f).

In addition, Ma & Zheng (2019) find in a multi-country study about satisfaction among public e-service users that the perceived use is motivated by actual correspondence rather than just by electronic information consumption. Satisfaction in this regard is produced through an exchange of information in the way of form submission to the public authorities (Ma & Zheng,

p. 518f). These two studies underline the value of our former stated aim to encounter if there are major differences in the conditions that are sufficient for high active or passive usage rates among the EU countries.

Deriving from this, two different definitions of users will be applied in this study: *Passive public e-service users are citizens, who obtain information or download forms from public authorities via the internet*, whereas *active public e-service users are citizens, who engage in an information exchange with the public authorities by messaging or sending forms to them via the internet*.

2.3. Diffusion of innovation theory

Now, in order to identify likely conditions that impact differences in public e-service usage rates among EU populations, the diffusion of innovation theory, originally introduced in 1962 by the American sociologist Everett M. Rogers (2003), will be applied. Although Rogers uses primarily innovations in the agriculture business as examples in his original work, the theory also got frequently utilized in existing literature to determine variables that explain different levels of public e-service developments (see e.g., Carter & Bélanger, 2005; Shareef et al., 2011; Seri et al., 2014). Therefore, the diffusion of innovation theory provides a good general guideline when building a comprehensive framework for understanding how innovations, like public e-services, spread not only within national societies but also across different populations.

Unpacking the diffusion of innovation theory, this approach emphasizes that the adoption of new technologies or innovations follows predictable patterns characterized by the "diffusion process" (Rogers et al., 2005). This process is generally taking place in a cumulative s-shape with "innovators" among the population adopting the new innovations first, followed by so-called "early adopters", the "early majority", the "late majority", and "laggards" (Rogers, 2003, p. 247ff). How fast this s-shape reaches full adoption is however guided by the interplay of five key elements: "relative advantage", "compatibility", "complexity", "trialability", and "observability" (Rogers, 2003, p. 210ff). The relative advantage refers to how much a user can profit from adopting a new innovation, regardless of if this profit comes from economic or social benefits (Rogers, 2003, p. 213). In regard to public e-services, one could think of lower time expenditure or more anonymous communication with public authorities as representatives of the relative advantage. However, it is important to mention that for the actual adoption by users it is most important if this advantage is also perceived (Rogers, 2003, p. 218).

The next key element, compatibility, describes how much a new innovation fits the values, needs, and former experiences of a potential adopter (Rogers, 2003, p. 223). For example, if citizens in the past experienced that the level of support in an analog office of a public authority was better than through other digital channels, these citizens might assume that internet-based services are less compatible with their needs. The affinity towards internet-based technology also plays a significant role when it comes to the element of complexity, referring to the degree of how difficult to use a new innovation is (Rogers, 2003, p. 230f). Complexity issues for the use of public e-services could in this regard arise from a lack of service quality or more general a lack of personal knowledge about how to use the internet.

The element of trialability on the other hand is defined by how much opportunity users have to test a new innovation before they need to decide about its long-term adoption (Rogers, 2003, p. 231). In regard to public e-services this element can rather be neglected as public authorities due to their public ethos would very likely not prohibit users from using a service again in an analog way after having tried out the internet-based one before. However, it might still play a role if users have no trust in the public authorities applying this public ethos. The last of the five key elements, observability, is then based on the social dynamics within a society as it refers to the level of visibility of benefits a new innovation offers (Rogers, 2003, p. 232). In the case of public e-services such visibility could be promoted for example through advertising campaigns by the public authorities for the adoption or good service quality. Also, recommendations by citizens who were satisfied with the internet-based services earlier could be a factor in regard to observability.

All in all, the diffusion of innovation theory thus offers valuable insights into potential reasons for differences in the level of public e-service adoption among European countries. Originally established to analyze diffusion factors on an individual level, the theory has especially in recent years also been successfully adopted for country-level studies (see e.g., Seri et al., 2014; Takieddine & Sun 2015; Heiskanen & Matschoss, 2017). Roger's key elements in the adoption process will therefore in the next sub-chapter serve as the theoretical basis for identifying and discussing potential predicting factors for the level of public e-services usage rates among the EU countries.

2.4. Conditions for usage of public e-services

That said, already since the 1990s, numerous scholars have worked on identifying independent variables or conditions that can explain the adoption of public e-services by citizens. Some of the most significant variables that have been found in these studies will be introduced in the following and discussed under the light of the innovation diffusion theory.

2.4.1. Service accessibility and quality

A first and foremost condition is that a public service must be accessible for users via the internet (see e.g., Shareef et al., 2011; Seri et al., 2014; Krishnan et al., 2017; Yera et al., 2020). Most of the reviewed literature does not mention this condition as research is only conducted on a citizen-level in the same jurisdiction. This can be explained by the reflection that the accessibility of a service most likely is not a differentiating variable in these research designs. In the case of a cross-country study, this condition however must be considered as highly relevant in order to develop a meaningful model for evaluating public e-service usage rates.

Nevertheless, it might be tough to argue for a condition that covers only the amount of available services. Through the lens of the innovation diffusion theory, a poorly designed service would not be adopted because citizens would hardly see a relative advantage in adopting such a service. Through the lens of pursued comparability across jurisdictions in this research design, it does not make sense to compare the pure availability without also assessing the quality. To give just a fictional example: If country A has 95 percent of their services available via the internet, but these services are very inconvenient to use, it can still be reasonably assumed that country B with only 50% of services available online, but in a very user-friendly design, has higher adoption rates. Therefore, the quality of the services should play a significant role as well.

This assumption also finds support in existing pieces of literature, which observe that citizens very likely still opt for the analog alternative if public e-services are not designed in a way that makes them easy to use (see Zhang et al., 2015, p. 7.) Thus, the service quality has been proven to also have a significant impact for its adoption by the users (see e.g., Kumar et al., 2007; Shareef et al., 2009; Jansen & Ølnes, 2016). But now, before diving deeper into the theoretical considerations about the linkages between the diffusion theory and public e-service quality, it is a good point to clarify what implications the former outlined differentiation between passive and active users on the service accessibility and quality has.

To remind, I have argued that also the public authorities can value from e-service adoption if citizens decide to correspond actively with them, for example by submitting forms via the internet. However, it needs to be assumed that facilitating this behavior requires special in-place quality measures. To give two examples, in the case of the Hungarian online income tax declaration, pre-filled forms have been proven to increase such active use of public e-services (Aranyossy, 2022, p. 492), whereas in Germany the poor useability of electronic identities (eIDs) is seen as a major reason for low adoption rates of public e-services (Riedel, 2019). Jansen & Ølnes (2016) describe the eID technology and pre-filled forms as key enablers that facilitate the transition of users from just obtaining information to also sending information, or in the words of our conceptualization: to transform them from purely passive users into active users. Quality in this regard is also a proven driver of re-usage of public e-services, leading to a constant preference for the choice of digital instead of analog form submission (Belanche et al., 2014). Therefore, it makes sense to introduce a special condition that specifically supports the two-sided correspondence, like the availability of main IT enablers, when explaining active usage rates. For just obtaining information from public authorities via the internet it could be assumed that these quality measures do not play a role, but for the willingness of submitting forms they do.

After this important differentiation, I now also want to shed some light on how the quality of public e-services is linked to the diffusion of innovation theory. Having mentioned the re-usage just before, this condition has at least some linkages to the trialability element in Roger's theory. That is the case because if citizens try out the internet-based service but find out that its usage does not offer them a relative advantage, they will in future just opt again for the analog service. The accessibility and quality in this regard must be seen as crucial for the perception of users whether it is worth to switch to the online-based service provision. This accounts not only for the element of relative advantage but also for the element of compatibility. If the online support is poor while the former experiences of the analog service are sufficient, citizens are unlikely to adopt the public e-service. The need for support could additionally also result out of too much complexity of the services, meaning a lack of user centricity. For instance, if the used language is very technical, citizens would probably need to seek support by a public servant anyways which harms the advantage of making use of the more autonomous online path. Lastly, a service that is not very accessible to use will not find great support in society, meaning that current users will not have the motivation to recommend its usage in talks with

acquaintances. Therefore, the availability of in-place public e-services will not spread as much as it would likely be the case with services of better quality.

Out of these considerations, I assume that a high general level of service accessibility and quality is sufficient for high active and passive usage rates of public e-services, while additionally a high level of key enabler availability is sufficient for high active usage rates of public e-services.

2.4.2. Digital literacy of citizens

Now, another condition that is frequently identified as a driver of public e-service use, is the digital literacy of citizens (see e.g., Delopoulos, 2010; Nawafleh, 2018; Rodríguez-Hevía et al., 2020). Calling back on the digital diffusion theory, this makes sense in many dimensions. First of all, a citizen will only see a relative advantage in using the internet-based service if he is confident in being able to use it accordingly. Also, the compatibility of public e-services can be assumed as determined by the digital skills of the user. Citizens with higher digital skills are more likely to have already used other digital services like e-commerce shops. These citizens are therefore used to handling their personal matters online and often demand this option also from their public authorities. Additionally, due to their experience with digital tools, these citizens can be assumed to tolerate complexity more likely than less experienced online users.

Deriving from that, I make the assumption that a mature level of digital literacy of citizens is sufficient for high active and passive usage rates of public e-services.

2.4.3. Perceived usefulness by citizens

The next condition I want to introduce is the perceived usefulness of digital tools. Already at first sight, this aligns very well with the relative advantage element of the digital diffusion theory where it is all about the benefits that a new innovation offers. In that sense, users will adopt the internet-based version of public services if they assume that the use is more convenient than the analog one. Supporting this initial finding, also several scholars have shown that if citizens suppose, or maybe even already know, that are service is convenient to use, they are more likely to adopt public e-services (see e.g., Carter & Bélanger, 2005; Horst et al., 2007; Lean et al., 2009; Camilleri, 2020).

Hence, the guiding assumption in this work is that a high level of perceived usefulness of public e-services among citizens is sufficient for high active and passive usage rates of them.

2.4.4. Trust in public authorities

Last but not least, the condition of trust in the public authorities is identified. This condition has its basis rather in the elements of the diffusion of innovation theory that deal with social dynamics. As already hinted before, the triability element might play a role in cases where citizens have a very low level of trust in their public authorities. It might be argued that these citizens then do not make use of services by the state in general. Still, in some cases like taxes they cannot opt. In addition, several scholars have shown that institutions who are seen as trustworthy are more likely to get support and cooperation from citizens, which facilitates the adoption of e-services and reduces resistance to change (see e.g., Teo et al., 2008; Colesca, 2009; Wang & Lo, 2013). Regarding the observability element in the diffusion of innovation theory, this likely entails that citizens with a higher level of trust are not only more willing to obtain official public information instead of from other sources on the internet, but also to positively respond to public campaigns for the adoption of new ways of public service delivery.

Out of these considerations, I assume that a high level of trust in public authorities among citizens is sufficient for high active and passive usage rates of public e-services.

2.5. Conceptual Frameworks for the analysis

Deriving from these former empirical findings and theoretical assumptions, I will now introduce two slightly differentiating frameworks which will serve as the conceptual basis for the analysis to conduct. The differentiation between the two frameworks is applied on the basis of the considerations outlined in chapter 2.4.1. about the service accessibility and quality but will in addition be put to the test in the later analysis. This will be done by also applying the conceptual framework for passive use to the framework for active use, and vice versa the conceptual framework for active use to the framework for passive use. In that way, the analysis will also give insights about if the differentiation between active and passive use of public e-services matters substantially in practice.

2.5.1 Conceptual framework for explaining passive use of public e-services

The conceptual framework for explaining different degrees among countries in the passive use of public e-services, meaning obtaining information from public authority websites and/or downloading forms, consists of four conditions (see Figure 1). First, the accessibility and quality of public e-services in a country because citizens only see a relative advantage in using online services if they are designed user-friendly. Second, the digital literacy of citizens as pre-knowledge in handling digital devices is needed in order to be able to use the available services. Third, the perceived usefulness by citizens as they will only adopt public e-services if they believe in benefiting from it. And forth, the trust among the population in public authorities because information gets only retrieved from sources people believe in. All in all, I assume that differences in passive usage rates of public e-services among the EU countries can be explained by looking at the level of service accessibility and quality, digital literacy of citizens, perceived usefulness by them, and their trust in public authorities.

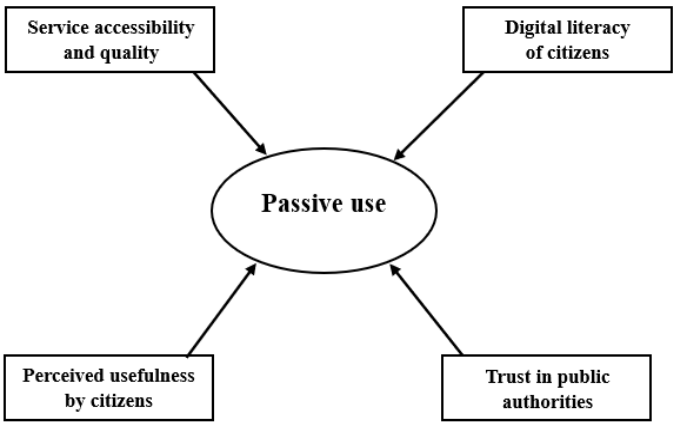

Figure 1: Conceptual framework for explaining passive use of public e-services

2.5.2. Conceptual framework for explaining active use of public e-services

The conceptual framework for explaining different degrees among countries in the active use of public e-services, meaning the active provision of information to public authorities via the internet, consists of the four conditions also included in the framework for passive use plus additionally the condition of in-place key enablers (see Figure 2). The service accessibility and quality condition is again crucial because as much as user-friendliness is important in the presentation of information, it also is when citizens communicate with

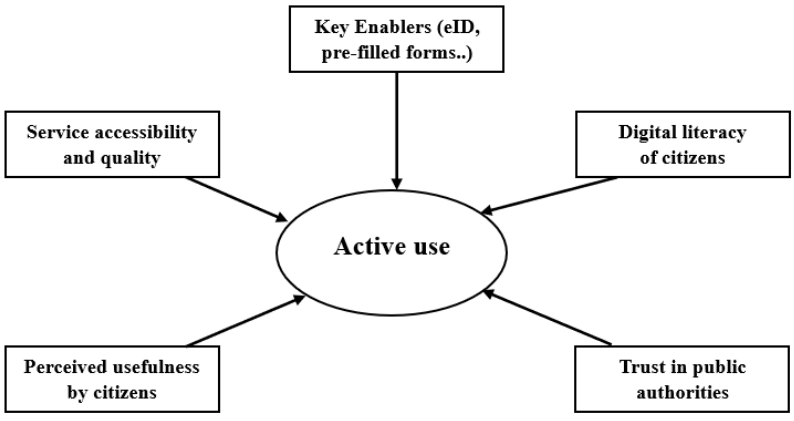

Figure 2: Conceptual framework for explaining active use of public e-services

public authorities online and send forms. However, in this procedure an additional quality condition comes into play. While the access to websites usually just requires a web browser, actively sending information to the public authority needs additional facilitators like secure identification methods such as the eID or automatized help with complicated documents like pre-filled forms. Therefore, this additional condition is added to the framework alongside the other conditions of digital literacy, perceived usefulness, and trust in public authorities. All in all, I assume that differences in active usage rates of public e-services among the EU countries can be explained by looking at the level of service accessibility and quality, availability of key enablers, digital literacy of citizens, perceived usefulness by them, and their trust in public authorities.

3. Research design, data, and methodological approach

Having developed these conceptual frameworks and expressed my assumptions, the following chapter will outline how they are applied in an empirical research design. Hence, the data which is used to measure the variables from the conceptual frameworks in each country of the EU-27 will be presented and explained. I will also introduce the methodology of fuzzy-set Qualitative Comparative Analysis (fsQCA) and describe why this approach is chosen for the purpose of this thesis. Furthermore, not only the underlying procedures to put the frameworks to the test with fsQCA (calibration, analysis of necessity, truth table, and logical minimization) will be explained, but also decisions in terms of measurements and calibration thresholds. For the purpose of transparency, I already want to point out that the data calibration for this thesis is conducted with R, whereas the analyses of necessity and the truth tables as well as their specification are made with the help of the well-established "Fuzzy-Set/Qualitative Comparative Analysis" software developed by Ragin and Davey (2022) in the latest 4.1. version.

3.1. Measurements and data sources

Following up, I will now first explain on which data basis the variables, identified in the second chapter, will be measured. For all variables, existing data published by the European Union will be used. This ensures not only the building of a harmonized set of data across countries, but also in terms of its timeframe to allow for valid conclusions about the interaction between the different variables. Hence, all data used was compiled in the year 2021. The information is retrieved from official websites by organizations of the European Union (see also Appendix A: Codebook) and converted into a newly built data frame for the purpose of this work.

3.1.1. Usage rates of public e-services

Beginning with the measurements of the outcome variables of "active usage rate" and "passive usage rate", the data source for both indicators is a representative survey conducted by national statistical institutes based on Eurostat's annual model questionnaire on "the use of Information and Communication Technologies (ICT) in households and by individuals" (Eurostat, 2023). This survey is conducted every year but as described earlier, the data from 2021 is used here. While the "active usage rate" outcome variable only contains the share of citizens between 16 and 74 years of age who submitted forms to public authorities over the internet in the last twelve months, the "passive usage rate" outcome variable also includes individuals who just obtained information or downloaded official forms from public authority websites during the

same timeframe. Therefore, the differentiation will be in line with the formulated definitions at the end of chapter 2.2.. All data is collected either through face-to-face interviews, online questionnaires or telephone interviews and each countries usage rates are based on at least 50 but usually a lot more individuals, making it a reliable source for the assessment (Eurostat, 2023, 18.3.f). The two scores in the raw data set represent the percentage of individuals who at least once used public e-services passively/actively.

3.1.2. Accessibility and quality of public e-services

Assessing the condition of public e-service accessibility and quality on the other hand, must probably be seen as a bit less straight-forward in a research design that aims to detect patterns for 27 country-level cases. Having stated that, it can be measured in a large variety of ways and to give an example, Halaris et al., (2007) identified not less than 36 different features of quality, although some of them being focused not only on the citizen but also the business user dimension. For the purpose of this work, it is needed to filter for quality factors that are rather easy to access, but at the same time provenly relevant. An enriching path here is offered by the "User centricity" score of the EU eGovernment Benchmark (European Commission, 2023). Former studies show that the measures by this index are highly correlated to other indexes that evaluate different levels of public e-service maturity in countries, e.g., the E-Government Development Index (EGDI) by the UN (Yera et al., 2020, p. 20). The eGovernment Benchmark by the EU is however especially suitable as it not only ensures consistency in the used data sources, but also provides a rich number of sub-categories with respective sub-dimensions, allowing for a more nuanced understanding of public e-service quality.

Talking about nuanced understandings, the sub-category "User centricity" itself consists of three sub-dimensions: online availability of information and services, their mobile friendliness, and the underlying user support (European Commission, 2023, p. 9). In line with our definition of users, only "life events" (see European Commission, 2023, p. 10) of citizens are taken into account, leaving out the perspective of business users. The data scores are generally derived from a mixture of automated tools and the "mystery shopping method" (see European Commission, 2023, p. 16f). This method is a well-established evaluation technique in market research that has also been applied by the EU since 2010 in order to assess service quality in the public sector (European Commission, 2023, p. 16). In the mystery shopping method, individuals get trained to act as prospective users, who observe, engage in, and evaluate service processes. The process involves two primary phases: the landscaping phase, in which the scope and attributes of services are delineated for each country and the evaluation phase, where the

trained individuals proceed to evaluate identified websites using a predefined questionnaire. The quantitative data gathered through mystery shopping then undergoes thorough scrutiny by central experts and member state delegates to verify accuracy (European Commission, 2023, p. 17).

Coming back to the rich number of sub-dimensions of the index, it is also important to note that not all sub-dimensions for the user centricity category ("online availability of information and services", "mobile friendliness", and "user support") are equally important for the score. The availability dimension already accounts for two thirds of the score, while the other third is based to 67 percent on the user support dimension, and to 33 percent on the mobile friendliness of the information and service provision (European Commission, 2023, p. 35). Therefore, the user centricity score provides a good middle way path between availability and quality, however with a bigger emphasis on the availability dimension. In line with our theoretical considerations about the passive usage of public e-services, this score could most likely already be seen as satisfactory, but when it comes to the active usage where forms are being sent, probably a higher emphasis on the quality is needed.

Here, the "key enablers" variable, which is another dimension of the EU eGovernment Benchmark, comes into play as a condition. The scores represent "the extent to which main IT enablers (eIDs, eDocuments, Authentic sources, Digital post and security) are available during services processes" (European Commission, 2023, p. 5). Same as for the user centricity variable before, the extend is measured on the basis of the mystery shopping method and automated tools (European Commission, 2023, p. 16). The dimensions of eIDs, eDocuments, authentic sources and digital post account equally to the scores and are assessed on the basis of technical readiness in the services for the application of these facilitators for submitting forms to public authorities online. To give an example, also the former stated pre-filled forms are covered here by the assessment of the question: "When applying for this service, is personal data pre-filled by the service provider? (based on data from authentic sources such as National register, Tax registers)" (European Commission, 2023, p. 32). As the assessment methodology is again the same for all EU countries, the variable should provide a good way of measuring the extra quality dimension for explaining differences between the countries' active public e-service usage rates.

3.1.3. Digital literacy of citizens

After this clarification of measurements for the accessibility and quality dimension, I will now introduce the basis of "digital literacy" assessment. Again, a source by the European Union is used. This time in the form of the Digital Economy and Society Index (DESI). To measure digital literacy among citizens in the EU countries, the indicator "At least basic digital skills" from the 2022 edition will be used (European Commission, 2022). Based on the same survey questionnaires in all European countries, the scores of this indicator represent the percentage of individuals between 16 and 74 "with 'basic' or 'above basic' digital skills in each of the following five dimensions: information, and data literacy, communication and collaboration, problem solving, digital content creation and safety" in 2021 (ibid.). The results are mostly based on a sample size between 3000 and 6000 individuals for each country (Eurostat, 2024c), making them a very accurate source for assessing digital literacy, which also has been used already for this purpose in former academic research (see e.g., Stofkova et al., 2022).

3.1.4. Perceived usefulness by citizens

Moving on with my measurement clarification, the assessment of the "perceived usefulness" condition is based on the "Special Eurobarometer 518 - Digital rights and principles" (European Commission, 2021a). In this non-regular edition of the standardized Neuromotor opinion survey of the EU, citizens were asked whether they think "the use of digital tools and the internet" will bring them "more advantages or disadvantages" in their life (European Commission, 2021a, p. 2). The scores used for the perceived usefulness condition represent the share of respondents who answered the question with "more advantages than disadvantages" in the conducted face-to-face interviews. These interviews were held in the timeframe September 2021 to October 2021 among at least 1000 randomly selected people aged 15 years and above for each country with the exception of Malta and Luxembourg where 500 people served as the minimum sample size (European Union, 2024). This measurement must be seen as a compromise because the survey question asks citizens more broadly about their perceptions towards digital tools in general and not particularly public e-services. However, with no such specific data being available for the year 2021 among all EU countries, this measurement still offers a good path. Perceived advantages of digital tools may vary depending on the context in which they are used, but there is good reason to assume that there would be a high correlation between the more general perceptions about digital tools and the perceptions towards public e-services. Nevertheless, I want to make sure that this limitation in the used data for the analysis is transparent.

3.1.5. Trust in public authorities

Last but not least, also the "trust in public authorities" condition is based on Eurobarometer data. For this variable, the responses to the "Standard Eurobarometer" question "How much trust do you have in certain institutions? For each of the following institutions, do you tend to trust it or tend not to trust it?" – "The [Nationality] Public Administration" (European Commission, 2020, p. 58). The scores used for the trust in public authorities condition represent the share of respondents who "tend to trust". As three Eurobarometer's were conducted in the timeframe of the usage assessment, the average of those Standard Eurobarometer 93, 94, and 95 makes up the score (European Commission, 2020; European Commission, 2021b, European Commission, 2021c). Therefore, a timeframe between July 2020 and July 2021 is covered with the sample sizes for each country and Eurobarometer version being the same as outlined for the perceived usefulness condition. Now, there might be the question why I opted to assess this condition on the basis of the national public administration and not the government or local authorities which are also assessed in the surveys (see European Commission, 2020, p. 45ff). My consideration behind that is that trust in the government is a lot more volatile and probably based rather on short term decisions by the current government, for example in 2021 the COVID-19 restrictions in a country, in comparison to the more neutral public administration. Also, the public administration represents a good institution for comparing different political systems as responsibilities within them might differ heavily based on the degree of centralization in a country with the public administration however being the state institution that is overall perceived as the main service provider (see Bourgon, 2007).

3.1.6. Dataset and its terminology

Hence, these measurements will be the data basis for the later analysis in this thesis. For more convenience, the variables are named slightly differently in the newly built data frame and the tables that are later on part of the result presentation in this work. The outcomes of passive usage rates and active usage rates are named "passiveuse" and "activeuse". The conditions for service accessibility and quality are named in line with the variable names in the EU eGovernment Benchmark "usercentricity" and "keyenablers". Digital literacy of citizens is named also as in the original dataset "digitalskills", whereas perceived usefulness by citizens is named "usefulness" and trust in public authorities "trust_pa".

3.2. Fuzzy-set Qualitative Comparative Analysis (fsQCA)

After this clarification and presentation of the data sources, I will now dive deeper into the chosen methodology of this work to explain how the analysis can make sense out of this in the

light of my research question. Therefore, a general introduction into the roots and usefulness of fsQCA for the purpose of this thesis will be given, before explaining in depth how the procedures of this methodology function.

3.2.1. Introduction and general considerations

Qualitative comparative analysis (QCA) is a methodological approach that was invented in the 1980s by Charles Ragin (2009) in order to study patterns of association among variables. As the title of his original book 'The comparative method: Moving beyond qualitative and quantitative strategies' (Ragin, 2014) already hints, he aimed to introduce a systematic framework that overcomes the traditional separation of qualitative and quantitative research in social science by integrating strengths of both approaches into a new methodology for the comparison of cases (Pappas & Woodside, 2021, p. 2). Applying the logic of Boolean algebra and set theory, Ragin seeks to enable scholars to identify patterns of associations among different variables with a mixture of quantitative and qualitative techniques (Ragin, 2009, p. 1f). By that means, cases in QCA are conceptualized as sets of attributes, in our case for example: high accessibility and quality of public e-services, low digital literacy of citizens, low perceived usefulness of digital tools by citizens, high trust in public authorities.

In the most basic form, also known as Crisp-set QCA (csQCA), this data is dichotomized into binary categories, where cases are either fully included (1) or fully excluded (0) in set of conditions or outcomes (Denk & Lehtinen, 2014, p. 3479). This binary approach simplifies the analysis by treating variables as either present or absent, with no consideration for degrees of membership or ambiguity. However, Ragin (2014, p. 3) also developed an advanced method on the basis of QCA, allowing for finer gradations in the degree of membership, which will be used in my analysis. This method, called fuzzy-set Qualitative Comparative Analysis (fsQCA) allows for a more nuanced understanding of relations when dealing with variables where a binary classification appears to be inappropriate. At the same time, the results preserve all the robustness and analytical rigor the set-theoretic approach offers (Ragin, 2014, p. 3). For this work, such a more gradual approach makes sense as all variables used are in its raw version of ratio scale level describing complex phenomena. Therefore, they all entail degrees of presence in a country where a dichotomized approach does not allow for the identification of shades of grey.

Now, before resuming with a description of the actual analytic steps in fsQCA, I want to spend some considerations on criticism that might occur from the identified variables in combination

with the chosen methodology. Indeed, fsQCA usually empowers its full advantage from the set-theoretic approach over other methodologies when variables are assumed to be not linearly related to the outcome (Ragin, 2014, p. 15f). However, deriving from the theoretical considerations above I assume that all conditions have a linear relationship to the outcomes. Why is a fsQCA approach then still a worthwhile approach in the light of the aim of this paper?

The first point rather practical point is that a sample size of 27 cases (All EU member states) does not allow for meaningful quantitative analysis in the form of a regression analysis as it would typically be conducted in the case of assumed linearity. However, fsQCA by its nature also conducts a robustness check of the assumed linearity. If the outcome of specific cases derived from the assumed linear conditions is out of line with the linear assumptions, it can easily reveal the need for deeper investigation to get a better generally applicable framework. What makes fsQCA also valuable is that it allows for an understanding of multiple pathways to a sufficient outcome. Therefore, it might reveal that already a limited combination of conditions might be sufficient for achieving high usage rates. Hence, despite the assumption of linear relationships, fsQCA offers a valuable path in analyzing relationships in the case of small sample sizes to test the sufficiency of assumed linear assumptions. Moreover, fsQCA allows for the identification of outliers that need further investigation to strengthen the model and gain deeper knowledge about the determinants of a specific outcome.

3.2.2. The analytic procedures in fsQCA

Continuing with the actual procedures to conduct a fsQCA analysis, the first step is always to calibrate the data, meaning to assign values to cases based on their degree of adherence to each condition and outcome (Ragin, 2009, p. 94f). As already outlined, unlike csQCA, fsQCA also allows for more than two degrees of membership which is very valuable here as all conditions and the two outcome variables allow for this differentiation due to their ratio level scale in the raw data set (see also Table 2 in Chapter 4). However, the choice of how many degrees and especially the chosen thresholds for distinguishing them is very crucial (Ragin, 2009, p. 83f). While a higher differentiation can potentially increase the precision to get a more nuanced understanding, it can also lead to an overfit of the model and difficulties in their interpretation (Ragin, 2009, p. 133). The decision about the number of membership degrees therefore has to be taken on the basis of theoretical considerations, but also the number of included conditions and cases (ibid.).

In terms of the number of conditions our decision is already made by our established conceptual frameworks in chapter two (Figure 1 and Figure 2). With a sample size of 27 cases, the amount of four conditions is seen as the best recommendation by experienced fsQCA scholars, while also five conditions are still seen as appropriate, making the models well-applicable (Berg-Schlosser et al., 2008, p. 20). When it comes to the number of membership degrees, a maximum of four different membership scores is advised in a situation with this sample size (Schneider & Wagemann, 2007, p. 262f). The choice to make is therefore between a three-value fuzzy set or a four-value fuzzy set. Three-value fuzzy sets naturally cause the problem of "intermediate-set membership" (Pappas & Woodside, 2021, p. 10) where cases coded as 0.5 (neither in nor out) get dropped for the analysis. There is a lively debate among scholars whether such 0.5 scores which mark the exact crossover point should be avoided (see ResearchGate, 2022). But especially in situations with a small sample size, it is rather recommended to rule out these droppings from the analysis to ensure meaningful results.

Therefore, the calibration will be based on a four-value fuzzy set, which was formerly applied in numerous other studies among the EU countries (see e.g., Casady, 2021, Marienfeldt, 2021; Scherer & De Ville, 2022). This means that conditions and outcomes can be coded as full-membership (1), rather in than out (0.67), rather out than in (0.33), or non-membership (0). Hence, this differentiation into four values applies best practice from former research and facilitates the advantages of fsQCA in getting a more nuanced understanding than csQCA. At the same time, typical problems of larger value fuzzy sets, like model overfitting, get avoided.

Now, in order to conduct the actual calibration, the "indirect calibration method" by Ragin (2008, p. 94f) will be applied. For all conditions, the mean of the raw data scores will serve as the crossover-point which differentiates between the fuzzy set scores of 0.67 and 0.33. The mean can also be seen as the "central tendency" (Ragin, 2008, p. 77) and thus marks the threshold if each country has a higher or lower score in relation to the other EU members. The use of the mean for this differentiation is not only reasonable in my case, but also common practice in studies with a four-value fuzzy set design (see e.g., Marienfeldt, 2021; Yao & Li, 2023). The most obvious alternative would be to choose the median as the crossover-point, as this would allow for the most equal variation. However, I believe that the mean score is better suited as a calibration based on the median would always raise the challenge of a decision if the 14th highest score has to be considered rather in or out. At the same time, the mean also works satisfactory as the crossover point in terms of ensuring a good level of variation which is needed for meaningful analysis results (Ragin, 2008, p. 77). The further differentiation

between 0.67 and 1 as well as between 0.33 and 0 on the other side follows logical structures in terms of its size (half of population, three fourths, 80 percent etc.) and the general distribution of cases. To give an example, the mean among the EU-27 members for "activeuse", so citizens who submitted forms to public authorities over the internet in the last twelve months, is 48.9 percent. This percentage therefore serves as the crossover point between 0.33 and 0.67 in the fuzzy set membership scores. In addition based on the distribution of cases and logical structures in terms of the size, 33.3 percent (a third of all citizens in a country) is defined as the crossover point between the fuzzy set membership scores 0 and 0.33, whereas 66.7 percent (two thirds of all citizens in a country) is defined as the crossover point between fuzzy set membership scores of 0.67 and 1. Deriving from that, six countries each are assigned to the fuzzy set membership scores of 0, 0.33, and 1, while the remaining nine cases are assigned with the score of 0.67, ensuring a relatively equal distribution. All crossover points used in this work are shown in Table 1 on the left of this page while the complete results from the applied calibration together with the raw data set is outlined in Table 2 later on in Chapter 4.

Table 1: Crossover points for all conditions and outcome in the calibration process

Outcome/ condition	**Crossover points in the calibration process**		
	0.33	0.67	1
passiveuse	50%	64.8 %	80%
activeuse	33.3%	48.9%	66.7%
usercentricity	0,85	0.903	0.95
keyenablers	0.6	0.717	0.8
digitalskills	50%	56.3%	66.7%
usefulness	35%	44.9%	55%
trust_pa	40%	52.04%	66.7%

After this calibration of the data is conducted, the "analysis of necessity" is the next step to proceed in fsQCA. Our developed frameworks include four and five conditions that are assumed to have an impact on the usage rates of public e-services. However, it is in the nature of complex real-life phenomena that some conditions are more important in triggering an outcome than others (Duşa, 2024, p. 115). They might even be so important that the outcome would not occur without their presence, making them a necessary part of every combination of conditions (ibid.). In order to identify if such conditions appear in the frameworks of this thesis, an analysis of necessity is conducted for both outcome variables, active and passive usage rates of public e-services.

This analysis detects the extent to which each condition is present in cases with a certain outcome. In this work, a necessary condition exists if one of the conditions is fulfilled in all sets with high usage rates as the outcome. This necessity of a condition would be indicated by a consistency score of "1" in the output of the analysis of necessity for this condition (Duşa, 2024, p. 122). However, in large datasets of real-life occurrences there are rarely such perfect

necessary conditions which is why scholars often use a score of 0.9 as the threshold for determining necessary conditions (Duşa, 2024, p. 138). Though, this does not mean that the results from this analysis are useless if no such high scores appear because the consistency scores also give valuable insights into the sufficiency of a condition. In general, the higher the consistency scores of a condition, the more sufficient it is for the outcome to occur (Duşa, 2024, p. 141ff). Therefore, the consistency scores in the analysis of necessity already indicate how important a condition is for explaining the outcome.

Another output that the analysis of necessity gives is the coverage score of the condition. For the coverage, a score of 1 means that the condition is not only always fulfilled in sets with the exemplary outcome high usage rates of public e-services, but that it is also not fulfilled in sets with low usage rates. The condition would therefore uniquely cover the specified outcome (Duşa, 2024, p. 153). Hence, the coverage score is also a very important element for the interpretation of the results because it identifies conditions which are just trivial without actually explaining anything (Duşa, 2024, p. 126f).

After gaining first hints from the analyses of necessity, the main tool of every fsQCA analysis will be applied: the truth tables. They are constructed in order to list all possible combinations of conditions and outcomes across the cases. Each row in the truth table represents a unique configuration of conditions. In fsQCA, the truth tables get transformed to binary variables (0 and 1) in the process with scores under 0.5 getting transformed to 0 and scores over 0.5 getting converted to 1, simplifying them and allowing for better interpretation. As explained before, this clear cut at 0.5 is the reason why I opted for the four-value fuzzy set which prevents the problem of intermediate set-membership (Pappas & Woodside, 2021, p. 5). As the analyses of necessity, also the truth tables extract an output including the terms consistency and coverage. First of all, there is a "raw consistency" score for each configuration and therefore each row in the truth table calculated. This score indicates how well each configuration of conditions fits with the observed outcomes across cases and also takes into account the fuzzy-membership scores for each case, or in other words "how consistently a configuration is a subset of the outcome" (Legewie, 2013, p. 34).

Now, there are three ways to proceed in fsQCA, depending on what kind of solution a scholar aims to interpret: the "complex solution", the "parsimonious solution", and the "intermediate solution". These three solutions differ in their application of the so-called "logical minimization" which refers to reducing the complexity within the truth table to make it more

interpretable (see Duşa, 2024, p. 179f). The complex solution in this regard represents the full truth table without any simplification. This solution includes all possible combinations of conditions, regardless of their actual appearance, and their associated outcomes observed in the data (see Duşa, 2024, p. 183ff). The parsimonious solution on the other hand is the most simplified representation of the truth table achieved through rigorous logical minimization. It retains only the essential configurations of conditions that are necessary and sufficient for producing the outcome, excluding assumed non-sufficient configurations (see Duşa, 2024, p. 191ff).

In this thesis, I will however opt for the third option, the intermediate solution, which can be seen as a compromise between the parsimonious and the complex solution. The intermediate solution is described by Ragin (2009, p. 175) as usually the most valuable to interpret as complex solutions are likely to be overly encapsulated due to their missing simplification. Parsimonious solutions on the other hand are likely to be unrealistically simple considering that we are dealing with real-life phenomena due to too much exclusion of complexity (ibid.).

Now, in the intermediate solution, logical minimization first of all is applied by setting a threshold for the raw consistency score to determine which solutions are sufficient to the outcome. Most commonly a threshold of 0.8 is recommended here as this point represents a good balance between reducing false negative and false positive predictions (Pappas & Woodside, 2021, p. 15). Therefore, the 0.8 threshold for raw consistency scores will also be applied in this work. The second step of logical minimization of the truth tables for the intermediate solution is to simplify the tables by removing so called “logical remainders” (Greckhamer et al., 2018, p. 489). These are configurations that are not present in the dataset and therefore do not have any interpretable value for the analysis (ibid.).

After this is done, an output is generated that again includes the terms of consistency and coverage, in the case of the truth table these terms are more specifically the solution consistency and the solution coverage (Ragin, 2009, p. 44). These specifications indicate the strength of empirical support for the built conceptual frameworks, meaning how well the set of identified conditions can explain passive- and active usage rates of public e-services among the EU members. The solution consistency in this regard measures the degree of how much the cases that share a common set of conditions lead to the same outcome, signaling how significant the empirical connection is (Ragin, 2009, p.44f).

The solution consistency score is calculated as follows (see Ragin, 2009, p. 52f):

$$Solution\ Consistency_j = \frac{\sum_{\{i=1\}}^{\{N\}} min(X_{\{i,j\}}, Y_i)}{\sum_{\{i=1\}}^{\{N\}} (X_{\{i,j\}})}$$

where $X_{\{i,j\}}$ is the membership score of case i in configuration j.

Y_i is the membership score of case i in the outcome.

$\min(X_{\{i,j\}}, Y_i)$ is the minimum of the membership scores for the condition configuration and the outcome for each case.

N is the total number of cases

Ragin (2009, p. 48f) claims that "significantly" higher scores than 0.8 for the solution consistency can lead to the assumption that the assigned set of conditions is "almost always" sufficient for the outcome to occur.

The solution coverage on the other hand is described as comparable with the R-squared reported in regression-based analyses (Pappas & Woodside, 2013, p. 13). This does not mean that fsQCA is comparable to regression in its general design but the interpretation of these scores is quite similar. The best model fit is again reached with a score of 1, meaning that a set of conditions perfectly accounts for the instance of an outcome (Ragin, 2009, p. 44). Hence, the solution coverage, as R-squared in regression, indicates the empirical importance of the conditions' presence or absence (ibid.). The solution coverage is calculated as follows (see Ragin, 2009, p. 61):

$$Solution\ Coverage_j = \frac{\sum_{\{i=1\}}^{\{N\}} min(X_{\{i,j\}}, Y_i)}{\sum_{\{i=1\}}^{\{N\}} (Y_i)}$$

where $X_{\{i,j\}}$ is the membership score of case i in configuration j.

Y_i is the membership score of case i in the outcome.

$\min(X_{\{i,j\}}, Y_i)$ is the minimum of the membership scores for the condition configuration and the outcome for each case.

N is the total number of cases

According to Ragin (2009, p. 55), there is often a trade-off between the solution consistency and the solution coverage. To illustrate why this is the case he gives the example of people in the US who can avoid poverty through combining "excellent school records, high achievement test scores, college-educated parents, high parental income, graduation from Ivy League universities" (ibid.) A perfect consistency of 1 here would not come in as a surprise, but still the model does not really have explanatory power as the model is formulated so narrowly that the coverage of the outcome comes in very trivial (ibid). By our data calibration, I already avoided this scenario through aiming for a relatively equal distribution of the membership scores. However, I wanted to give this example in order to illustrate that both, the solution consistency and solution coverage scores, matter while the aim in fsQCA is to find a model that has a high consistency as well as high coverage (> 0.8).

The solution consistency and solution coverage scores are therefore the core basics when analyzing a truth table in fsQCA. However, there are also more descriptive procedures to take in order to shed light on the full picture in the analysis. In this regard, also the specific rows with their specific condition fulfillment configurations will be analyzed based on their outcome predictions. Here it is also from special interest which cases might be projected as sufficiently fulfilling the outcome, meaning to have high usage rates of public e-services, but in reality have low usage rates and vice versa. By identifying such outliers, I will be able to have a deeper look at these cases in order to evaluate where the conceptual frameworks might miss out on important aspects that also influence the adoption of public e-services. By combining all these analytic techniques, I therefore aim to give substantial insights how differences in usage rates of public e-services among the EU member states can be explained.

3.3. Limitations of this research design

Now, before diving into the actual analysis, I want to discuss some limitations of the research design applied in this thesis. In sub-chapter 3.1.1., I already addressed some points considering linearity and why fsQCA can still give very valuable insights in designs with an assumed linearity of all the conditions and the outcome.

In addition to that, some measurements of the conditions are not the perfect fit in regard to the theoretical considerations in Chapter 2. There might be differences among the EU countries about which institution is most relevant for the provision of public e-services, potentially influencing the perceived trust of citizens. The choice for the public administration dimension in the Eurobarometer here is a reasonably good guess for the most relevant one among the EU

members. However, there might be countries in which the trust in the government or the local authorities is more important. Also, the survey used for the perceived usefulness by citizens is not exactly targeting public e-services but generally digital tools. I made the case why there is good reason to believe that the perceived usefulness for these two variables correlate. Still, this limitation has to be clearly noted here.

Another limitation, or rather noteworthy aspect, is that the decisions made in the calibration process have an immense impact for the results in a fsQCA design (Pappas & Woodside, 2013, p. 8). The mean is a very common measure for the most important threshold between 0.33 and 0.67 (ibid.) and I made my argument why it is important to aim for comparatively equal distribution of fuzzy set membership scores for the outcomes and conditions in order to get meaningful and interpretable results. However, there might be scholars who would argue for different calibration thresholds out of other conceptual considerations. It should not come as a surprise that I also tested for other calibrations, e.g., using the same thresholds for active and passive usage rates of public e-services in order to allow for potentially better comparison between the two conceptual frameworks. Deriving from these tests, however, I decided that the finally applied calibration measures offer the best way to ensure both: conceptual backing and feasibility in terms of the interpretation of the results.

The last limitation I want to outline is that in a cross-country study, differences in at least the active public e-service usage rates might also derive from a lack of need to submit forms within the last twelve months. Countries may differ not only in the quality of public e-services, but also in the frequency with which citizens need to submit forms to the authorities. The analysis is not able to account for such potential differences as the survey question for assessing the active usage rates of public e-services only asks citizens for if they have submitted forms, regardless of if there was a case of need for the citizens to do so, either analog or digital.

With this limitation kept in mind, I now want to finally proceed with the actual analysis in the next chapter.

4. Analysis

The first output I want to present in this part are the results from the application of the outlined calibration process together with the raw data for all outcomes and conditions in the EU-27 countries[1] (Table 2). As a reminder, for the actual fsQCA analysis steps, only the fuzzy set membership scores are applied. Nevertheless, it is beneficial for the interpretation to keep the raw data in mind, too. This accounts especially for cases where the decision for inclusion in a specific fuzzy set membership group was very close.

Table 2: Raw data and fuzzy set membership scores for all variables in the EU-27 countries[1]

Country	Raw data							Fuzzy set membership scores						
	Outcome		Conditions					Outcome		Conditions				
	passiveuse	activeuse	usercentritcity	keyenablers	digitalskills	usefulness	trust_pa	passiveuse	activeuse	usercentritcity	keyenablers	digitalskills	usefulness	trust_pa
BE	70%	51%	0.93	0.79	54%	43%	52%	0.67	0.67	0.67	0.67	0.33	0.33	0.33
BG	27%	16%	0.83	0.66	31%	37%	34%	0	0	0	0.33	0	0.33	0
CZ	68%	52%	0.85	0.59	60%	45%	54%	0.67	0.67	0.33	0	0.67	0.67	0.67
DK	92%	68%	0.98	0.94	69%	63%	77%	1	1	1	1	1	1	1
DE	50%	27%	0.91	0.60	49%	52%	67%	0.33	0	0.67	0.33	0	0.67	1
EE	82%	76%	0.96	0.94	56%	51%	64%	1	1	1	1	0.33	0.67	0.67
IE	91%	66%	0.91	0.50	71%	61%	63%	1	0.67	0.67	0	1	1	0.67
EL	55%	37%	0.86	0.46	53%	28%	30%	0.33	0.33	0.33	0	0.33	0	0
ES	69%	55%	0.96	0.79	64%	40%	45%	0.67	0.67	1	0.67	0.67	0.33	0.33
FR	81%	71%	0.94	0.75	62%	29%	58%	1	1	0.67	0.67	0.67	0	0.67
HR	45%	24%	0.88	0.57	63%	37%	31%	0	0	0.33	0	0.67	0.33	0
IT	34%	23%	0.91	0.62	46%	36%	27%	0	0	0.67	0.33	0	0.33	0
CY	57%	46%	0.71	0.43	50%	43%	35%	0.33	0.33	0	0	0.33	0.33	0
LV	77%	65%	0.93	0.87	51%	54%	32%	0.67	0.67	0.67	1	0.33	0.67	0
LT	62%	52%	0.93	0.94	49%	55%	45%	0.33	0.67	0.67	1	0	1	0.33
LU	78%	52%	0.95	0.76	64%	49%	81%	0.67	0.67	0.67	0.67	0.67	0.67	1
HU	73%	66%	0.92	0.84	49%	39%	61%	0.67	0.67	0.67	1	0	0.33	0.67
MT	63%	45%	0.99	0.94	61%	61%	59%	0.33	0.33	1	1	0.67	1	0.67
NL	87%	75%	0.95	0.85	79%	56%	66%	1	1	1	1	1	1	0.67
AT	73%	54%	0.92	0.81	63%	34%	68%	0.67	0.67	0.67	1	0.67	0	1
PL	48%	40%	0.85	0.61	43%	34%	44%	0	0.33	0	0.33	0	0	0.33
PT	49%	34%	0.95	0.87	55%	43%	47%	0	0.33	1	1	0.33	0.33	0.33
RO	15%	9%	0.73	0.24	28%	25%	40%	0	0	0	0	0	0	0.33
SI	69%	38%	0.90	0.65	50%	34%	38%	0.67	0.33	0.33	0.33	0.33	0	0
SK	56%	25%	0.85	0.68	55%	37%	47%	0.33	0	0.33	0.33	0.33	0.33	0.33
FI	89%	74%	0.99	0.93	79%	67%	70%	1	1	1	1	1	1	1
SE	91%	80%	0.94	0.76	67%	62%	69%	1	1	0.67	0.67	1	1	1

In the next step, the results from the analyses of necessity will be presented and described to get a first overview of how important the identified conditions are assumed to be. Then the produced truth tables will be introduced in order to identify patterns of under which sets of conditions high public e-service usage rates occur. In the following discussion, also outliers for which the models are unable to predict the empirically correct outcome are identified. These false predictions will also be discussed and further analyzed in order to find indications as to the causes for them.

[1] Country Codes: AT = Austria, BE = Belgium, BG = Belgium, CY = Cyprus, CZ = Czechia, DE = Germany, DK = Denmark, EE = Estonia, EL = Greece, ES = Spain, FI = Finland, FR = France, HR = Croatia, HU = Hungary, IE = Ireland, IT = Italy, LT = Lithuania, LU = Luxembourg, LV = Latvia, MT = Malta, NL = Netherlands, PL = Poland, PT = Portugal, RO = Romania, SI = Slovenia, SK = Slovakia, SW = Sweden

4.1. Results

Now, the first actual results that I want to present are the two tables of necessity for both outcome variables in the conceptual frameworks, passive- and active use (Table 3 and Table 4). The results indicate that active and passive use are strongly related to each other and if they would serve as a condition for the respective other use variable, they would meet the 0.9 consistency threshold that typically indicates the necessity of a condition (Greckhamer et al., 2018, p. 489).

Table 3: Analysis of necessity for passive use

Outcome: passiveuse		
Condition	**Consistency**	**Coverage**
activeuse	0.91	0.93
~activeuse	0.37	0.41
usercentricity	0.86	0.77
~usercentricity	0.39	0.51
keyenablers	0.77	0.72
~keyenablers	0.37	0.46
digitalskills	0.77	0.89
~digitalskills	0.49	0.48
usefulness	0.72	0.77
~usefulness	0.49	0.51
trust_pa	0.72	0.80
~trust_pa	0.44	0.45

Looking at the actual conditions identified for determining the maturity of public e-service use, none of the variables is solely necessary, although the service accessibility and quality variables already reach very high consistency scores which underpins their relevance indicated by the literature review in the theoretical part of this thesis. However, the coverage scores of under 0.8 for these variables, "usercentricity" and "keyenablers", indicate that it is not trivial to assume that the degree of service accessibility and quality matches with the maturity of public e-service adoption among citizens. This supports the value of the set-theoretic fsQCA approach that enables the additional consideration of the other identified conditions to see what the reason for lower adoption rates besides good service quality might be. The tables also show that neither of these other three conditions (digital literacy, perceived usefulness, and trust in public authorities) reaches a consistency threshold of 0.8 for both usage definitions. The fulfillment of these conditions is therefore far from being necessary for high public e-service usage rates, but all variables are proven to be of a high-level of sufficiency, making it valuable to proceed with the truth tables including them.

Table 4: Analysis of necessity for active use

Outcome: activeuse		
Condition	**Consistency**	**Coverage**
passiveuse	0.93	0.91
~passiveuse	0.35	0.39
usercentricity	0.88	0.77
~usercentricity	0.35	0.45
keyenablers	0.81	0.74
~keyenablers	0.30	0.37
digitalskills	0.76	0.86
~digitalskills	0.50	0.48
usefulness	0.71	0.75
~usefulness	0.47	0.49
trust_pa	0.74	0.80
~trust_pa	0.47	0.47

Having said that, I will resume with the actual key tool of the fsQCA analysis: the truth tables. The first truth table (Table 5) is built upon the former identified conceptual framework for passive use of public e-services, so the obtainment of information or download of official forms from public authority websites. The accessibility and quality of the service ("usercentricity") is included in this model, as well as the digital literacy of citizens ("digitalskills") of the users, their perceived advantage of digital tools ("usefulness"), and their trust in the respective public administration ("trust_pa").

Table 5: Truth table for the model with four conditions and passive use as the outcome

Intermediate Solution Truth Table:

	Conditions				Outcome			
Row	usercentricity	digitalskills	usefulness	trust_pa	passiveuse	consistency	number	cases
1	0	1	1	1	1	1	1	CZ
2	1	0	0	1	1	0.92	1	HU
3	1	1	0	1	1	0.91	2	FR, AT
4	1	1	1	1	1	0.91	7	DK, IE, LU, MT*, NL, FI, SE
5	1	0	1	1	1	0.84	2	DE*, EE
6	1	1	0	0	1	0.83	1	ES
7	0	1	0	0	0	0.798	1	HR
8	1	0	1	0	0	0.71	2	LV*, LT
9	1	0	0	0	0	0.69	3	BE*, IT, PT
10	0	0	0	0	0	0.47	7	BG, EL, CY, PL, RO, SI*, SK

solution consistency: 0.84 / solution coverage: 0.9 / cases marked with an * are predicted wrong

The results show a strong relation between the set of conditions and the outcome (solution consistency score of 0.84, solution coverage score of 0.9). Ten out of 16 different configurations have been identified as present, meaning that six configurations are logical remainders and not reported here. More than half of the 27 EU countries are part of the configurations in row 4 and 10, which are the most homogeneous ones in terms of their (non-)fulfillment of the conditions. Denmark, Ireland, Luxembourg, Malta, the Netherlands, Finland, and Sweden have all higher than average scores for the four conditions, whereas Bulgaria, Greece, Cyprus, Poland, Romania, Slovenia, and Slovakia are all countries with lower than average scores for all conditions in the model. Very surprisingly, in reality a higher percentage of Slovenian than Maltese citizens obtain information or downloads forms from public authority websites (69 % in Slovenia, 63% in Malta).

Slovenia and Malta are therefore among five countries in which the model predicts an incorrect outcome based on the configuration of set-conditions. The other cases are Germany in row 5, Latvia in row 8, and Belgium in row 9. While higher usage rates are incorrectly predicted for Germany, the model wrongly assumes lower usage rates for Belgium and Latvia. The different configurations of set-conditions do not show clear patterns in terms of combinations that inevitably lead to higher public e-service usage rates. For example, the configuration of

Czechia (row 1), which lacks the very important service accessibility and quality, is still sufficient with its fulfillment of the digital literacy, perceived usefulness, and trust in public administration conditions. Also, sometimes the fulfillment of half of the conditions is already sufficient, in some cases it is not. An interesting pattern however is witnessable in the column for trust in public authorities, where no cases not fulfilling this condition are predicted to have high usage rates. Nevertheless, I already identified before that Latvia, Belgium, and Slovenia among these non-fulfilling countries in reality do have high passive usage rates.

Thus, it seems very much sense-making to test the same conditions now also with the other usage definition of active use, meaning the active submission of filled forms to public authorities over the internet.

Table 6: Truth table for the model with four conditions and active use as the outcome

Intermediate Solution Truth Table:

	Conditions				Outcome			
Row	usercentricity	digitalskills	usefulness	trust_pa	activeuse	consistency	number	cases
1	1	1	0	1	1	0.91	2	FR, AT
2	1	1	1	1	1	0.91	7	DK, IE, LU, MT*, NL, FI, SE
3	0	1	1	1	1	0.86	1	CZ
4	1	1	0	0	1	0.83	1	ES
5	1	0	0	1	1	0.83	1	HU
6	1	0	1	0	0	0.79	2	LV*, LT*
7	1	0	1	1	0	0.77	2	DE, EE*
8	0	1	0	0	0	0.70	1	HR
9	1	0	0	0	0	0.69	3	BE*, IT, PT
10	0	0	0	0	0	0.42	7	BG, EL, CY, PL, RO, SI, SK

solution consistency: 0.89 / coverage: 0.79 / cases marked with an * are predicted wrong

The additional truth table (Table 6) shows an even stronger relation between the set of conditions and the outcome in terms of the solution consistency score (0.89), but a significantly lower solution coverage score (0.79) in comparison with the former original model, indicating a slightly lower fit. Obviously the same ten different configurations have been identified as the set of conditions did not change in this model. The fulfillment of all conditions again leads to the prediction of higher than average public e-service usage rates by Maltese citizens, which is also in the case of the alternative use definition not in line with the reality. Slovenia however in contrast to the passive use, is having below average active usage rates. Therefore, the outcome is in this model predicted correctly for this country. Nevertheless, for four cases, the configuration of conditions assumes lower than average active usage rates wrongly. These countries are the three Baltic countries of Latvia, Lithuania (both Row 6) and Estonia (Row 7), as well as again Belgium (Row 9).

Again, it is difficult to identify clear patterns among the set-conditions that lead to higher public e-service usage rates based on the truth table. Some combinations of two present conditions

are sufficient (Rows 4 and 5), for a different one it is predicted not to be (Row 6). There is even a set with three fulfilled conditions predicted to be not sufficient (Row 7). Interestingly, among these outlined combinations, three of four cases are among the wrongly predicted ones. Therefore, I will now assess if the addition of the "keyenablers" condition, that captures the extent to which service processes support the use of main IT enablers like the eID, helps to give the model more precision.

Thus, the next truth table (Table 7) is based on the second identified conceptual framework. Recalling our theoretical assumptions, the key enablers condition should only be relevant in cases of active form submissions, however the same set of conditions will also be applied for the passive use variable later on in order to test for the robustness of this expectation.

Table 7: Truth table for the model with five conditions and active use as the outcome

Intermediate Solution Truth Table:

	Conditions					Outcome			
Row	usercentricity	keyenablers	digitalskills	usefulness	trust_pa	activeuse	consistency	number	cases
1	1	1	1	0	1	1	0.90	2	FR, AT
2	1	1	1	1	1	1	0.89	6	DK, LU, MT*, NL, FI, SE
3	1	1	1	0	0	1	0.89	1	ES
4	1	0	1	1	1	1	0.88	1	IE
5	0	0	1	1	1	1	0.86	1	CZ
6	1	1	0	1	0	1	0.83	2	LV, LT
7	1	1	0	0	1	1	0.82	1	HU
8	1	1	0	1	0	1	0.82	1	EE
9	1	1	0	0	0	0	0.75	2	BE*, PT
10	0	0	1	0	0	0	0.66	1	HR
11	1	0	0	0	0	0	0.60	1	IT
12	1	0	0	1	1	0	0.57	1	DE
13	0	0	0	0	0	0	0.36	7	BG, EL, CY, PL, RO, SI, SK

solution consistency: 0.88 / coverage: 0.86 / cases marked with an * are predicted wrong

Now, this model with the added key enablers variable indeed strengthens the relation between the set of conditions and the active usage rates of public e-services (solution consistency score of 0.88, solution coverage score of 0.86) in comparison to the model without these main IT enablers (Table 6). 13 out of 32 different configurations have been identified as present, leading to the exclusion of 19 logical remainders from the report. Again, the two rows with the most homogenous configurations of conditions account for around half of the observations. In contrast to the former model with four conditions, Ireland (Row 4) is not part of the row that fulfills all the conditions (Row 2) anymore due to falling short of the mean threshold for the key enablers score. Row 13 therefore represents the set of conditions that is most often present (Bulgaria, Greece, Cyprus, Poland, Romania, Slovenia, Slovakia) with all of the conditions being not fulfilled.

In terms of the accuracy of outcome prediction, this third model works very well. Only the outcome of two countries is forecasted wrongly. Unsurprisingly, considering the results of the

first two models, one of these cases is Malta (Row 2) which again fulfills all conditions, including the additionally introduced one of in-place main IT enablers. The other case is Belgium (Row 9) where in reality the fulfillment of both service quality variables (usercentricity and keyenablers) is already sufficient for higher than average active usage rates, although lacking an above average degree of digital literacy, perceived usefulness, and trust in public administration.

Looking solely at the truth table of this model, it is however again difficult to identify clear patterns how much condition fulfillment is already sufficient. For example, Germany (Row 12) fulfills the three conditions of "usercentricity", "usefulness", and "trust_pa" but is still far away from meeting the consistency threshold of 0.8. Different set of conditions with three fulfillments and two non-fulfillments on the other hand like in the rows 3, 5, 6, 7, and 8 are sufficient for above average active usage rates. Nevertheless, the model in general works out very well in predicting the maturity of public e-service adoption.

Stating that, the same set of conditions are now also applied to the passive use variable (Table 8) in order to test the reliability of the theoretical assumptions regarding the key enablers.

Table 8: Truth table for the model with five conditions and passive use as the outcome

Intermediate Solution Truth Table:

	Conditions					Outcome			
Row	usercentricity	keyenablers	digitalskills	usefulness	trust_pa	passiveuse	consistency	number	cases
1	0	0	1	1	1	1	1	1	CZ
2	1	0	1	1	1	1	1	1	IE
3	1	1	0	0	0	1	0.91	1	HU
4	1	1	0	1	1	1	0.91	1	EE
5	1	1	1	0	1	1	0.90	2	FR, AT
6	1	1	1	1	1	1	0.89	6	DK, LU, MT*, NL, FI, SE
7	1	1	1	0	0	1	0.89	1	ES
8	1	0	0	1	1	1	0.85	1	DE*
9	0	0	1	0	0	0	0.78	1	HR
10	1	1	0	0	0	0	0.75	2	BE*, PT
11	1	1	0	1	0	0	0.75	2	LV*, LT
12	1	0	0	0	0	0	0.70	1	IT
13	0	0	0	0	0	0	0.42	7	BG, EL, CY, PL, RO, SI*, SK

solution consistency: 0.92 / coverage: 0.81 / cases marked with an * are predicted wrong

With the conditions being unchanged, again 13 configurations are present among the EU countries, leading to the exclusion of 19 logical remainders from the reported truth table. The results also show a strong relation between the set of conditions and the passive usage rates of public e-services (solution consistency score of 0.92, solution coverage score of 0.81) with the solution consistency being even higher than in the same model with active use as the outcome but to the disadvantage of the solution coverage which is a bit lower here. Having said that, also the accuracy of the outcome prediction is lower, leaving five of the 27 cases predicted incorrectly. These cases are again Malta (Row 6) and Belgium (Row 10), but in addition also

Germany (Row 8), Latvia (Row 11) and Slovenia (Row 13). These are the same countries that were also identified for the first model with four conditions and passive use as the outcome (see Table 5). Therefore, Malta and Slovenia are again especially surprising due to their homogeneity in the (non-)fulfilment of all conditions that would lead to the clear assumption of correct predictions.

Just as for the former models it is demanding to identify clear patterns among the truth table that exceed the finding that the fulfillment of more conditions leads to a higher likelihood of sufficiency for higher public e-service adoption. As for the passive use model with four conditions, also this model predicts no cases which are not fulfilling the trust in public authorities condition to have high usage rates. But again Belgium, Latvia, and Slovenia are predicted wrongly in this regard. Now, in order to examine more in detail how the four truth tables vary and what similarities exist, I will compare all models in the next sup-chapter more in depth. In addition, possible underlying reasons for these patterns will be discussed.

4.2. Model comparison and Interpretation

So, taking all four models into consideration, what can already be drawn from the results? A first interesting pattern that can be derived not only from the analyses of necessity but also the similarities among the truth tables is the strong overlap between the two different outcome variables of active and passive usage rates of public e-services. In the vast majority of cases, the definition of public e-service use does not matter when comparing countries within the EU in this fsQCA research design as there is a very high likelihood that countries with a higher rate of users obtaining information also have a higher rate of users sending filled forms and vice versa. A user-level analysis of why there is such a strong correlation and by which factors this is caused seems valuable for future research in order to unpack this relationship more in depth.

Another generalizable finding is that the solution consistency and solution coverage scores for all models indicate a strong sufficiency relationship between the conditions and the different use variables. Referring back to Ragin (2009, p. 48f), I can claim that the assigned set of conditions from our framework is sufficient for the occurrence of high public e-service usage rates. Therefore, very reliable assumptions about the maturity of public e-service adoption among citizens can already be made and the diffusion of innovation theory is proven to work very well in explaining variations in the adoption among national populations in the EU. Or in other words: public e-service accessibility and quality, the digital literacy among the citizens,

the perceived usefulness of digital tools, and the trust of public administration in combination can sufficiently explain adoption.

Nevertheless, there are also differences in the fit of the different models. Here it is very interesting to shed light on the question of whether the introduction of the extra key enabler variable was beneficial. This can be answered with a yes as this extra condition raised the solution coverage in the active use model significantly (0.79 to 0.86) while holding the solution consistency almost constant (0.89 to 0.88). Also, the model based on the second conceptual framework with five conditions and active use as the outcome, is the most precise in forecasting the outcome fulfillment correctly. Only Malta's and Belgium's outcome is predicted wrongly, meaning that for 25 out of 27 EU member states the assumptions made by the model also occur in reality, which is a very strong result.

Nevertheless, as even this model does not provide perfect solutions, a more in depth look at these wrongly predicted countries that therefore serve as outliers is valuable. Hence, in these cases there must be so called "alternate causal conditions" (Ragin, 2009, p.39) leading to the outcome that are very worth identifying. The most eye-catching outlier is Malta which is assumed with a fulfilment of the outcome in all four models due to its fulfilment of all the applied conditions. However, in contrast to the other cases with the same condition configuration (Denmark, Luxembourg, the Netherlands, Finland, Sweden) Malta in reality has below average usage rates of public e-service rates for both applied definitions of usage.

Another case where this applies for is Belgium. Also, for this country the expectations in all tested models do not match with the real-life empirical data, being predicted a lower adoption EU member state while actually being one with higher adoption rates for both public e-service use variables. This case is especially interesting as all the conditions that directly refer to the user side (digital literacy, perceived usefulness, and trust in the public administration) are lacking, while the supply side with above average service accessibility and quality as well as main IT enablers is fulfilled. This configuration is the same as in Portugal where in reality the adoption is indeed below average, allowing for a direct comparison of the two countries in a search for alternative conditions not covered by the conceptual framework here.

Very enriching already based on the former model comparison are the outlier cases of the two neighboring countries of Latvia and Lithuania. Comparing the two models for active use (Tables 6 and 7), the addition of the key enablers condition led to a correct prediction which was not in place in the simpler model with four conditions. Both countries share an above

average level of public e-service accessibility and quality alongside an also above average rates of perceived usefulness of digital tools. At the same time, digital literacy and trust in the public administration is below average in both countries. Looking at the raw data (Table 2), both countries are particularly far developed in their application of main IT enablers. Considering that Lithuania is the sole country where the active use is above average and the passive use is below average, this case offers a good additional argument for the inclusion of the additional quality variable in the second conceptual framework.

Another argument that speaks in favor of this is that Latvia and Lithuania alongside their Baltic neighboring country of Estonia were all considered incorrectly with lower active usage rates in the model with four conditions and the active use outcome variable (Table 6). The raw data displays that all three countries are among the cases with the lowest differentiation between the active and passive usage rates of public e-services. Considering that Latvia, Lithuania, and Estonia share an above average degree of public e-service accessibility and quality combined with a low degree of digital literacy, it appears to be reasonable that the digital literacy is a main hindrance of higher general usage of public e-service in cases where the services themselves are well developed.

Talking about Estonia, this case could also partly explain incorrect outcome predictions of Germany, at least in the first model (Table 5). Estonia and Germany were grouped together because they share a set of above average scores for the conditions of “usercentricity”, “usefulness”, and “trust_pa” while having below average scores of “digitalskills”. Nevertheless, this grouping in reality is not very sense-making out of numerous considerations that are not captured by the conditions included in this analysis. Whereas Germany is the most populous countries in the EU, Estonia is among the least populous (World Bank, 2024). Germany is a federalized country, Estonia is unitary centralized (Marienfeldt, 2021). Germany is a founding member of the EU, Estonia joined in 2004 (European Commission, 2024). Taking these alternate causal conditions into consideration, the grouping of Estonia and Germany together in a set-theoretic approach might be the cause of such wrong predictions.

The last case to consider when talking about outliers is Slovenia. As mentioned before, Slovenia does not fulfill any condition and is therefore considered as having a below average public e-service usage rate. However, while this is indeed true for the active use definition, Slovenia in reality has, in contrast to the other countries with the same set of condition-fulfilment (Bulgaria, Greece, Cyprus, Poland, Romania, Slovakia), an above average passive

usage rate (see Table 2). Solely looking at the models, there is no sense-making explanation for this empirical finding in the Eurostat data. Hence, the next sub-chapter aims to identify alternative conditions that might have led to the wrong predictions for Slovenia, as well as for the former mentioned outliers of Malta and Belgium.

4.3. Outliers and alternate causal conditions

Now, in order to do so, literature specifically dealing with the respective countries in depth is reviewed and findings from that will be presented alongside a variety of own considerations. I will start by looking at the outlier of Malta before resuming with Belgium and Slovenia.

4.3.1. Malta

When talking about Malta, the first eye-catching feature of the country considers its geographic location. As a small island in the very South of Europe, Malta is grouped together with Denmark, Luxembourg, the Netherlands, Finland, and Sweden. These are all countries located in the Northern part of Europe. The North-South divide in Europe is a frequently studied topic, usually referring to cultural and economic differences between the north-western regions of Europe and the southern and central ones that already account back to the times of the Industrial Revolution (Fochesato, 2018). Concerning the internet, Norris (2000) already raised the question of the beginning of the century if we will witness a new North-South Divide in the adoption of the new technology. Looking at the ranking of EU country based on the raw data of the active usage rates of public e-services, the first Southern European country is Spain in 10th position if Southern Europe is defined based on the definition of the region by the UN (United Nations, 2024a). It therefore seems that there is indeed such a divide between Northern and Southern Europe when it comes to the adoption of public e-services. However, this pattern is also widely visible when looking at the conditions where Malta is alongside Spain and France the only Sothern European country with mostly above average measures, whereas Portugal, Italy, Greece, Cyprus, Croatia, and Slovenia mostly have scores below average. Therefore, the geographical location of Malta is eye-catching, but it is hard to proof an alternate causal condition deriving from it.

Another feature of Malta that might be worth to explore is its lower economic prosperity in comparison to Denmark, Luxembourg, the Netherlands, Finland, and Sweden. In 2021, Malta's GDP per capita was below average among the EU, whereas for all other countries in the group it was above that average (Eurostat, 2024d). Unfortunately, there is lack of recent studies that analyze the relationship between the economic prosperity and the adoption of e-services. This

lack might be an indicator that the economic status is not considered to be an important factor in the adoption of public e-services. In line with this, Gounopoulos et al. (2020, p. 406) finds in a user-level study in Greece that the household income is not an important predictor for public e-service adoption. Also, a look into the raw data raises doubts about the influence of a countries economic prosperity on the usage rates with lower income countries like Estonia, Hungary, and Latvia being among the Top Ten in terms of the active usage rates.

More promising, however, is an explanation given by Priscilla Bugeja, the Head of the eGovernment Services Department in Malta's Information Technology Agency. She explains the low adoption rate by referring to the very high population density of the country, stating that in Malta an additional challenge occurs from "the proximity to the physical Government offices" (Fenech, 2024). In this regard, she explains that in contrast to very rural areas in other European countries, Maltese citizens can very easily attend government offices in person (ibid). This argument makes sense because the pursued relative advantage of using an e-service is lower when it saves less time. Former studies about the internet voting adoption in Estonia have shown in line with this that there is a strong positive relationship between the distance to the next physical polling station and the likeliness to vote via the internet (Ehin et al., 2022). Considering that Malta also is a strong outlier in regard to population density, being the most dense country in the EU with more than three times higher population density than the second ranked country (Eurostat, 2024e), I consider this variable as an alternate causal condition for the low adoption of public e-services in the special case of Malta.

4.3.2. Belgium in comparison with Portugal

Moving on with Belgium, I want to remind that Belgium was in opposite to Malta predicted wrongly with low usage rates in all four applied models. The case of Belgium features higher levels of service quality and accessibility in the "usercentricity" as well as the "keyenablers" condition while at the same time being assigned to with lower scores for the digital literacy, the perceived usefulness of digital tools, and the trust in public authorities. As outlined before, Belgium shares these features with Portugal. However, passive as well as active usage rates of public e-services are significantly higher in Belgium than in Portugal. When talking about Malta, I already outlined that cultural differences deriving from Europe's North-South divide might play a role, but that this is hard to proof.

Another factor might derive from the time perspective. Remembering the diffusion of innovation theory introduced in Chapter 2.3., the process of innovation adoption is generally

taking place in a cumulative s-shape among the population. This means that the adoption of public e-services takes time after they have been made accessible. A recent report by Estevez et al. (2021) indicates that Portugal made particularly big steps in its service quality in recent years. Unfortunately, the EU eGovernment Benchmark used for assessing the service accessibility and quality in our work was only established in its current form in 2020, not allowing for a longer comparison of the score evolutions. However, I outlined before that the E-Government Development Index (EGDI) by the UN was found to be highly correlated which is why I will take a deeper look at the scores of Portugal and Belgium over the last years in this index to assess if the time perspective might be an explanation for the different outcomes of Portugal and Belgium.

In 2010, Belgium was ranked 16th worldwide in the EGDI with a score of 0.72 while Portugal was ranked 39th with a score of 0.58 (United Nations, 2024b). Over the next eight years, Portugal constantly closed this gap till in 2018, Belgium was ranked 27th with a score of 0.81 while Portugal was ranked 29th with a score of 0.80 (ibid.). In 2020, Portugal even overtook Belgium in the ranking (ibid.). This data is at least an indicator that the differences in the adoption rate of public e-services might be caused by the very recent development of highly accessible and user-friendly services in Portugal, while in Belgium the services are already established for a longer period of time. In order to give this argument more reliability, future research could extend the design used in this research by adding a time perspective that allows for comparison of not only different cases at one point, but also the same cases at a different time.

4.3.3. Slovenia

Last but not least, I also want to take a deeper look at the outlier case of Slovenia. To remember, this was the case with no conditions fulfilled in the first conceptual framework, but still in reality higher than average passive usage rates of public e-services. So, despite a lack of accessible high-quality services, digital literacy, perceived usefulness of digital tools, and trust in the public authorities by Slovenians, citizens in the small neighboring country of Italy, Austria, Hungary, and Croatia, opt to a high degree for obtaining information and downloading forms from official public authority websites. According to my review, existing literature about Slovenian public e-services has not addressed this topic yet. Therefore, I will go back to additional data of the EU survey of “ICT usage in households and by individuals” in order to find possible paths of explanation.

In 2013, Eurostat made a survey about experiences with the use of public authority websites. Interestingly, Slovenia did comparably well here in terms of the satisfaction with these websites. In the satisfaction level for the ease of finding information, the country ranks 9th among the EU-28 with 41 percent of the users being mainly satisfied whereas in the whole EU only 32 percent stated that (Eurostat, 2024f). Another pattern this survey shows is that all the other countries, Slovenia was grouped together with in the truth tables (Bulgaria, Greece, Cyprus, Poland, Romania, Slovakia), have lower satisfaction rates than these 32 percent across the EU (ibid.). The same pattern is visible when users were asked about their satisfaction level with the usefulness of the available information. For this question, Slovenia even ranks 7th among the EU-28 with a satisfaction rate of 47 percent (EU: 33 percent) (ibid.). Also for this question, all the other countries with the same set of conditions in the fsQCA analysis fall short of the EU average.

Surely, it needs to be taken into account that this survey was conducted already eight years before my actual time of analysis, but this survey still gives a good hint why Slovenia might be an outlier for passive public e-service use. Referring back to the diffusion of innovation theory again, these relatively good experiences with the public authorities' information provision through websites might till today have a positive effect on the perceived compatibility among Slovenian citizens as in the past their needs were to a good amount fulfilled by the information provided.

Another interesting survey that gives a possible first insight into the big differences between active and passive usage rates in Slovenia was conducted by the EU in 2022. When asked about the reasons for not submitting any completed forms to public authorities via the internet in the last twelve months, five percent of Slovenian citizens responded that it was because of the lack of electronic signature which is the highest percentage among all European countries (Eurostat, 2024g). This indicates that the lack of main IT enablers is also particularly important in this case for explaining the differences between the two usage rates. In the end, the above average scores for the passive usage rates of public e-services in the original dataset are still surprising, considering the low measures for service accessibility and quality, digital literacy, perceived usefulness, and trust in the public authorities in Slovenia. But the two additional surveys at least give a good first sense why Slovenia is an outlier among the group of non-fulfillers of all the identified conditions in the conceptual frameworks. However, in order to provide more reliable answers for the high passive usage rates, an up-to-date user level study about Slovenia seems to be an appropriate way to proceed.

5. Conclusion

To wrap up, the objective of this thesis was to enrich the existing body of academic research on the varying usage rates of public e-services among the member states of the European Union. By applying two well-established conceptual frameworks derived from the diffusion of innovation theory within a fuzzy-set Qualitative Comparative Analysis (fsQCA), this study found strong general patterns. In combining the levels of accessibility and quality of the services, digital literacy of the citizens, their perceived usefulness of the e-services, and their trust in public authorities, public e-service usage rates among the EU countries can be explained very well. Both models derived from the conceptual frameworks reach solution consistency and solution coverage scores of at least 0.84, indicating that the set of conditions is highly sufficient for high public e-service usage rates to occur.

Stating that, two slightly different conceptual frameworks were applied as I have argued that it makes a difference if citizens use public e-services only passively by obtaining information or also actively through submitting forms to public authorities. Another key finding of this thesis, however, is the strong overlap between active and passive usage rates of public e-services among the EU, suggesting that countries with high rates of users obtaining information also tend to have high rates of users sending filled forms, and vice versa. Nevertheless, the addition of the condition of in-place main IT enablers, that was assumed to be only relevant for the active usage rates, was still worthful as it first of all strengthened the model fit, but also produced a model that is able to predict the outcome of 25 out of 27 countries correctly. The analysis derived from the second conceptual framework, explaining active public e-service usage rates, therefore gives the most precise answer to the research question how differences in usage rates of public e-services among the EU-27 countries can be explained.

However, despite the robustness of the model, some outliers occurred. Hence, I identified these cases in order to assess possible alternate conditions not covered in the conceptual frameworks. Malta's low adoption rates, despite perfectly favorable conditions, may be attributed to its high population density and close proximity to physical government offices, reducing the perceived benefit of e-services. Belgium’s higher-than-expected adoption rates, compared to Portugal, might occur due to the more established nature of its public e-services over time, emphasizing the importance of the outlined adoption processes in the diffusion of innovation theory. Slovenia, with unexpectedly high passive usage rates despite the non-fulfillment of all the

conditions, may benefit from relatively good past experiences by citizens with government websites.

Highlighting that, this thesis also offered valuable paths for further research about the determinants of differences in public e-service use rates. First of all, it would be enriching to discover the strong overlap between the fuzzy set membership scores of passive and active usage rates more in depth to explain this phenomenon. Other paths derive from the outlier discussion, where possible alternate conditions, like population density and user satisfaction, were identified. These conditions have the potential to further improve the models applied in this thesis, getting an even more nuanced understanding about differences in public e-service usage adoption. The comparison of Belgium and Portugal also gave hints that it could be valuable to assess differences over time in order to see how usage rates respond to changes in the condition fulfillment. Last but not least, despite the issue of data availability, it would be worth to encounter if the design could be extended beyond the borders of the EU in order to access if the conceptual frameworks also work well in explaining differences in public e-service usage rates globally.

In conclusion, this thesis demonstrated a strong path to explain varying usage rates of public e-services among the EU27 member states by combining the variables of public e-service accessibility and quality, digital literacy of citizens, their perceived usefulness, and their trust in public authorities into a set of conditions. Both models, derived from conceptual frameworks that were established on the basis of the diffusion of innovation theory, exhibited high sufficiency in explaining high public e-service usage rates. As expected, dealing with real-life phenomena, still some outliers occurred in the analysis. The first assessment of causes for this in the cases of Malta, Belgium, and Slovenia already gave suggestions about alternate conditions not covered in the conceptual frameworks. All in all, this thesis therefore provides an additional step for a better understanding of diffusional factors for public e-service usage rates on the country-level.

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Appendix A: Codebook

passiveuse: Percentage of individuals who ticked the box [Interaction (obtaining information or downloading forms or submitting forms) with public authorities via the internet] for the question "Have you performed any of the following activities via a website or an app of public authorities or public services for private purposes in the last 12 months?"

- Based on year 2021 of "EU survey on the use of Information and Communication Technologies (ICT) in households and by individuals".
- Source: https://ec.europa.eu/eurostat/databrowser/view/isoc_ciegi_ac/default/table?lang=en&category=isoc.isoc_i.isoc_ciegi

activeuse: Percentage of individuals who ticked the box [Sending filled forms to public authorities over the internet] for the question "Have you performed any of the following activities via a website or an app of public authorities or public services for private purposes in the last 12 months?"

- Based on year 2021 of "EU survey on the use of Information and Communication Technologies (ICT) in households and by individuals".
- Source: https://ec.europa.eu/eurostat/databrowser/view/isoc_ciegi_ac/default/table?lang=en&category=isoc.isoc_i.isoc_ciegi

usercentricity: Score based on the extent to which information and services are available online, supported online and compatible with mobile devices

- Based on data from the 2021 EU "eGovernment Benchmark"
- Source: https://digital-decade-desi.digital-strategy.ec.europa.eu/datasets/e-gov-2020/charts/egov-analyse-one-indicator-and-compare-countries?indicator=e_gov_1_uc&indicatorGroup=egov2020&breakdown=egov_life_events&period=2021&unit=egov_score&country=AT,BE,BG,CY,CZ,DE,DK,EE,EL,ES,EU,FI,FR,HR,HU,IE,IT,LT,LU,LV,MT,NL,PL,PT,RO,SE,SI,SK

keyenablers: The extent to which main IT enablers (eIDs, eDocuments, Authentic sources, Digital post and security) are available during services processes, which can be used to assess the presence of the technical pre-conditions of the efficient and effective use of online services.

- Based on data from 2021 e-Government Benchmark by the EU (Mystery Shopping and automated tools method: https://ec.europa.eu/newsroom/dae/redirection/document/88734
- Source: https://digital-decade-desi.digital-strategy.ec.europa.eu/datasets/e-gov-2020/charts/egov-analyse-one-indicator-and-compare-countries?indicator=e_gov_3_ke&breakdown=egov_life_events&period=2021&unit=egov_score&country=AT,BE,BG,CY,CZ,DE,DK,EE,EL,ES,EU,FI,FR,HR,HU,IE,IT,LT,LU,LV,MT,NL,PL,PT,RO,SE,SI,SK

digitalskills: Individuals with 'basic' or 'above basic' digital skills in each of the following five dimensions: information, and data literacy, communication and collaboration, problem solving, digital content creation and safety.

- Based on data from 2021 in the 2022 "DESI Index" by the EU
- *https://digital-decade-desi.digital-strategy.ec.europa.eu/datasets/desi/charts/desi-indicators?indicator=desi_1a2&breakdown=ind_total&period=desi_2022&unit=pc_ind&country=AT,BE,BG,HR,CY,CZ,DK,EE,EU,FI,FR,DE,EL,HU,IE,IT,LV,LT,LU,MT,NL,PL,PT,RO,SK,SI,ES,SE*

trust_pa: Percentage of survey answers “tend to trust” to the question: “How much trust do you have in certain institutions? For each of the following institutions, do you tend to trust it or tend not to trust it?” – “The [Nationality] Public Administration”

- Based on average of the “EU Standard Eurobarometer 93-95 (July 2020 - July 2021)”
- Source: https://europa.eu/eurobarometer/surveys/detail/2532

usefulness: Percentage of survey answers “more advantages than disadvantages” to the question: “When you imagine your life in 2030, do you think the use of digital tools and the internet will bring you more advantages or disadvantages?”

- Based on the EU “Special Eurobarometer 518 - Digital rights and principles” (September 2021 - October 2021)
- Source: https://europa.eu/eurobarometer/surveys/detail/2270

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