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SCUOLA DI INGEGNERIA INDUSTRIALE  
E DELL'INFORMAZIONE

# Interoperability: the precondition for proactive public service provision

TESI DI LAUREA MAGISTRALE IN  
MANAGEMENT ENGINEERING  
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Authors: Livio Lodato, Chiara Messa

Student ID: 968901, 968850

Advisor: Giuliano Noci

Co-advisor: Irene Vanini

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## Abstract

The digital transformation that the whole world is passing through affects also the public sector, indeed citizens are expecting from the public sector the same level of digitalization and personalization that the private sector offers. Governments are investing in the development of their digital infrastructure to be able to provide digital services to citizens and with the objective of developing proactive services. This thesis work is aimed at investigating proactive services and their foundation, in particular, since one of the main characteristics that an e-government needs to have in order to be capable of providing proactive services is interoperability, the following empirical research is focused on it. Through a systematic literature review the proactive service and interoperability issues have been studied and a literature gap has emerged in relation to the actual implementation of interoperability in a society. The contribution of this work relates to the identification of six areas of interventions for a country that wants to improve its interoperability. Interviews with experts in the field of e-government and interoperability from four EU countries have been conducted. Consequently, one case study per country has been developed, deepening the digitalization process of the e-government and the key interventions performed. Lastly the analysis and the clustering of the common characteristics have been performed in order to determine the main interventions that a country has to go through to increase interoperability in its public sector. The empirical analysis is complemented with the assessment of the Italian public sector digitalization, to facilitate the determination of the necessary interventions to implement in order to increase interoperability and the public service provision quality. This work tackles important societal issues that all the governments around the world have to address not to lose the unique opportunity of reducing the PA efforts and, at the same time, increase the quality of public service provision.

**Key-words:** proactive services, interoperability, e-government, digital public sector, public administration.



## Abstract in italiano

La trasformazione digitale che il mondo sta attraversando riguarda anche il settore pubblico; infatti, i cittadini si aspettano dalla pubblica amministrazione lo stesso livello di digitalizzazione e personalizzazione che il settore privato gli garantisce. I governi stanno investendo nello sviluppo delle loro infrastrutture digitali per riuscire a fornire servizi digitali ai cittadini e con l'obiettivo di sviluppare servizi proattivi. Questa tesi ha l'obiettivo di indagare i servizi proattivi e le loro fondamenta, in particolare, dal momento che una delle caratteristiche principali che un governo digitale deve avere per fornire servizi proattivi è l'interoperabilità, la seguente analisi empirica è incentrata su quest'ultima. Attraverso un'analisi sistematica della letteratura sono stati studiati i servizi proattivi e il concetto di interoperabilità e una lacuna letteraria è emersa relativamente all'effettiva implementazione a livello sociale dell'interoperabilità. Il contributo di questo lavoro riguarda l'individuazione di sei aree di intervento rivolte un a Paese che voglia migliorare la propria interoperabilità. Sono state svolte svariate interviste con esperti di interoperabilità e governo digitale provenienti da Paesi dell'Unione Europea. Successivamente, è stato elaborato un caso studio per Nazione, con approfondimenti riguardanti il processo di digitalizzazione del governo digitale e gli interventi chiave attuati. In ultima istanza è stata svolta l'analisi e la clusterizzazione delle caratteristiche comuni per identificare gli interventi principali che un Paese deve affrontare per aumentare l'interoperabilità nel proprio settore pubblico. L'analisi empirica è stata integrata con una valutazione della digitalizzazione del settore pubblico italiano, per agevolare l'identificazione degli interventi necessari per aumentare l'interoperabilità e la qualità dei servizi pubblici forniti ai cittadini. Questo lavoro risponde a importanti problemi della società che tutti i governi del mondo devono affrontare per non perdere l'opportunità unica di ridurre il dispendio di energie della pubblica amministrazione e, allo stesso tempo, aumentare la qualità dei servizi pubblici erogati.

**Parole chiave:** servizi proattivi, interoperabilità, e-government, settore pubblico digitale, pubblica amministrazione.





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EXECUTIVE SUMMARY OF THE THESIS

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## 1. Introduction

Nowadays, e-government is well established and widespread among public organizations, as many governments are increasingly focusing on developing e-government initiatives (Erlenheim *et al.*, 2020). Indeed, an increasing number of services are provided online and progressively more information is available through different databases (Erlenheim *et al.*, 2020). The role of the state is constantly changing, and the government has more functions to accomplish as increasingly more services are expected to be delivered in a more efficient manner to citizens (Sirendi, Taveter, 2016).

## 2. Literature review

### 2.1. Proactive services

The relationship between citizens and PA, during the pandemic, has changed. Citizens have started to expect from the PA services digitally, as private company have done from several years. ICT and digital technologies can help actuate a paradigm shift in the public service provision: allowing the PA to provide proactive services to the citizens,

meaning pushing the service provision rather than waiting for the citizens to request a certain service.

Making a public service proactive is a complicated process that needs a strong e-government infrastructure in order to be completed. A technological integrated and interoperable infrastructure is at the base to reach a proactive service provision (Sirendi *et al.*, 2018).

Additionally, it is fundamental to build and design the service around the citizen and their needs. This is the starting point of the process; hence it is then necessary to take into consideration the needs of the entire stakeholder audience. Therefore, a multi stakeholder approach needs to be taken when designing. Sirendi and Taveter (2016) claim that better and more efficient services can be designed by efficiently modelling stakeholders' roles, goals, interactions, interests, and knowledge through the Agent-Oriented Modelling (AOM) methodology.

The aforementioned design principles are at the base of a proactive service provision approach. The realization of the latter can be facilitated by the concept of moments of life, which can be further divided in "human" life events and business events (Körge *et al.*, 2019). The PA that is able to connect the service provision to the citizens'

moments of life is more user oriented and able to actuate a proactive service provision.

Erlenheim *et al.* (2020) suggests ten design principles necessary to ensure proactivity in service delivery: Wholesomeness, Once-Only Principle, Digital-by-Default Principle, Possibility to Opt-out, Personalized and role and situation-centered, Intuitivity and Simplicity, Transparency, Recent and timely information, Reliability and security and Multilingual access. Then also implementation strategies are suggested by the literature, Kuhn *et al.* (2021) proposes three different strategies that can be followed to reach a proactive service provision: internalized user activities, where the providing entity takes over all the citizen's activities; leverage other parties, where a third party, different from the providing agency, takes over the different activities; and enable the user to automate, where the service provider offers the user the possibility to outsource the activities, making the user the one that triggers the shift.

The increase of facilitation in public services usage can be achieved through the creation of a one-stop shop, which is defined by Wimmer (2002) as "A single point of access to electronic services and information offered by different public authorities". This creates an integrated front office from the citizens' point of view, bringing together and delivering the citizens the information they need through a personalized interface. The one-stop shop is just considered the starting point for proactive service provision, whose further development results in the no-stop shop (Scholta, Lindgren, 2019). The no-stop shop is government service delivery that has an integrated back end and is proactive or predictive (Scholta *et al.*, 2019). It is important noticing that not every government has to go through the one-stop shop in order to achieve the no-stop shop and that not every service can be made fully proactive due to its intrinsic characteristics.

Oude Luttighuis *et al.* (2021) argues that an inverse relationship between the level of proactivity and the amount of interaction effort that a citizen has to perform exists and Erlenheim *et al.* (2020) claims that proactivity can be defined as a spectrum. In their papers the authors propose two different frameworks: Erlenheim *et al.* (2020) suggests the reactivity proactivity spectrum in which he defines

different proactivity stages and Luttighuis *et al.* (2021) presents a framework in which the level of proactivity is determined based on the eligibility process and the delivery process. Concluding not every service can be made fully proactive, thus proactivity has to be considered as a characteristic that has different levels and that can be incorporated with a certain degree.

## 2.2. Interoperability

The delivery of digital and proactive services requires collaboration and seamless exchange of data between government agencies (Kubicek, 2008) and the lack of these interconnections could prevent the provision of the service (Lampathaki *et al.*, 2010). For these reasons, the concept of interoperability, which is the ability to exchange data and to share information and knowledge by using common standards (Er Riyanto *et al.*, 2018), is introduced as a fundamental precondition for e-government and proactive service delivery, as already anticipated by the analysis of the proactive service literature.

Interoperability has a multifaceted nature, meaning that, when dealing with interoperability, governments have to go beyond the technical dimension and covering also the formal and social one (Backhouse, Halperin, 2009). The broad meaning of interoperability reflects on the definitions that the authors gave to the concept. Initially, interoperability was conceived only for the field of information technology and systems engineering services therefore the definitions had purely a technical perspective. Later, the concept was presented with a much broader and high-level view which considers, along with technical aspects, cultural, social, political and organizational factors crucial for ensuring interoperability. The complexity of the concept contributes also to the diffusion of many frameworks describing interoperability as a structured concept composed of different layers (Ordiyasa *et al.*, 2016), each representing a perspective or area where it is necessary to intervene to guarantee interoperability. The frameworks describe many perspectives (layers) of interoperability underlining again its multifaceted nature. Some examples of interoperability layer are: technical, formal, informal, syntactical, semantic or organizational. The evolution overtime of the frameworks reflects the evolution



path followed by the definitions: the older models were centered on the technical layer, while the more recent models gave the same relevance to all perspectives.

APIs are useful tools employed to introduce and enhance interoperability between different systems and players (Vaccari *et al.*, 2021; Puspitasari *et al.*, 2021), in particular the technical aspect (layer) of interoperability, that deals with the design of the technical infrastructure and make possible the actual data exchange between systems. An API is a software intermediary that, serving as an interface, allows two applications or systems to interact and facilitates smooth flow of data (Williams, 2018; Stani *et al.*, 2020). Applied to the public sector APIs can be used by a PA to transfer information of a citizen to another PA, thereby preventing the need to register the same data twice (Once Only Principle) (Stani *et al.*, 2020) and facilitating accessibility and re-usability of information (Vaccari *et al.*, 2021). Therefore, APIs can create ecosystems by establishing interrelationships between various groups of stakeholders. Adoption of APIs in government needs to take into account many aspects: first, the role played by the PA in the API Journey (provider, consumer or publisher) and the data quality matter (Stani *et al.*, 2020); second, general enablers, drivers, barriers and risks, and challenges need to be taken into account in implementing APIs (Vaccari *et al.* 2021); third, all the challenges related to sensitive data and privacy (security, regulation and specifications or standards) (Williams, 2018). Despite the benefits APIs give, a common view, regarding who should define APIs, how they should be defined and whether to standardize their creation, is still lacking (Borgogno, Colangelo, 2019). For this reason, the EU institutions encourage to use open, standardized and well-documented API more broadly. The European Commission started also advocating the adoption of standardized and common data formats and common protocols, in order to facilitate data gathering and processing, in an interoperable manner, from different sources. This would enable the usage of a single type of API to gather and process data across organizations. With this respect, the Single Digital Gateway project would be benefited. Joint Research Center Study on API presents a number of APIs use cases demonstrating

the major benefits that APIs can bring in terms of interoperability.

### 2.3. Research questions

The literature addresses in a comprehensive manner the most efficient frameworks that a country that wants to increase its public sector interoperability has to implement. On the contrary the literature does not specify how to actually introduce the framework in an already existing digital society to reach the objective of building a functioning e-government able to provide to the citizens also proactive services. In our thesis, in order to fill this gap, we will answer the following research questions:

- *RQ1: What are the interventions undertaken by virtuous countries to increase the e-Governance quality?*
- *RQ2: Which are the steps to follow to provide and/or increase interoperability in the public sector?*
- *RQ3: How can the Italian PA provide a higher e-Government service quality to the citizens?*
  - *RQ3.1: Which is the current level of digitalization and interoperability of the local PA in Italy?*
  - *RQ3.2: Which are the interventions that Italy can implement?*

## 3. Interoperability in the Italian public sector

The analysis of the results of the questionnaire, focused on digitalization developed by the Digital Agenda Observatory and submitted to the municipalities, has been fundamental in order to define the actual Italian public sector interoperability situation.

The Italian e-government is defined by the eGovernment Benchmark 2022 as “non-consolidated”, meaning that interventions to increase interoperability and digitalize public serviced are required. Concerning the overall results about internal and external interoperability Italy places itself in a good starting situation since 82% of the respondents have integrated their internal databases and 50% of the municipalities have integrated their databases with external entities’ ones. Particularly on the one hand the internal database integration is widely diffused in

smaller municipalities while, on the other hand integration with external organization is not very spread and much more implemented by big municipalities. In regard to the criticalities municipalities run into, while performing integration projects, it emerges that the municipalities, regardless of their size, do not recognize only the technical aspect of interoperability, but also issues related to organizational, semantic and legal interoperability emerged, highlighting the need to intervene in all the different interoperability aspects to achieve the best solution possible, as the literature and the EIF emphasized.

## 4. E-government and interoperability: case studies from EU countries

The answers to our research questions were found in the analysis of four cases studies about EU countries that present a developed e-government structure and that throughout the past years have performed successful interoperability interventions. The four case studies are about: Denmark, Estonia, the Netherlands and Sweden. For each country we have developed an in-depth analysis about their digitalization journey, their specific interventions and the results that they were able to obtain. On the whole we have been able to gather all the common characteristics observed and cluster them, in order to provide guidance to increase interoperability and e-government quality.

### 4.1. Digitalization approach

The establishment of an interoperable public digital infrastructure cannot be built overnight, for example Estonia took 30 years to develop it and achieve the goal of providing proactive services. E-government experts suggest starting with the services that would most benefit citizens and businesses, working on interoperability between the entities that participate to their provision, in order to digitalize those. This approach will facilitate the citizens' usage of the service and its spreading in the society. Furthermore, a reasoning about the structure of the country service provision, needs to be made. As for countries that provide the majority of services through federal

public authorities creating interoperability is easier due to the larger size and smaller number of entities. While for countries where local governments have more power and provide a great number of services, creating interoperability is harder and more efforts in facilitating collaboration between different entities are required.

### 4.2. Collaboration

Collaboration, between the different public agencies is at the base of a fluent data and information exchange. The experts interviewed have repeatedly highlighted this fact, stressing the necessity to engage all levels of the public administration since the project definition phase, in order to improve the projects' outcomes and create a community. The first step is making the different administrations understand that sharing their data and information is beneficial also for them. Especially in the case of a PA management decentralization, the increase of collaboration is crucial and useful to solve matters of organizational interoperability, such as the alignment of business purposes and processes.

### 4.3. Technical interventions

Even though technical interventions are not the only aspect that countries willing to develop their e-government have to undergo, they are fundamentals. Each country at the beginning of their process has created a consistent digital infrastructure through the development of cross sectoral digital interventions. The most successful example, in this regard, is the Estonian X-Road which is an advanced data exchange layer that connects all information systems and all public organizations in Estonia, enabling secure data exchange and service provision. Additionally, the experts from the different countries suggested some key interventions that countries interested in developing their interoperability have to work on:

- The development of a single digital identification that can be used to access any type of governmental portal and service.
- The availability, for every governmental agency, of basic data.
- The harmonization and standardization of data formats through a common information model.

- The creation of a single point of contact with the citizen, a one-stop shop, where all the services that the PA provides are available and accessible by the citizen.

#### 4.4. Legal interventions

Legal efforts need to go hand in hand with the technical and infrastructural development, in order to achieve successful results. For instance, Estonia in 2001 enacted the Public Information Act that contains all the legal basis of their e-government structure. Legal interventions like the aforementioned one are essential, since define what the PAs can and cannot do, and facilitate, or even force, the implementation of interoperability interventions. One of the most discussed legal issues is data ownership, in the most advanced digital societies the PA does not own citizens' data, on the contrary the citizen is the only holder of their information and can allow a public entity to use their personal data for the service fruition. Moreover, one other issue is related to data duplication, as long as the different agencies will save every data they need in their own databases, interoperability will be hindered. With the introduction of a low prohibiting data duplication the interoperability implementation would be facilitated.

#### 4.5. Incentives

All the interviewed experts stressed the importance of practically implementing and spreading interoperability. The deployment of the interoperability interventions across all the public sector levels is facilitated by a coherent regulatory setting, since laws can be binding and can oblige public entities to implement interventions. Many countries adopt a cooperative approach, involving all the interested since the first phases of the decision-making process. This approach incentivizes the respect of centrally given guidelines due to the fact that they are developed jointly, and every agency believes in them. Another approach widely diffused is binding new funds to the implementation of a part of the interoperability project. This approach is used by Sweden that developed ENA, the Swedish digital architecture, in a modular way and that manages the architecture implementation checking the realization of specific building block and unlocking new funds after their completion.

#### 4.6. Financing structure

The entirety of the country analyzed uses both EU and budget funds, since the grants that the EU provides to member countries are not enough to develop a functioning architecture. Estonia for example uses the EU funds for long term development and budget fund for the system every day running costs. Sweden, for specific projects complements the financing with money coming from the private sector. In regard to project financing every country uses its own method, Denmark for example uses a co-financing allocating 40% to the central government, 20% to the region and 40% to the municipality, in this way the responsibility is shared.

### 5. Methodology

Our master thesis has been structured in a literature review focused on the topics of proactive services and interoperability and in an empirical analysis on the best practices in the field of interoperability.

#### 5.1. Literature review

The literature review is made of two chapters: the first one on proactive services and the second one interoperability. In relation to proactive services, we have analyzed 25 papers and selected 9. The topics and the respective number of papers related are listed below:

<i>Topic</i>	<i>Number</i>
Proactive services	6
Service design for proactivity	4
Moments of life	3
One-stop shop and no-stop shop	2
Reactivity proactivity spectrum	3

Regarding interoperability we have executed two queries and selected 19 papers. The topics and the respective number of papers related are listed below:

<i>Topic</i>	<i>Number</i>
Interoperability definition	11
Interoperability frameworks	4
APIs	5

## 5.2. Empirical analysis

The empirical part of our thesis is composed of two sections: the analysis of the Italian public sector interoperability state and four case studies about four countries with a developed and well-functioning e-government.

The Italian analysis has been based on a questionnaire developed by the Digital Agenda Observatory of Politecnico di Milano and submitted to all Italian municipalities between August and October 2022. The questionnaire has been submitted to all the Italian municipalities and 952 of them answered. We analyzed the questions focused on interoperability, both between organizational units of the same agency and between different agencies, and on e-government interventions aiming at reducing citizens' fulfillments.

Concerning the case studies' analysis, we have interviewed 11 experts from four different EU countries: Denmark, Estonia, the Netherlands and Sweden. We conducted semi structured interviews asking questions related to the level of interoperability in their country, the path followed to reach the actual situation and the main steps they went through, their financing choices and the interventions in regard to organizational issues.

Through the answers received and the information present in institutional website we managed to build four case studies, one per country, and to identify the common characteristics, clustering them and define a guide to increase interoperability and e-government quality.

## 6. Conclusions and future developments

Through the evidence from our empirical analysis, we managed to develop six areas of interventions that supports governments and public administrations in introducing interoperability in the national public sectors. The cluster are digitalization approach, collaboration, technical

interventions, legal interventions, incentives and financing structure.

Our research is affected by limitations which generate the possibility for future developments. Extending the study to not EU countries, focusing future research to some specific layers of interoperability and looking at the private sector experiences are some possible hints for future development aiming at extending the knowledge on interoperability provided by this study.

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# 1 Introduction

E-government paradigm is associated to the usage and application of information and communication technologies to achieve a better government (OECD, 2003). Nowadays, e-government is well established and widespread among public organizations, as many governments are increasingly focusing on developing e-government initiatives (Erlenheim *et al.*, 2020). Indeed, an increasing number of services are provided online and progressively more information is available through different databases (Erlenheim *et al.*, 2020). The role of the state is constantly changing, and the government has more functions to accomplish as increasingly more services are expected to be delivered in a more efficient manner to citizens (Sirendi, Taveter, 2016).

Nowadays, the new advancement in technological innovation is creating new trends and possibilities. Digital innovations, mobile technologies and data, are shaping the world we live in. The widespread diffusion of new digital technologies, open and big data, data analytics practices and the advent of social media is affecting the way the private and public sector area addressing individuals' needs and providing services. Indeed, it is quite usual nowadays, to see people using a multitude of web portals and apps in their interactions with private companies for example with banks, insurance companies, and on e-commerce platforms (Oude Luttighuis *et al.*, 2021). Thanks to the massive amount of big, open and personal data, as well as data analytics techniques, the services offered by private sector organizations, especially the big tech companies, have become data-driven and able to better target customers and their needs. People have gotten used to this a high level of digitalization and personalization in the service delivery, typical of the private sector (Oude Luttighuis *et al.*, 2021).

These new transformations also affected the public sector, with citizens that expect the same level of digitalization and personalization of the private sector in the public service delivery and, in general, in every interaction they have with the government. Therefore, the advent of new digital technologies, open and big data and the demand for government services to become more and more efficient and user-oriented, pushed some of the countries with the most advanced e-government (e.g., Estonia, Taiwan, New Zealand) to start looking into providing proactive services based on and triggered by life and business events (Linders *et al.*, 2018; Kōrge *et al.*, 2019).

Proactivity is seen as the next steps of e-government and digital services development (Linders *et al.*, 2018; Scholta *et al.*, 2019) and it suggests a paradigm shift: from a pull

(i.e., reactive) approach, where the citizen needs and request the service or information to the government, to a push (i.e., proactive) approach, in which the government deliver the service or information to the recipient without their request (Linders *et al.*, 2018; Scholta, Lindgren, 2019). Since proactive services are born from the willingness to provide services personalized on citizens' needs, they should be designed taking the perspective of the citizens itself (Sirendi, Taveter, 2016). Therefore, we could say that proactive services have their roots in the service design thinking and in the user centricity principle (Sirendi, Taveter, 2016), approaches originally adopted by private sector companies to tackle the customer needs.

As proactive services are based and triggered by citizens needs and consequently by life events, the government agency delivering the service needs to actually have available all the necessary data about the citizen in order to provide the service. Therefore, a precondition of proactive event-based service provision is the possibility for different government agencies to share and exchange data about citizens when needed, through better cooperation of state agencies and their information systems (Körge *et al.*, 2019) and integration of databases and information infrastructures (Erlenheim *et al.*, 2020). This is referred to the concept of interoperability, defined as the ability to exchange data and to share information and knowledge by using common standards (Er Riyanto *et al.*, 2018). E-government provides services to citizens and companies based on the information stored in government databases and the lack of interconnection, communication or cooperation between these infrastructures, could prevent the PA to provide one-stop, proactive services oriented to citizens' needs (Lampathaki *et al.*, 2010). A particular trait of interoperability is that, even if it comes from the information technology field, nowadays the coverage of its meaning is wider, including also social, legal and organizational perspectives (Kubicek (2008); Ordiyasa *et al.*, 2016).

Interoperability, along with design of digital services that tackle citizens' needs, have gained so great importance that the EU and also the leading digital governments have strategically prioritized them in their digital programs. Concerning e-government, the "Tallin Declaration on eGovernment" of 2017 provides guiding principles for designing digital, open, accessible, inclusive services that purposefully tackle citizens' needs. The European Interoperability Framework (EIF) instead, represents the main reference point for any digital strategy and interventions concerning interoperability. Through guiding principles, recommendations and the framework for interoperability and digital service design, the purpose of the EIF is to drive and provide guidelines to EU countries to improve their e-government quality.

The purpose of this study is to specifically investigate and deepen the concept of interoperability as necessary precondition for proactive service delivery by means of the most significant scientific literature, papers, reports, governments and EU programs. Additionally, in order to expand this theoretical background and fill the literature gap, it is conducted a detailed analysis of the current Italian situation



concerning interoperability and the gap in terms of e-government quality with the most digitalize countries. Complementing this research, we will investigate the most effective interventions and strategies to practically implement the principles and guidelines proposed in the EIF and included in Italian strategy, by means of case study analysis and interviews with expert working for the most advanced EU digital public sectors.

The master thesis is organized as follows. In the chapter 2 it is included the literature review of e-government and proactive service, followed by the literature review of interoperability as public proactive services foundation. Chapter 3 includes an analysis and overview of interoperability in the Italian context, followed by chapter 4 where case studies on interoperability from EU countries, built through expert interviews and desk research, are presented along with the main evidence obtained. To conclude, chapter 5 describes the methodology used for this study and chapter 6 includes conclusions, research limitations and possible future developments.



## 2 Literature review

### 2.1. Proactive services: the new frontline of public service provision

ICT technologies have influenced and shaped the world and the way in which people live their lives. The pandemic played a role in magnifying this phenomenon, to the point that citizens are becoming more used to obtain services (private and public) digitally.

During the vaccination campaign almost every citizen booked their vaccination appointment using ICT technologies. In this sense citizens who were already used to digital technologies did not encounter any difficulty in booking their appointment, while people from older generations, who generally are not expert in ICT, struggled and needed support. If the responsible public administration (PA), instead of waiting for the bookings from the citizens, had directly contacted them providing the appointments, citizens would have enjoyed the service with less effort than before. Leveraging further the spread of ICT and digital technologies usage, a paradigm shift in service provision could be possible, a change in the relationship between citizens and PA, which does not react to citizens request for a service rather “pushes” or proactively delivers the service to them. This is the exact concept of a proactive service, which we will further deepen in the following chapter.

#### 2.1.1. Definitions of proactive services

The concept of proactive service is defined extensively in the academic literature:

*“Fully proactive services are services that can automatically be delivered without having to interact with a citizen.”*

*(Oude Luttighuis et al., 2021)*

*“Proactive e-services are citizen-centered. They are orchestrated in a way that the user does not need to be aware of them or need to navigate through extensive bureaucratic structures.”*

*(Erlenheim et al., 2020)*

Erlenheim *et al.* (2020) also provided a definition of proactive services in the public sector:

*“The notion of proactivity in the public sector involves providing services to the public on behalf of the government’s own initiative, based on the assumption that citizens support this and based on the data available in the government databases.”*

Additionally, the concept of proactivity is not only explored in academic papers, but it is also tackled by international authorities and governments:

*“Proactive services are the direct public services provided by an authority on its own initiative in accordance with the presumed will of persons and based on the data in the databases belonging to the state information system. Proactive services are provided automatically or with the consent of a person.”*

*(Estonian Government, 2017)*

*“Proactiveness represents the ability of governments and civil servants to anticipate people’s needs and respond to them rapidly, so that users do not have to engage with the cumbersome process of data and service delivery.”*

*(OECD, 2020)*

According to these definitions it is possible to list the characteristics that the proactive service provision needs to have:

- Citizen centric: citizens need to be at the core of the service provision. For this purpose, the service will be built around the citizens’ needs and, as a consequence, it will be easy for citizens to find and obtain the service desired.
- Anticipate the need: a PA that will provide services to its citizens in a proactive way. The PA will not wait for them to request a service, but it will deliver what they need when they need it.
- Data driven: the anticipation of the need is made possible by the data possessed by the PA. Citizens, in order to be the center of the public service provision and to receive the needed services promptly, will be required to give the PA the necessary data it requires.
- Simplification: it will be allowed by a data driven approach. Thanks to the information given by the citizens a more tailored and, as a consequence, simple service provision will be possible. Only the services that a citizen may need will be proposed and provided to them. This, in conclusion, will

remove the burden of bureaucracy from the citizens' shoulders and dealt with by the PA.

Proactive services or proactive government are the response of the PA to the increasing request to "push" services toward citizens, instead of getting them to "pull" services from the PA. The citizen must not seek information or service from the PA, but it is the PA that proactively and seamlessly delivers information and services to them (Linders *et al.*, 2018). Indeed, proactivity can manifest itself not only with respect to services, which are provided "automatically" or "in the background" without input from the user, but it can refer also to information services that guide the user into one designated place (Erlenheim *et al.*, 2020), called the one-stop shop that will be further discussed later. Another perspective to cast light upon the understanding of proactivity of service delivery is attention to life events, that can be used as triggers for the delivery of connected services, for instance, marriage, childbirth or starting a new business (Sirendi *et al.*, 2018). This relation serves also for the purpose of providing tailored services to citizens, exactly because services can be provided once the specific life event, which makes that service needed, occurs.

Proactivity can pave the road towards more inclusive public services, enabling the less experts in technology to benefit from the PA's full spectrum of services (Oude Luttighuis *et al.*, 2021). Proactive services identify administrative effectiveness, efficiency, quality of e-services and, most of all, quality of life for citizens as the objectives for their introduction (Linders *et al.*, 2018). They are the prerequisite for an inclusive, fair, and just society, since they enhance citizens' equal access to public services (Oude Luttighuis *et al.*, 2021).

Precisely around these topics the European general strategies and guidelines, for the EU countries' PAs, are built. For instance, the "Tallin Declaration on eGovernment" sets some principles and objectives to make the PAs of all EU countries open, efficient inclusive and able to provide personalized and digital end-to-end public services to all citizens and companies.

### 2.1.2. How to reach proactivity

In what follows the first steps and pre-condition for proactivity are reported. First, we describe the process that leads to the concept of proactive service delivery, from the e-government concept, the one-stop shop, and no-stop shop to the paradigm shift concerning exactly the public service delivery from reactive to proactive provision. Second, the necessary preconditions and enablers of proactivity, namely, technology, data, and interoperability, are explored.

Proactivity is a very important characteristic to add to the services provided PAs, but it cannot be built overnight. In order to provide proactive services to citizens it is important to have a strong e-government infrastructure.

*“The term “e-government” focuses on the use of new information and communication technologies (ICTs) by governments as applied to the full range of government functions. In particular, the networking potential offered by the Internet and related technologies has the potential to transform the structures and operation of government.”*

(OECD, 2001)

*“Electronic government refers to the use of information and communication technologies, and particularly the Internet, as a tool to achieve better government.”*

(OECD, 2003)

*“Egovernment refers to the use of information and communication technologies (ICT) - such as Wide Area Networks, the Internet, and mobile computing - by government agencies.”*

(UN, 2008)

The initial purpose of building an e-government infrastructure is to allow the PA to deliver services in an efficient and timely way, through digital means. Indeed, the process toward e-government is traditionally covered by established maturity models that focus on digitizing the traditional government functions and sequentially digitizing information, government-citizen interactions or transactions and service delivery (Sirendi, Taveter, 2016). The maturity models typically saw, as full maturity stage for the e-government, the realization of a one-stop shop, in the form of unified online portal (Linders *et al.*, 2018) where all the information and services are available in a single place for citizens and companies. Nowadays, this stage of the evolution of government's service provision has been achieved by many developed countries (Linders *et al.*, 2018). The UN found out, in its E-Government Survey of 2012, that 135 countries offered a one-stop shop website, concluding that it has become a “norm in most developed countries”. Some major examples are represented by USA.gov, Gov.UK, Singapore's eCitizen Portal or Taiwan's My E-Gov, and in the European Union the Estonia's Eesti.ee or the Denmark's Borger.dk. Nowadays the trend for these countries, is to work for increasing the digitalization, the efficiency, and the timeliness of these services, decreasing the time citizens have to wait before obtaining the requested service and increasing the number of services available online.

The paradigm shifts in service provision is the next step (Linders *et al.*, 2018; Scholta *et al.*, 2019): it is not only about making the PA more efficient through moving the whole system on electronic means as in the e-government model, but it is about proactively embed tailored public services into the citizen's everyday life (Linders *et al.*, 2018). This new possibility is given by the exponential advancement and rapid diffusion of new

technologies, mobile connectivity, big and open data, and data analytics (Linders *et al.*, 2018; Sirendi, Taveter, 2016; Erlenheim *et al.*, 2020; Oude Luttighuis *et al.*, 2021). The proactive approach to service delivery distinguishes itself from the reactive and traditional one: in the former the service is pushed by the PA before receiving an explicit request from the recipient, in the latter the service is pulled by the receiver of the service (either a citizen or a company) (Linders *et al.*, 2018; Sirendi *et al.*, 2018; Scholta, Lindgren, 2019; Scholta *et al.*, 2019; Oude Luttighuis *et al.*, 2021). In the reactive version, the recipient of the service assumes both the role of initiator, requesting a service to fulfill a specific need that arose, and the role of controller of the service, ensuring that the right information is sent to the right and responsible PA (Scholta *et al.*, 2019; Kuhn *et al.*, 2021). The flow of the service therefore is from the citizen (or company) to the government, the final user requests a service, and the public administration simply reacts to the request by starting the service provision process.

By exploiting the new technological means, it is possible to change the service flow, from the government to the citizen: it is the PA that initiates the process by directly pushing and delivering the service to the citizen in a proactive way, without the need of their request. With this approach the service user does not assume the role of initiator and controller of the service anymore. Consequently, proactive service serves also as a mean to reduce the effort that the citizen would have experienced to get the service, by freeing the final service user of administrative burden that will be taken over precisely by the PA. Changing the approach to service provision by moving from reactivity to proactivity, entails assuming a creative and suggestive position rather than responding to a situation after it has occurred (Erlenheim *et al.*, 2020).

The goal of these efforts is to move from a model of passive and static information repositories towards proactive, integrated service and information delivery coupled with data-driven personalization (Linders *et al.*, 2018). It is worth noticing that proactive services go beyond the provision of the service before it is asked, as it comprehends the possibility to offer a customized service tailored on the needs that could occur during the service recipient's life (Linders *et al.*, 2018; Sirendi, Taveter, 2016; Sirendi *et al.*, 2018; Scholta *et al.*, 2019; Oude Luttighuis *et al.*, 2021). For this reason, it is of crucial importance that these concepts will be deeply covered: the centrality of the user, the understanding of their needs and the connection of the needs with the life events when they could occur (Linders *et al.*, 2018; Sirendi *et al.*, 2018; Körde *et al.*, 2019; Scholta *et al.*, 2019; Erlenheim *et al.*, 2020; Kuhn *et al.*, 2021; Oude Luttighuis *et al.*, 2021).

After having described the necessary starting points, represented by e-government and one-stop shop, and the service delivery paradigms, the second contribution is to set which are the necessary pre-conditions and enablers of proactivity.

As understood also before, technology is key, and it is seen as an enabler for the transition from a stage of citizen-to-government to a stage of government-to-citizen.

Proactive services ought to be supported by the government technological infrastructure that needs to be integrated (Sirendi *et al.*, 2018); database, data standardization and information sharing are some of the prerequisites for proactivity. Leveraging big data and data analytics is essential in this transformation since they enable high personalization, the anticipation of citizens' needs and to deliver just-in time services (Linders *et al.*, 2018).

As citizens would not trigger services themselves anymore, proactive public services require exchanging information between different governmental organizations, which in turn requires some level of collaboration (Oude Luttighuis *et al.*, 2021). In this path, it is clear that an efficient cooperation between state agencies, as well as between information systems, is crucial (Körge *et al.*, 2019). The concept of interoperability, which will be analyzed extensively in the following paragraph, assumes crucial importance in the journey towards proactivity, as, in this context, it refers to the capability of different information systems and databases of dispersed government agencies to interface and communicate with each other exchanging and making use of data collaboratively. Behind the interoperability prerequisite there are several issues regarding data standardization, information sharing and data access, necessary for the PA to gather all the data, coming from other sources, needed to provide a certain proactive public service to citizens.

However, database interoperability and technology, as well as e-government infrastructure, one-stop-shop, are necessary but not sufficient conditions for proactive e-services, as they represent the foundations and basic conditions for the introduction of proactivity in the public service provision. Proactive services have to be thought as socio-technical systems (Sirendi *et al.*, 2018), where all the preconditions presented above, are crucial but just a part of the problem belonging to the technical sphere of the system. A remarkable attention needs to be devoted to the social sphere, namely to user and citizens:

*“Proactive public e-services should be designed in a way that supports the automation and intelligent processing of already available information to reflect the purpose of meeting the needs of different stakeholders yet maintaining a people first policy.”*

*(Sirendi, Taveter, 2016)*

This characteristic of proactivity in the public service domain will be addressed in the following paragraphs where additional steps and “ingredients”, functional for the actual design and development of proactive services are described. As starting point, some fundamental characteristics of service design are introduced, in particular the user centrality. Connecting to the idea of socio-technical system just stated before, for the creation of proactive services, the user has to be at the center of the service design enabling the provision of tailored services build around their needs. Later, following



the objective of providing customized services for the users, the concept of life event is introduced. The user-centric approach entails taking the perspective of the service recipient with the objective of providing the right service when it is needed, therefore a focus on the needs that encounters in different moment of life is essential. Lastly, an overview of the notion of one-stop shop is developed, described as a starting point to respond to the objectives at the core of proactivity: diminishing the effort the user needs to employ to obtain the service and reducing the information that they need to provide to the PA. One-stop shop is conducive for these requirements being a comprehensive digital environment where all the services that the user may need from the PA are present.

#### 2.1.2.1. Application of service design to proactivity

At the end of the previous paragraph, we highlighted the need to assume a socio-technical approach and perspective towards proactive services development. Technology, data, and interoperability are the pre-conditions for proactivity but further characteristics belonging to the “social sphere” of proactivity need to be addressed. Therefore, in the following paragraph these additional features of proactivity, useful for proactive services design, development and implementation are reported. First, we introduce the concept of service design applied to public institutions, seen as a mean to build public services that purposefully satisfy the needs of the service recipient, by putting the final user at the center of the design process and creating services customized on their needs. Second, we express the necessity to consider not just the needs of the users but the needs of all the stakeholders involved in the service provision. For this purpose, the literature proposes the Agent-Oriented Modelling (AOM), a tool that supports the detection of desires and needs of all the stakeholders involved in the service provision. Finally, we demonstrate how these tools and concepts could be applied for the proactive service design since service design theory, AOM and proactivity have in common the final goal to create and provide services tailored on users', citizens', or stakeholders' needs.

First, an introduction of the service design concept is necessary, since a public service, whether reactive or proactive, needs to be designed following the users' needs and requests, especially nowadays that citizens' demands, and needs changed with respect to the past; thanks to the new technologies everything has become faster and easier, and citizens expect the same from the public service provision. The application, by the government, of service design principles is the response to the changings in the citizens' expectations.

The term “service design” was firstly introduced by Lynn Shostack in 1982 (Erlenheim *et al.*, 2020) and it is a set of methodologies and tools through which the organization or PA seeks to create better, more user-friendly, and more usable services (Erlenheim *et al.*, 2020), making sure they are creating value for the user.

*“Service Design involves understanding and re-configuring people, infrastructure, and resources involved in delivering a service for the purpose of improving the service experience—with the public, internal and external service users, internal operators, or others.”*

(OPSI, 2022)

*“Service Design is about making government services easy for people to use. This means designing services that put people at the centre and help them do the task they need to do, like learning to drive or buying a house.”*

(New Zealand Digital Government, 2021)

Therefore, the essence of service design is user centrality as it puts the customer at the center of the design process, thus it aims at genuinely understanding the customer beyond merely statistical descriptions and empirical analyses of their needs (Erlenheim *et al.*, 2020). Applied to the public sector, the concept of service design enables the PA to create public electronic services that would truly and purposefully meet the needs of citizens, businesses, and NGOs, as this approach places the service users, and their needs, at the center (Sirendi, Taveter, 2016).

It is worth noticing that, when the concept of service design was discussed, the term “customer” was used to refer to the user of the service; this is due to the fact that service design principles are more commonly applied in the private sector, namely by private companies and enterprises. It is a design tool used with competitive purposes: it enables private businesses to increase the awareness about their customers’ needs, in order to propose high-quality services that truly pursue the market needs, finally, leading to more market share and higher customer retention.

Instead, our domain of analysis is the public sector where, even if the service design tool of the private sector is applied, there are not the same dynamics of competition over the service users (customers in that case). If users have needs that could be fulfilled by a specific public service, they are forced to address the responsible PA. Therefore, in this context it is possible to refer to the service recipients as “citizens” or, in order to be more comprehensive and considering also companies, using the original term “users”. Again, the application of the service design logic to the public sector is valuable because it enables to incorporate, to the public sector, the “market perspective” of the private sector, by deeply understanding the customers (citizens or users in the public domain), to offer a customized service suitable for their needs. However, the two domains need to be distinguished, as well as the terminology to refer to the service recipient, since dealing with customer in the private sector is not the same, for the service provider, as dealing with citizens or companies in the public sector.

Second, once having established the importance, for service design, of understanding and following the user's needs, it is necessary to enlarge this approach to anyone involved in the service delivery. According to Sirendi and Taveter (2016), even though user centricity is a key concept in service design, it is more accurate to consider the entire group of stakeholders involved in the service instead of just the users. Indeed, each service comes with at least two stakeholders: service provider and service consumer. Referring to public services, stakeholders could be divided into groups, depending on their role in the society, such as citizens, public servants, and representatives of an organization (company or NGO). Indeed, the most virtuous applications of service design comprehend the involvement of several service stakeholders in the process, precisely to gather feedbacks, validate the idea and really understand the needs, through a co-creative and collaborative approach. Therefore, multi stakeholder approach needs to be taken when designing and developing public sector services.

It is Sirendi and Taveter (2016) who claimed that better and more efficient services could be designed by efficiently modelling stakeholders' roles, goals, interactions, interests, and knowledge. For this purpose, AOM methodology to service design is suggested and applied by the authors to model the service of family benefits in Estonia (Figure 1).

Being "agent oriented", this methodology is very aligned with the user centricity characteristic of the service design and, therefore, with the willingness to offer highly customized services, tailored for the citizens' needs. Indeed, it is argued (Sirendi, Taveter, 2016) that by using AOM in the service design context, it would be possible to address more precisely human aspects and gain a better understanding of the existing issues in public electronic services.

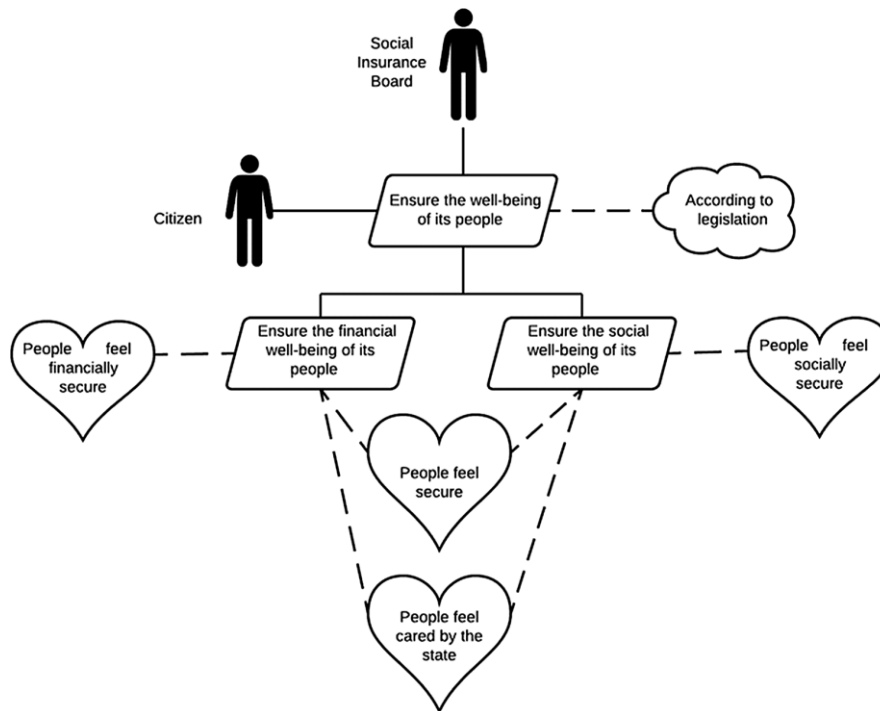


Figure 1: AOM model for family benefits in Estonia (Sirendi, Taveter 2016)

The concept of personalization and provision of tailored services, through service design approach, is one of the purposes that proactive services aspire to reach as well. Therefore, service design, together with user centricity and service customization based on user needs, are linked to the concept of proactivity. Providing customized services means offering the citizen choices “designed around their needs, not the needs of the provider” by “inferring, predicting, and possibly even influencing citizens' behaviors and needs” (Linders *et al.*, 2018). This is at the base of proactive approach to service provision, where the PA triggers the service on behalf of the citizen who does not need to be aware of the service or generally does not need to navigate through extensive bureaucratic structures (Erlenheim *et al.*, 2020). Consequently, for designing proactive services, service design thinking and AOM, are again instrumental because as users (agent) and personalization-oriented, they intrinsically support the notion of proactivity (Sirendi, Taveter, 2016).

#### 2.1.2.2. Proactive services and moments of life

The aspirational objective of personalization, that was defined through the design principles presented in the previous paragraph, requires a further step of connection between the public services provided and the needs of the citizens. This connection can be found in the service design metaphor of life events thanks to which it is possible to increase the citizen orientation of the public service provision (Körge *et al.*, 2019).

The life events can be “human” life events and business events (Körge *et al.*, 2019). The former are situations that a citizen may find themselves in during their lifespan in which they may need a service from the PA, these services range from the services

necessary when having a child to the ones needed when looking for a job. While the latter are services that a citizen may need when opening a business, when managing it or when they may need to close a business (Erlenheim *et al.*, 2020). This division helps during the service design phase, deepened in the previous paragraph, and in the actual proactive service provision. Indeed, authorities of different governments are starting to provide services once a life event occurs, letting the latter trigger the former. Additionally, some services are provided as a bundle to the citizens that goes through a life or business event (Sirendi *et al.*, 2018). For example, when a citizen decides to open a new business, once he starts the legal practices needed and the national authorities know their intentions, all the services needed in such occurrence will be delivered to them.

The metaphor of the moments of life can be further complemented with the concept of complex life events: as Erlenheim *et al.* (2020) discussed in their paper, some events occur for every citizen while some other events (e.g., having a disabled child) happen only to few citizens. The introduction of complex life events will allow the complete categorization of all the services provided and will also simplify the provision of these services personalizing it for every user.

Therefore, the connection between service provision and the life event concept supports the PA in being more user oriented and in delivering services proactively, as in this way they are able to associate and provide in a personalized way, what citizens need, when they need it.

### 2.1.2.3. Design principles and implementation strategies for proactive services

Once the service design background and the concept of life events are framed, it is possible to understand the principles guiding the design that is specific to proactive services. From what emerges by the literature review, there is no guidance on how to redesign government processes and service delivery for proactive services in practice. A limited number of studies proposes general and theoretical design principles and implementation strategies, which integrate the concepts of user centricity, life and business event already deepened, together with proactive services.

Starting from the design principles, some are proposed by Erlenheim *et al.* (2020) as necessary to ensure a proactive service delivery:

- Wholesomeness – The proactive service is mostly organized in an “invisible” manner, delivered automatically or with single communication time and triggered by a life or business event.
- Once-Only Principle – Service is provided proactively, taking into consideration the citizen’s presumed will and utilizing existing information in governmental databases. PA will not repeatedly ask for information that has been previously given to them by the person.

- Digital-by-Default Principle – Accessibility to the service through digital channels. The service is also provided through other channels in order to follow citizens' preferences.
- Possibility to Opt-out – The citizen has the possibility to “exit” from the proactive e-service format, with always the chance to return, opt-in.
- Personalized and role and situation-centered – The provision is based on the person's preferences and originating from the life events and personal situation.
- Intuitivity and Simplicity – Service environment and service provision are designed in an intuitive and simple manner.
- Transparency – It is clear to the person how the provision and processing of the service transpires and also what are the obligations of all stakeholders.
- Recent and timely information – The citizen has always access to the latest relevant information.
- Reliability and security – The citizen trust the PA sufficiently to allow its personal data processing.
- Multilingual access – Services and related information are provided in all most widely used languages.

This list of principle is similar to the one proposed in the “Tallinn Declaration on eGovernment” approved in 2017. The Declaration sets objectives and principles, for the 2018-2022 five years term, guiding the EU countries “to strive to be open, efficient and inclusive, providing borderless, interoperable, personalized, user-friendly, end-to-end digital public services to all citizens and businesses – at all levels of public administration”.

The principles are as follows:

- Digital-by-default – Guarantees that European citizens and businesses can interact through digital channels with the PA, provides them a consistent and high-quality user experience and work to increase the citizens' readiness towards the digital interaction. To do this, the services have to be built around the citizen's needs following the principle of user-centricity.
- Once-only – Citizens provide their personal data only one time, after that the PA, already holding them, is not allowed to ask the citizens again for data.
- Trustworthiness and security – Privacy and security of information need to be provided to the citizens and maintained in all the different typologies of service provision.

- Openness and transparency – It is fundamental to provide citizens and businesses a better alternative to manage their personal data held by the PA.
- Interoperability by default – The EU will work on the interoperability 'framework on a national level, respecting the relevant national standards.

These two lists of principle overlap with reference to the principles of once-only, digital by-default, security, and transparency. The last principle proposed by the “Tallinn Declaration on eGovernment” is important and at the base of proactive service provision and for this reason we will deeper explore it later.

The second point is the classification of implementation strategies for proactive services. For this purpose, Kuhn *et al.* (2021) identified recurring challenges in the redesign of government processes for proactive services and summarized them into three dimensions. Based on such dimensions, three implementation strategies to overcome the challenges are suggested. The three dimensions identified are:

- Service Trigger, which responds to the question “By whom is the service triggered?”. In a proactive service the trigger has to happen without the user. It is crucial to identify “which non-user entity has the necessary information to trigger the service”. The entity does not need to be necessarily the service provider as it could be another PA involved.
- Data Collection answers to the question “How is the data collected?”. In a proactive version of the service, since the aim is to minimize the user’s efforts, the data has to be collected by other entities, either by one central player in a concentrated effort or by decentralized and distributed entities.
- Process Control has as central question “Who is controlling the process across the involved entities?”. In the provision of a service, several public (or private) entities are involved and normally the orchestration of these parties is a central user effort, which has to make sure that the right sequence of steps is performed. In proactive services this control over the process is not the user’s responsibility anymore.

On top of these dimensions, three implementation strategies for proactive service delivery are suggested (Figure 2).

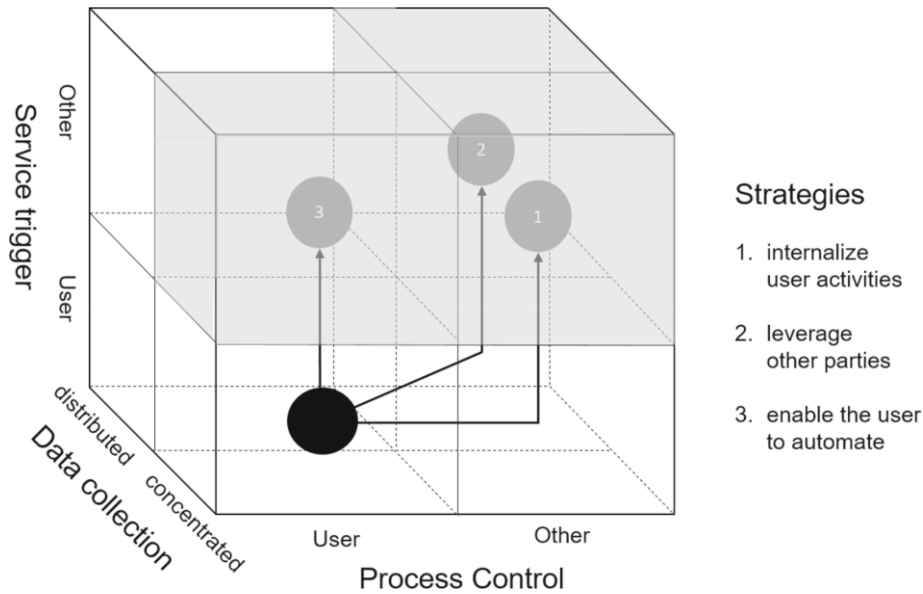


Figure 2: Implementation strategies represented through the three-dimensional space (Kuhn *et al.*, 2021)

With internalized user activities, the entity providing the service takes over all the activities and responsibilities that in a reactive service are performed by the user. The service is triggered, the data is collected, and the process is controlled directly by the providing institution.

The second strategy is similar, the only difference is that the service provider leverages on other parties' support in taking over the user activities. The other party could be another public entity involved in the service provision or a trusted organization. The third party could support in all the activities: as a trigger of the service, by notifying the providing entity based on an event, as a data collector by being organized by the providing entity to provide data necessary for the service provision and as process controller, orchestrating different phases of the service request.

The last alternative is enabling the user to outsource. This means that the service provider offers the user the possibility to outsource the activities to a trusted intermediary, which could be a person, an organization or a software such as an app. This differs from the others because the trigger is still the user that decides to receive the support of an intermediary.

In order to show the applicability of the strategies the author considers as an example the service concerning the request for a university grant. This is a simplified version of the service, including only the providing entity and the university since the income of the student's parents is not required, as it has the only purpose of giving a practical representation of the strategies.



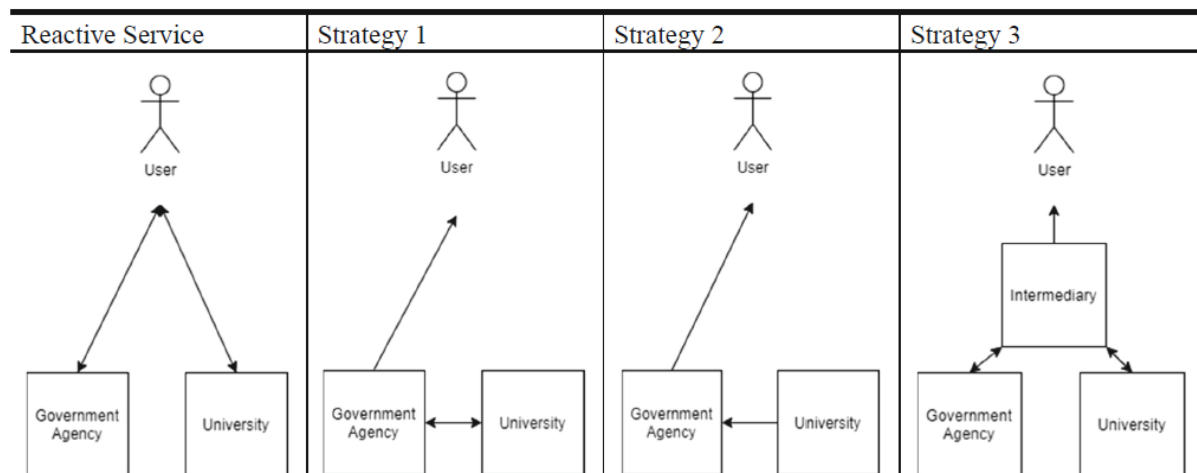


Figure 3: Schematic visualizations of the implementation strategies for an exemplary service (Kuhn *et al.*, 2021)

Normally, in a reactive scenario, the user has to perform two two-way interactions with both entities: first the student (user) has to request the enrollment certificate to the university, then, after the certificate is provided, it is used to apply for the grant to the agency. In both phases of the overall service, it is the user who triggers the interactions and controls the process. In addition, the data collection is performed entirely by the user, namely in a concentrated manner.

Applying the first strategy (internalize user activities), the service is redesigned in such way that all the activities are performed by the government agency itself: it carries out a two-way interaction with the university to obtain the certificate which later is used to directly provide the service to the user in a one-way interaction. In this case the agency is responsible for all the three dimensions, as it triggers the service requesting the certificate to the university, it control the process flow and it gathers the necessary information and data on its own in a concentrated way.

Pursuing the second strategy, it is the university that triggers the service by providing the agency, in a one-way interaction, the enrollment certificate of the student, which can immediately be used to provide the service to the user. Following the “leverage other parties” strategy, it is the university that serves as a trigger and controller of the service. Data collection is organized on a distributed way, the parties (only the university in this example) provide the data they are responsible for, necessary for the delivery of the service, to the service providing agency.

Following the third strategy, the university and the government agency allow an intermediary to take over the user activities. The intermediary obtains the certificate from the university through a two-way interaction and uses the certificate to apply for the grant to the agency. After receiving the service, the intermediary provides the service to the user in a one-way interaction.

From these implementation strategies and their application on a practical example, the support role played by technology in the proactive service provision is clearly understandable. The third strategy, outsourcing the activities to an intermediary, could be automated using a software-based solution. This is relevant because in the proactive service provision the PA can enable, for instance, proactive delivery by supplying application programming interfaces (APIs). APIs are software intermediaries that allow the exchange of information between two different databases, in the university grant example, the intermediary can obtain the certificate from the university and transfer it to the governmental agency through APIs, reducing the time and effort needed for the service provision (Kuhn *et al.*, 2021). In addition, it is possible to find again the concepts of collaboration and interoperability between different entities, which could be applied to make the process of gathering data in a centralized way, leaner and smoother. This is visible in the first strategy, where the government agency has to request the certification to the university: if their databases were interoperable, the agency could directly access the certificate without sending request to the university and, therefore, avoiding the time-consuming two-way interaction.

Despite the implementation strategies provide valuable insights for the proactive services development, they have some limitations, since they strongly depend on the type of service they are used for. In this case, it is taken for granted that the student is interested in receiving the university grant, since in each strategy the service is triggered always by someone else other than the final user. This leads to infer that these implementation strategies are suitable for services that a user (citizen or a company) surely requests in their life, which could be services connected to duties that a citizen or a company must fulfill; so, the service could be pushed to the user without a specific request. For other services, in which the user could, theoretically, refrain from receiving them, it is necessary to receive a request that triggers the service or, at least at a certain point of the provision, it is necessary to ask the user to express willingness to receive the service. This reasoning allows us to introduce the concept of level of proactivity or desired level of proactivity according to service characteristics, which are topics that will be covered in paragraph 2.1.3 of the literature review.

#### 2.1.2.4. The journey towards no-stop shop

Before going in dept with the one-stop shop and no-stop shop approaches to service delivery, some considerations are necessary. Public service delivery generally is generated by the citizen who actually needs and requests it. When the citizen starts this process, data necessary for the provision, are collected through interfaces between the citizen and the PA. Consequently, the data are stored in databases and finally, they are used to deliver the service. In this context, forms have played a crucial role in the initial step of the service delivery, as primary interface between citizen and government and primary mechanism for collecting the information required to trigger

the service delivery. It is well known that forms, to be compiled for every single service requested or every interaction with the PA, have a negative impact on citizen's experience, who would desire to provide the same information once only and that data are shared between different government departments (Scholta *et al.*, 2019).

One way to deal with this issue is to implement a one-stop shop which is defined by Wimmer (2002) as "A single point of access to electronic services and information offered by different public authorities". It is seen as a single point of contact where the PA can collect data for one or more services through a single, integrated digital form (Scholta *et al.*, 2019). Without a one-stop shop, every government department is likely to have its own citizen interface (e.g., forms), and citizens must contact each government department individually, distributing their data themselves. While, with a one-stop shop, the interface also referred to as the front office is integrated from a citizen point of view. The one-stop shop should be citizen-centric by being structured according to life and business events, offering support in compiling online forms (Scholta *et al.*, 2019).

The one-stop shop also supports the information provision for citizens. In order to reduce their efforts in searching the needed information, as Sirendi *et al.* (2018) discussed, it is necessary to bring together information and deliver it to citizens through a personalized one-stop shop. Citizens will no longer need to spend time searching through different websites and going directly to the different PA websites to obtain a service, but through a simple search in the one-stop shop portal citizens will be able to find the information and services they need.

So, the one-stop shop does not overcome completely the issue of interface: it enables to reduce the number of forms that a citizen needs to compile by combining and integrating them, but a form is still needed as primary mean to collect the information. For this reason, even with the one-stop shop it is still the citizen that triggers the service in a reactive way. Despite this, the fact that the one-stop shop is oriented to increase citizen satisfaction by reducing confusion (Scholta *et al.*, 2019) and the amount of bureaucratic effort for the citizens, it is considered as the starting point for proactive government and proactive services, not the ending one.

Given the limitations of the one-stop shop, (i.e., it still requires a compiled form to collect the information, it does not integrate the back end and the services remain largely reactive, as the citizen still needs to trigger the service) and the emergent paradigm of proactivity, the literature proposes a new approach which is the no-stop shop. As discussed by Scholta and Lindgren (2019) the single user interface provided to citizens by the one-stop shop can be further developed in order to relieve the bureaucratic burden from the citizens by becoming a no-stop shop, where "services are delivered proactively and predictively, and no data is to be transmitted from the recipient". The no-stop shop is government service delivery that requires no forms, has an integrated back end and is proactive or predictive (Scholta *et al.*, 2019). In this

new approach, every step of the service provision, (data collection, data storage and data use) exposed in the introduction, changes: data collection is developed to a point that citizens do not have to provide data to the government; data storage is such that all departments of the government have access to all citizens data; data use has evolved to the point in which services are delivered in proactive or predictive way (Scholta *et al.*, 2019).

The aforementioned typologies of service delivery, proactive and predictive, are deepened by Scholta *et al.* (2019), who specifies that the difference between the two, is related to the moment in which the PA triggers the service: before the need for the service emerges, for the predictive service provision or in the moment in which the need for the service emerges, for the proactive service provision. For instance, the issuing of a visa for an international student who has applied for a semester abroad is a proactive service, since the service is triggered by the PA when the student's application for the university is approved. Instead, an example of predictive service delivery is the renewal of the passport or the identity card. The PA can send a new document before the old document expires: this is predictive since the PA provides a new document before the need for a new document arises, avoiding, in this way, an action from the citizen.

So, with respect to traditional e-government stage model of one-stop shop, the no-stop shop differs for many dimensions. First, while the one-stop shop focuses on integrating forms, the no-stop shop aims at their elimination. This step requires that the government departments share information about citizens, collect these data without citizens' involvement and anticipate the citizens' needs (Scholta *et al.*, 2019). Second, while the one-stop shop stage highlights the need for interoperability of IT systems, standardization and integrated databases, the no-stop shop emphasizes a native integration of data storage across government departments achieved, not necessarily with interoperability but through a single database (Scholta *et al.*, 2019). Third, the one-stop shop aims at aligning government services to citizens' needs, while the no-stop shop goes beyond the traditional personalization according to citizens' needs by not only offering and recommending personalized services to citizens but also initiating and delivering services without requiring an input or a trigger from citizens (Scholta *et al.*, 2019).

Scholta *et al.* (2019) proposed an updated e-government stage model that includes also the newly introduced concept of no-stop shop. The model supports the transformation of e-government from one-stop shop to no-stop shop.

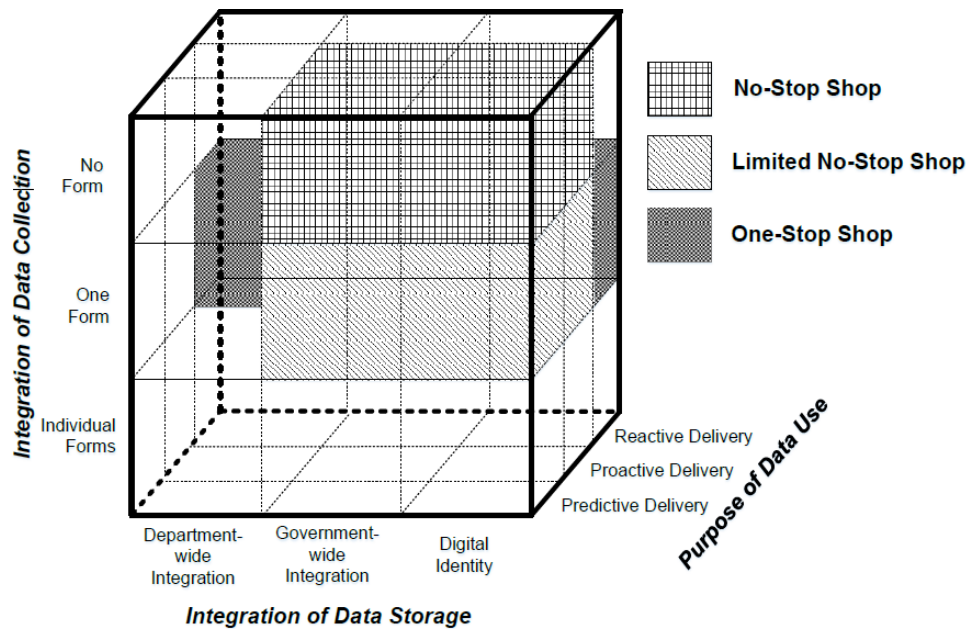


Figure 4: Scholta Framework (Scholta *et al.*, 2019)

The model described is structured based on three dimensions. The first is integration of data collection which refers to the forms management and has three stages:

1. Every government department has its own form to obtain data from citizens.
2. All the government departments gather data from citizens through a single form.
3. Government departments do not need a form to collect the necessary data, because they have other sources rather than citizens.

The second dimension is integration of data storage which deals with data management and sharing between the different government departments. An integrated data storage means that all the government departments can access all the PA databases. This allows to eliminate, or at least reduce, the forms that need to be filled by citizens since the majority of the data that a government department needs will be already available in the PA databases. It is possible to highlight in the data storage dimension three stages:

1. Department-wide integration: each department has access only to its own data.
2. Government-wide integration: each department has access to its own and the other departments data (this can be achieved through a common database or an interoperable IT system).
3. Digital identity: the data ownership and management are transferred to the citizens, who have the right to decide the data that a certain public organization can access.

The third dimension is purpose of data use which can be: reactive delivery, proactive delivery, and predictive delivery. Having a proactive or predictive delivery is fundamental to determine the achievement of the no-stop shop.

These three dimensions together allow the derivation of the e-government stages, namely: one-stop shop, limited no-stop shop and no-stop shop.

The one-stop shop is distinguished by an integrated front end that uses a single form to gather and integrate data from citizens and a distributed and fragmented back end. The defining feature of the one-stop shop is the integration of data collection which can span across all the three stages described above. The service provision is neither proactive nor predictive since it always requires an input from the citizen to trigger the service provision.

The limited no-stop shop is the intermediate step between the one-stop shop and the no-stop shop. In this stage the PA provides proactive and predictive delivery but, in order to do so, an action from the citizen is still needed: first, the PA verifies the citizen's eligibility for the service, second, the decision is communicated to the citizen without the need of their involvement, third, some missing data are needed and collected from the citizen through a single form. For a comprehensive application of the limited no-stop shop stage an integrated data storage is required, particularly a government-wide or digital identity data storage integration is needed.

The last stage, no-stop shop, does not require any form to be filled by the citizen even after the delivery of the service from the PA. This is possible thanks to the government-wide or digital identity data storage integration which allows the PA to have all the data necessary for the service provision. During the service delivery data between different government departments are aggregated in order to provide the service proactively or predictively, without any action needed from the citizen. It is worth noticing that in the case in which the PA misses some necessary data for the service delivery the no-stop shop is not applicable, and the limited no-stop shop has to be put in practice.

The authors argue that not all the governments go through all the three stages described in the model and, since not all the services can be made predictive or proactive, the final configuration of a government can be a combination of the different stages: some services, due to their characteristics, are better provided through a one-stop shop, limited no-stop shop or no-stop shop. An example can be the life event "opening a business", the services needed by a citizen that opens a new business, since the PA is not aware of the citizen's intentions, are unlikely to be provided in a proactive or predictive way.

Concerning the no-stop shop stage, a further consideration can be made, public services can be distinguished in compulsory and voluntary. In the no-stop shop case, differently from the one-stop shop one, the service delivery is completely managed by the PA and the citizen does not have a voice in the service provision. On the one hand,

for compulsory services no issues arise since the citizen is obliged to carry out them and having the PA doing it on their behalf brings them only benefits. On the other hand, for voluntary services some considerations are needed. A voluntary service can be provided through a no-stop shop if it provides clear benefits and no disadvantages for the citizen, otherwise an action from the citizen is needed (i.e., communicating whether receiving the service) and a no-stop shop is not applicable (Scholta, Lindgren, 2019).

This thematic about delivering services with the right level of proactivity will be extensively analyzed in the following paragraphs.

### 2.1.3. Reactivity proactivity spectrum

Proactivity in public services aims to flip the relationship between the citizen and the PA, by providing the service without an explicit request from the citizen which results in the elimination, or at least reduction, of interactions and efforts that the citizen needs to perform to get the service. One of the purposes of proactive service is exactly the willingness to free the final user from the administrative burden and transferring it to the service provider, in order to provide a positive experience by offering a service for which the user does not have to take care of. Therefore, the introduction of proactivity in service provision is connected to the efforts required by the citizen to reach the service (Kuhn *et al.*, 2021):

*“In a continuous interpretation, proactivity of a service can be seen as inversely proportional to the interaction effort the has user to get the service”*

This is something remarked explicitly by Oude Luttighuis *et al.* (2021):

*“An inverse relationship exists regarding proactivity and the amount of interaction effort a citizen has to put in the entire service process.”*

On these bases, the literature argues that the main variable to be considered to assess the proactivity of a service is exactly the amount of effort or interaction that a citizen needs to perform to get the service (Oude Luttighuis *et al.*, 2021). It is then easily understandable that public services cannot be merely reduced to a dichotomous classification between reactive and proactive. Since the levels of user effort in obtaining a service could be multiple, more levels of proactivity exist:

*“Proactivity could be looked at more like a scale or spectrum rather than a fixed point in service delivery.”*

(Erlenheim *et al.*, 2020)

The literature specifies that not all public services can be transformed into proactive service or, more generally, not all public services could have the same degree of proactivity due to some structural feature of the service itself:

*“A wide range of service characteristics influences the suitability of a public service to be a candidate for becoming a proactive service.”*

*(Oude Luttighuis et al., 2021)*

However, many services could benefit from the incorporation of a certain proactivity level. Many questions arise regarding what the right level of proactivity is, therefore, it becomes necessary the introduction of a framework for the assessment and the classification of proactive services.

The literature studies explored propose some models of reactivity proactivity spectrum. Erlenheim *et al.* (2020): provide a framework based on some empirically witnessed stages, through real-life examples and on other stages defined “aspirational” (Figure 5).

Proactive	
Aspirational and future developments	<b>Life-event-based services.</b> Services are functioning in the background.
	<b>Life-event-based services.</b> Person does not have to express will but needs to approve service provision.
	<b>Life-event-based services.</b> Person needs to express will to get access to services.
Empirically witnessed	<b>“Pushed”</b> Person does not have to search for information or service. Government provides services on own initiative.
	<b>“Interoperable”</b> Service can be consumed by expressing will.
	<b>“Informational”</b> Person searches independently. Information has been collated.
	<b>“Pulled”</b> Person searches for information from different locations.
Reactive	

Figure 5: Reactivity - Proactivity Spectrum (Erlenheim *et al.*, 2020)

The main difference is that in the aspirational stages there is the introduction of the notion of life events, so the fact that here is not the provision of only one service but of a set of service related to the need of the citizens triggered by a life or business event. Here the growth of the proactivity level is given by the characteristics of the provision: in the first stage the user has to express the will of receiving the proactive service, in



the second the user just needs to approve the provision and in the last stage the service runs in the background.

Oude Luttighuis *et al.* (2021) follow another approach, proposing a framework of the proactivity spectrum, where the total level of proactivity is determined by:

- Eligibility process, which is the degree to which the PA is able to determine autonomously when the citizen is eligible to receive a service.
- Delivery process which is the capability of the PA to deliver autonomously the service.

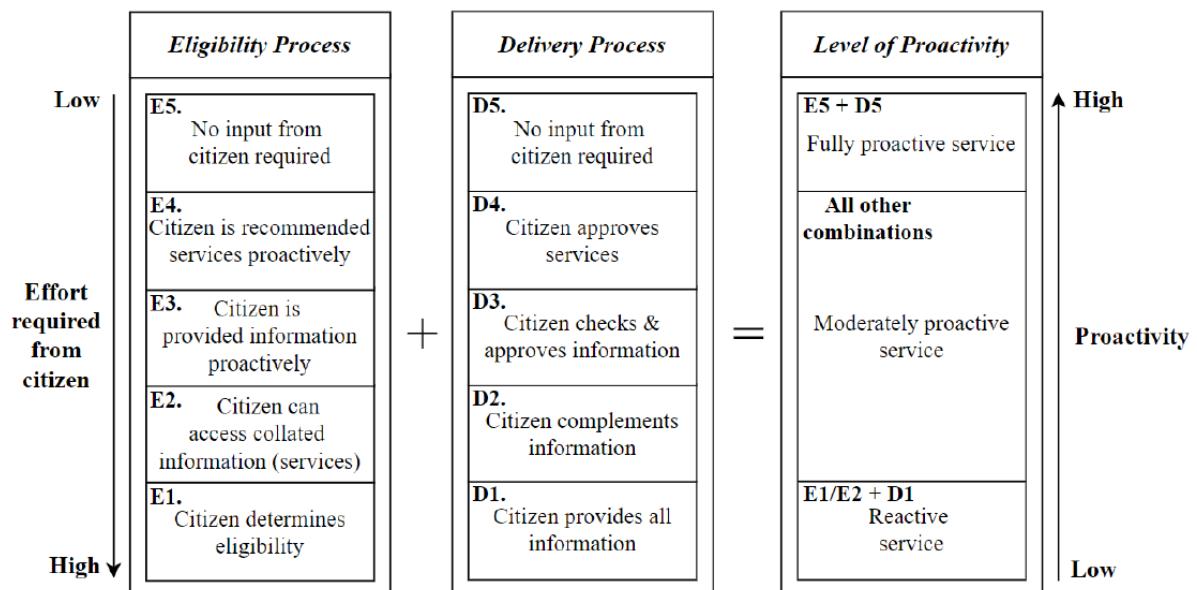


Figure 6: Proactivity Spectrum derived from eligibility and delivery process (Oude Luttighuis *et al.*, 2021)

*“A combination of a stage in the eligibility process (E1-E5) with a stage in the delivery process (D1-D5) leads to a certain level of proactivity. If both of these processes can be fulfilled without interacting with a citizen, a service can be classified as a fully proactive service (E5+D5). If this is not possible, there are various moderate levels of proactivity possible.”*

The authors underline what was mentioned before: understanding the level of proactivity is crucial since proactivity cannot be fully incorporated in all services due to their characteristics and because proactivity is not always desired by the citizen in the services or could even be disadvantageous. Therefore, the framework can be used to assess the services based on their proactivity and understanding the existing obstacles and enablers for raising the level of proactivity.

### 2.1.3.1. Levels of proactivity and incorporation of additional proactivity: further considerations

A further distinction that needs to be made for the incorporation of proactivity or for the attempt to increase the level of proactivity is whether the service is a right or a duty (Oude Luttighuis *et al.*, 2021). The eligibility of the citizens is more easily measured for mandatory services which can often be fully proactive, while public services that grants the citizen rights can only be recommended as these require a decision from the citizen, therefore an interaction and an effort. Consequently, proactivity can be incorporated only to a certain degree. For example, the PA can proactively inform all new students of the possibility to request for a study loan, as the government knows when a person applies to university.

This distinction does not cover all possible cases, as the PA sometimes does not know when a citizen desires a public service or information (Oude Luttighuis *et al.*, 2021), so it cannot even recommend it proactively. For example, when a citizen wants to start a company, a decision has been taken by them and it cannot be known beforehand by the PA who is not able to recommend or start a service related to the new opened company until an effort is made by the citizen for registering the company.

As explained before it does not exist only one typology of proactive service, but different levels of proactivity need to be taken into account as well, according to the characteristics of the service (for example right or duty) or the willingness of the citizen to give away the initiative. To achieve proactive service, on one hand, the PA has to be in the lead, taking the initiative to provide the service with minimal interaction and information requested to citizens, on the other hand, it must be ensured that the citizen can understand and be in control of the process and of their personal information. The concept of service personalization, already explored as one of the proactivity foundations, can help in both instances (Oude Luttighuis *et al.*, 2021).

Concluding, proactive services could be seen as an attempt to create a more user oriented PA and service provision process, that does not just limits its actions to give in an effective way to the citizens what they need but, doing that by creating the simplest process possible from the user perspective, and this translates, by definition of proactivity, in trying to provide a service that it is actually needed without any necessary action by the citizen. In the literature, it is recognized that it is not always possible to completely transform the user into a “passive” entity; for functional impediments of the service, for instance if it is explicitly necessary for the provider entity, the expression of willingness by the user to receive a specific service, before proceeding with the provision process, or for a desire of the citizen, who wants to keep a certain degree of control on the process or because too much proactivity is disadvantageous. These considerations, therefore, make necessary to treat the concept of proactivity in services, not as something that could either be present or not but, as a characteristic that has different levels and that can be incorporated with a certain

degree, as the concept of proactivity spectrum suggests. The different frameworks presented in the previous pages have the common purpose of supporting the introduction of proactivity in public services by triggering further reflections about the suitability of the service to incorporation of a certain level of proactivity and which factors and service characteristics need to be considered to determine the suitable degree of proactivity.

## 2.2. Interoperability: the foundation of digital government

From the previous chapter we understood that interoperability, which is the ability to exchange data and to share information and knowledge by using common standards (Er Riyanto *et al.*, 2018), is a crucial component for e-government as well as for proactive services. Indeed, e-government provides services to citizens and companies based on the information stored in government databases and the lack of interconnection, communication or cooperation between these infrastructures, could prevent the PA to provide one-stop, proactive services oriented to citizens' needs (Lampathaki *et al.*, 2010).

It is recognized that the delivery of high quality, digital and proactive services often require collaboration and a seamless exchange of data between two or more government agencies (Kubicek, 2008). The integration of the databases, various data types, formats and workflows in the agencies involved, are necessary in order to enable smooth data exchange (Kubicek 2008; Kook *et al.*, 2009). Therefore, the concept of interoperability was introduced as a necessary condition for proactivity.

### 2.2.1. The concept of interoperability

A quite complete definition of interoperability is given by the European Commission (2017):

*“Interoperability is the ability of organisations to interact towards mutually beneficial goals, involving the sharing of information and knowledge between these organisations, through the business processes they support, by means of the exchange of data between their ICT systems.”*

*(European Commission, 2017)*

This definition, together with the characteristics cited above, allows us to grasp the collaborative nature of interoperability that entails interaction between organizations to gain mutual benefits. As a matter of fact, interoperability involves various parties, inter-agency, cross-sector and it needs willingness and mutual understanding to make it happen. This characteristic is clearly expressed by Er Riyanto *et al.* (2018), that lists

all the parties and components involved in interoperability (Figure 7). The authors identify five components of the so-called Interoperability Environment:

- Data sources and public service providers.
- Applicant user information: who needs data, information or service from the e-government.
- Supporters: consist of technical and non-technical components. Technical components are information technology and communication infrastructure in each PA, while non-technical components include policy and political will as key success of interoperability.
- Laws / regulations: provide guidance for the development of interoperability (e.g., types of data and information provided and accessible, relations between public agencies, public service mechanisms).
- Ministry web / government agencies.

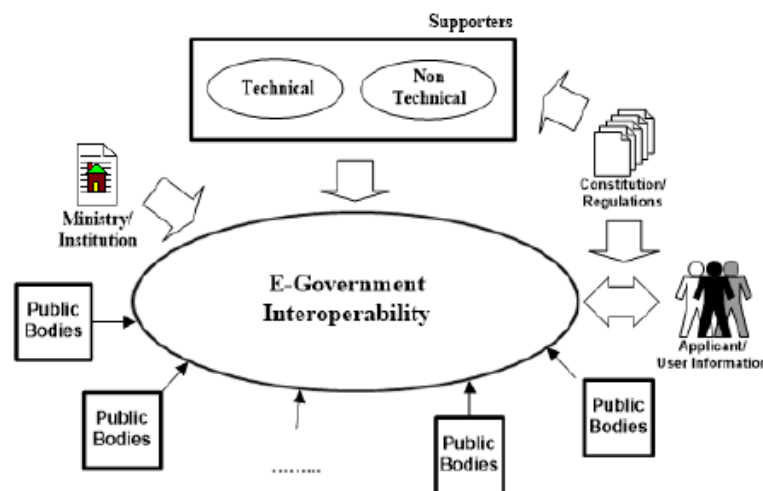


Figure 7: E-Government Interoperability Environment (Er Riyanto *et al.*, 2018)

Another feature of interoperability is its multifaceted nature: meaning that interoperability is a concept that goes beyond purely technical aspects, running also in the formal and social spheres. Interoperability does not only refer to data exchange protocols or interconnectedness of databases, but it deals also with defining data ownership, roles or responsibilities (Backhouse and Halperin, 2009). The broad meaning of interoperability, on one hand made it difficult to give a comprehensive definition of the term, on the other hand it gave the possibility to the authors to define different layers that cover a specific perspective of the concept.

In the following paragraph we present different definitions of interoperability.

### 2.2.1.1. Definitions of interoperability

Interoperability emerges from the need to communicate data across different systems for a specific purpose. Since transferring data represents a technical challenge, interoperability deals with purely technical aspects such as transmissions protocols, exchange formats, content-related semantic aspects (meaning of codes and information), interconnection of databases (Kubicek, 2008; Backhouse, Halperin, 2009). However, data transfers also impact the ownership and custodianship, and this has effects on power structures, roles, responsibilities and on risk. Therefore, when governments have to deal with interoperability, they have to go beyond the technical dimension covering also the formal (setting a common regulatory field) and social (acting on the different business partners processes' structure) (Backhouse, Halperin, 2009) one.

Initially, interoperability was defined for information technology and systems engineering services to allow for information exchanges, therefore the definitions that were given had purely a technical perspective:

*"[Interoperability is] the ability of processes and systems to effectively exchange and use information services"*

(Miller et al., 2001)

*"[Interoperability is] the ability of different types of computers, networks, operating systems, and applications, to exchange information in a useful and meaningful manner"*

(Moen, 2000)

*"The condition achieved among communications-electronics systems or items of communications-electronics equipment when information or services can be exchanged directly and satisfactorily between them and / or their users"*

(Woodall, 2000)

*"Interoperability can be defined as the ability by which different applications can talk and cooperate with each other."*

(Cömert, 2004)

In contrast with this technical view of interoperability, Landsbergen and Wolken (2001) argue that, within an ICT environment, the goal of interoperability is to overcome the challenge of assimilating people and organizations and to encourage the sharing of information. This view is supported also by Choi and Whinston (2000) who

stress the idea that technological standards and elements at the infrastructure level are relatively easier to solve than those at the applications and business process levels. The authors continue with this line of thinking describing cultural and practical differences as the major causes of pitfalls in establishing standards in the application layer and ultimately in ensuring interoperability. Therefore, most of the failures of interoperability projects has not been confined to the technical realm, but to political or informal frictions among public agencies.

Thanks to these contributions we are presented with a much broader, higher-level view of interoperation, in which technology is an essential element, but a broader consideration of the concept needs to take into account social, political, and organizational factors that impact system-to-system performance. Rather than one narrow definition strictly focused on the technical perspective, interoperability needs to be presented as a holistic notion that can serve as an umbrella concept beneath which many disparate, yet complementary definitions may exist, according to a given perspective or level of abstraction (Backhouse and Halperin, 2009).

#### 2.2.1.2. Different layers of interoperability

In the literature that we explored, many authors proposed frameworks that describe interoperability as a structured concept composed of different layers. As discussed previously, interoperability is a notion that for its nature needs to be assessed against many aspects, spanning from technical and technological to organizational and informal. The layers refer to several perspectives and areas where it is necessary to intervene in order to guarantee the achievement of interoperability. Therefore, the layered structure of interoperability is derived from the complexity of the concept itself.

In the following, different interpretations and frameworks describing the layers of interoperability are presented.

The first model is the TFI model proposed by Liebenau and Backhouse (1990). According to the model, information systems may be conceptualized and described as comprising technical (T), formal (F) and informal (I) layers:

- Technical layer which refers to the information technology component and its spheres of convergence, that is, hardware, software, data formats, protocols, as well as the design of the technology.
- Formal layer which refers to the shared understanding of attributes and their formal structure. Therefore, policies, regulations and standards are typical manifestations of the formal layer.
- Informal layer which refers to the ability to operate with attributes and context across domains. Behaviors, system of beliefs, expectations and culture are all elements of the informal layer.

The layers of the TFI model are correlated and interdependent. As Stamper *et al.* (2000) argue, the formal norms cannot exist without the informal norms which are needed to interpret the formal norms. At the same time the technical element does not play a role, unless embedded in a system of formal norms. In other words, technical requires formal and formal requires informal. This is also represented by Figure 8, which clearly expresses the idea that a layer cannot be examined without considering and unwrapping the outer layers.

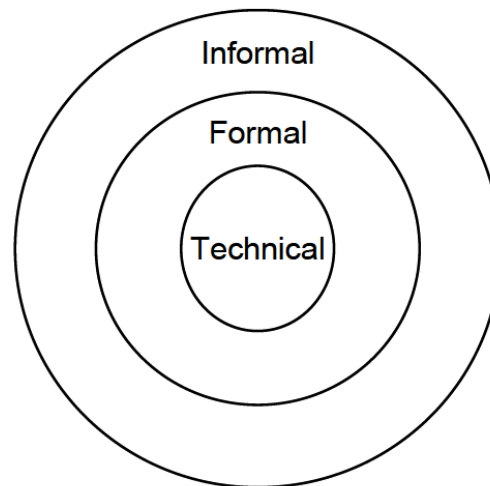


Figure 8: TFI model (Stamper *et al.*, 2000)

The second framework is proposed by Kubicek (2008), the author argues that frameworks give us classifications of what has to be standardized and proposes a framework that identifies four interoperability layers:

- Technical Interoperability whose aim is to secure data transfers from a technical point of view and that can be achieved through already fully developed protocols.
- Syntactical Interoperability which can be achieved through the standardization of data exchange formats.
- Semantic Interoperability which is based on having a common interpretation of data and information and has the goal of allowing all the actors involved to process and interpret the received data and information in the right way.
- Organizational Interoperability that refers to the automatic linkage of processes between different system and that can be achieved through the application of architectural models and standardized process elements.

The third model that Ordiyasa *et al.* (2016) discussed in their article, describes interoperability as a three faceted element composed of:

- Organizational Interoperability which refers to the differences in structures and business processes of different partners. Here the interoperability solution needs to be applied at the organizational level.
- Semantic Interoperability which refers to the different interpretations that organizations give to the same exchanged information. In this situation an intervention on the semantics is necessary.
- Service Interoperability which refers to the connections of systems and services. In this case problems in terms of not close interfaces, interconnection, data integration and middleware, data presentation, data exchange and accessibility may arise.

The frameworks analyzed follow an evolution similar to the one highlighted in the previous paragraph about the definitions. The model proposed by Liebenau and Backhouse (1990) is centered on the technical interoperability and the other two layers proposed (formal and informal) have a complementing function since to obtain full interoperability, the technical layer is not enough. While the frameworks proposed by Kubicek (2008) and Ordiyasa *et al.* (2016) describe interoperability as a multilayer issue where the technical part does not assume a central role anymore. Indeed, they give the same relevance to technical and organizational factors.

The research carried out by the scientific community that we just discussed was used by public institutions in order to build an interoperability framework easily understandable and usable by different countries. The European Commission in 2017 proposed the “New European Interoperability Framework” where an interoperability framework applicable to digital public services is defined, we will further deepen the model afterward in the paragraph “European guidelines: European Interoperability Framework”.

### 2.2.2. Web APIs

All the interoperability frameworks discussed in the literature agree upon the necessity of having technical interoperability. Technical interoperability is the interoperability layer that deals with the design of the technical infrastructure (i.e., software, hardware, data formats, protocols) and makes possible the actual exchange of data and information in a secure way between information systems of different PAs<sup>1</sup>. Technical interoperability can be achieved through the usage of APIs (Application Programming Interfaces).

#### 2.2.2.1. API: definitions and characteristics

An API is a software intermediary that allows two applications to talk to each other (Stani *et al.*, 2020), meaning, exchanging information and functionality in a discrete and

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<sup>1</sup> <https://www.bucap.it>



computable fashion (Gordon, Rudin, 2022). More specifically, it is a set of clearly defined protocols and methods of communications which defines how software components communicate with one another (Williams, 2018; Borgogno, Colangelo, 2019). APIs represent a set of rules and specifications that a software program can follow to access and make use of the services and resources provided by another particular software program that implements that API (Boillot, 2012; Ong *et al.*, 2015; Puspitasari *et al.*, 2021). Essentially, through a set of protocols and routines, they allow a digital application to interact with an associated program by describing the kind of data that can be retrieved, how to do it and the format in which information will be filed (Borgogno, Colangelo, 2019). Therefore, an API, serving as an interface between different software programs, ensures a smooth flow of data (Borgogno, Colangelo, 2019) and facilitates their interaction, similarly to the way user interface facilitate interaction between humans and computers (Puspitasari *et al.*, 2021). APIs simplify and standardize interfaces by reducing complexity and development costs with respect to custom built interfaces. For this reason, they represent an architectural approach that revolves around providing programmable interfaces to different applications. They contribute to create a flexible architecture made up of several components that can more easily be switched in and out (Williams, 2018).

Since APIs are a link to transfer data between a provider and a consumer, they can be used by a PA to transfer the information of a citizen (e.g., birth certificate) to another PA, thereby preventing the need to register the same data twice (Once Only Principle) (Stani *et al.*, 2020). In this way, APIs facilitate the accessibility and re-usability of information, thus they contribute to achieve a higher level of transparency and openness of government data (Vaccari *et al.*, 2021). APIs also provide the ability to share information and functionality more widely: to developers, in order to reduce complexity and development costs, and, ultimately to citizens, for consumption through web or mobile based applications (Williams, 2018).

When the scientific literature discusses about APIs, it refers to the so-called Web APIs. These APIs are exposed by Web services as endpoints that can be accessed by any internet-enabled language or software, in exactly the same way browsers access websites and services. Web APIs deliver requests to the service provider, and then send the response back to the requestor. They are an interface for web applications, or applications that need to connect to each other via the Internet to communicate<sup>2</sup> (Williams, 2018).

APIs can be developed with different purposes, Borgogno and Colangelo (2019), in their paper, distinguish between closed and open APIs. Closed APIs (or internal) are used and accessible only by those working within a firm. This solution is used extensively by several companies as they enhance internal integration and speed up data sharing among different departments and employee teams. A smooth data

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<sup>2</sup> <https://federaltechnologyinsider.com>

sharing within the firm improves productivity by a better exploitation of internal data streams and optimization of existing processes. Open APIs, instead enable integration with third parties (partners, external developers or even competitors) by allowing these actors to access specific databases.

Entering in a more technical realm, Web APIs themselves can be broken down further based on the type of data format that they harness. For example, well known types are Simple Object Access Protocol (SOAP), Remote Procedure Call (RPC) based APIs, and the Representational State Transfer (REST) architectural style (Williams, 2018). In particular, Vaccari *et al.* (2021) specify the distinction between RPC APIs and RESTful APIs. RPC APIs are characterized by a set of procedures or methods that the client application can invoke and are executed by the server to fulfil a task, for example, data exchange or a data validation service call. While RESTful APIs, are based on the REST architectural style which is a hybrid style derived from several of the network-based architectural styles and combined with additional constraints that define a uniform connector interface (client-server, stateless interaction, uniform interface, layered system and code on demand).

#### 2.2.2.2. API and interoperability

After having defined what an API is, we will deepen the link between APIs and interoperability, especially in relation to the technical layer. As a matter of fact, since APIs allow PAs to easily access the data gathered by another PA facilitating the exchange of data, they are useful tools used to strengthen and increase interoperability among different systems and players (Borgogno, Colangelo, 2019). Indeed, it is commonly recognized in literature that APIs could be used to introduce or enhance interoperability between databases or information systems (Borgogno, Colangelo, 2019; Stani *et al.*, 2020; Vaccari *et al.*, 2021; Puspitasari *et al.*, 2021).

Many EU countries have developed over the years their computing infrastructure building a network of legacy systems with interfaces to pass information from one system to another (Williams, 2018), which were point to point and custom build to meet the needs of a specific project or agency. The problem arose when the number of interfaces necessary grew leading to higher maintenance costs, inter-relationships and data duplication (Calabro *et al.*, 2017). The result was inefficient “siloes”, legacy systems which made difficult data sharing and service delivery across the ecosystem (Williams, 2018). Williams (2018) in the Digital Government Benchmark argues that, in this context, APIs provide an opportunity, a “structural workaround”, to enable the information within these legacy systems to be exposed with low complexity and investment. They enable to bypass the complex interfaces of existing systems allowing data sharing to be accomplished easily, thus increasing interoperability between systems.

### 2.2.2.3. API ecosystems

API based ecosystems can be defined as the extended interrelationships that link various groups of stakeholders to each other via API based solutions that use the internet to communicate. These interrelationships are enabled by developers who create applications. The API ecosystems may be created within a government agency, between agencies, or it may be wider reaching, for example between a government and another government or between a government, their citizens, and potentially third-party providers. Williams (2018) distinguishes several ecosystems that APIs facilitate in the public sector.

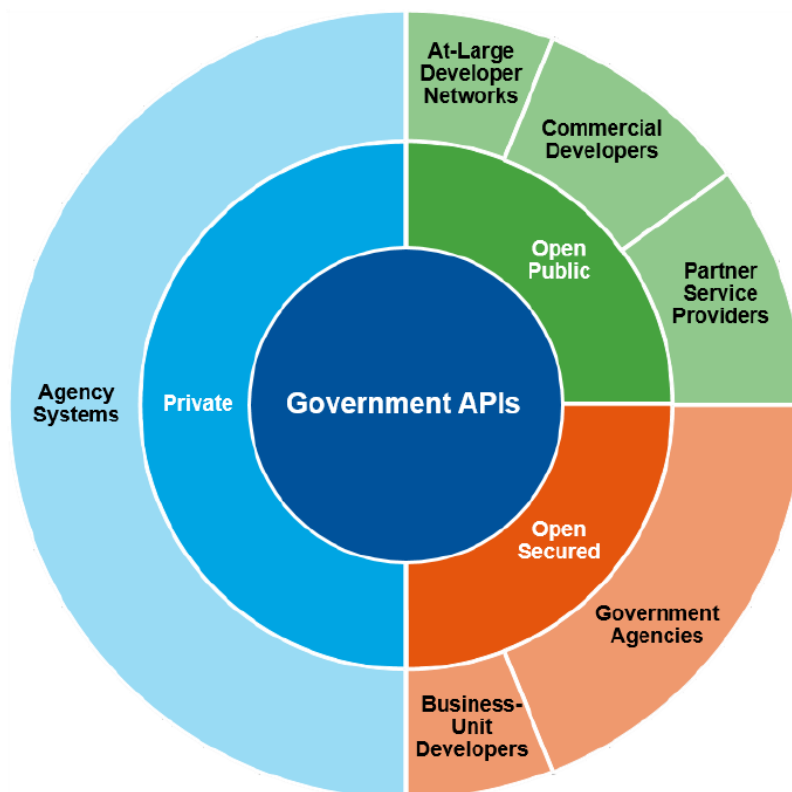


Figure 9: Ecosystems enabled by government API (Williams, 2018)

- Private – Agency Systems: are ecosystems created when APIs are used to facilitate data sharing between systems within an agency, avoiding the need for a complex point to point integration. Being private they are not visible to anybody outside the agency and are generally in the domain of the IT department.
- Open Public: there are three different ecosystems created by the usage of Open Public APIs, which do not require permission to be accessed:
  - Open Public – At Large Developer Networks: Open APIs which are the access point for developers to large public data sources from which to create applications.

- Open Public – Commercial Developers: it is the same as the previous type, but the developers seek to use the data in applications that can be sold.
- Open Public/Secured – Partner Service Providers: the APIs are open to partners that provide a service. An example are healthcare providers who can be interested in healthcare records or in the eligibility of a citizen for free or subsidized treatment based on data held by the government.
- Open secured: there are two different ecosystems created by the usage of Open Secured APIs, which are available to other government agencies and allow data sharing following the authentication.:
  - Open Secured – Government Agencies: are ecosystems created instead when the APIs are available to other government agencies allowing them to share data. We previously discussed about the APIs' feature of enabling interoperability by facilitating integration of different PAs' information systems. These ecosystems are the most related to this characteristic since they enable to gather the data only once from the citizen and share securely between government agencies when needed. An example could be sharing of citizen data between the agency responsible for income and taxation and those providing benefits in order to confirm the eligibility of the benefit.
  - Open Secured – Business Unit Developers ecosystem: it is similar to the previous, but instead of basic inter-agency data sharing, in this case the data is used and then in some way supplemented in order to be useful by developers within a government agency. They are used to create custom applications around internal data assets for agency use.

According to Williams (2018) the creation of ecosystems clearly expresses the APIs ability to provide access to the core of the government which also “allow government to realize its objectives of openness, and of delivering efficient, secure, transparent and interoperable citizen centric services”.

#### 2.2.2.4. APIs adoption in governments

API adoption and development in governments and PAs is a matter that is quite discussed in the literature. Indeed, when building an API several aspects must be considered, for example the role that the PA plays within the API journey, and the PA commitment of ensuring the quality of data (Stani *et al.*, 2020).

Concerning the first aspect, it is important for the PA to reflect on the reasons why an API is needed and whether it is worth building it. Therefore, it is crucial to understand

which is the role of the PA within the API Journey. There exist three main roles that PA can play in the API context: provider, consumer and publisher.

- **Provider:** provides data to citizens or other PAs. For example, personal data of citizens are provided to other PAs through the API, when needed in order to deliver some services, as long as proper consent from the citizens has been granted.
- **Consumer:** consumes data shared by other organizations. For example: a marriage certificate being transferred from one municipality to another.
- **Publisher:** PAs can publish data, generally on behalf of other PAs, by providing discoverability services such as APIs catalogues that gather all available APIs of public services or catalogue of public services that are provided as APIs.

The PA, when adopting or developing an API, has to ensure the quality of data that is managed. The API provider needs to put in place tools and mechanisms to ensure that the API is working in conformance with the designed features and to validate and check the quality of the data provided by the API itself.

Vaccari *et al.* (2021), instead analyze APIs adoption and implementation in governments following another approach: by listing the enablers, drivers, barriers and risks, and challenges that could be encountered when adopting APIs in the public sector.

According to the paper, the main drivers pushing to APIs implementation appear to be related to organizational policies and external stakeholder demands for specific APIs and application powered by APIs. New regulations can also be considered drivers, since they encourage APIs adoption in the attempt to make data more open and available, and legal drivers as well.

Concerning the enablers, the authors argue that in an organizational perspective, the multi-stakeholder and multilevel cooperation, political support and potential legislation, the existence of API development communities as a living ecosystem around the APIs are recognized as key enablers for API strategy design. The authors also mention as important enablers, from the budgetary perspective, the availability of funds and EU initiatives of funding. Proceeding in the technical sphere, as key enablers the authors identify the availability of standards, specifications and guidelines, alongside with the consensus on the identification of patterns of when to apply different standards.

As for the enablers, the authors distinguish between several types of barriers that cover different perspectives. Organizational and cultural barriers are identified as the most relevant barriers impeding APIs adoption. For example, a change in the political context, strategies and goals can affect API investments in the medium and long term and consequently their implementation process. Resistance to change should also not

be overlooked, especially when APIs are presented as alternatives to the long-invested legacy systems that some organizations have in place and understand well. The operational and technical barriers identified are related to the time and costs associated with re-engineering existing systems to APIs, but they are also related to the lack of harmonization of agile solutions, even within organizations. In the political perspective, the obstacles are tied to the decision makers' lack of understanding of the APIs potential and the lack of visible benefits. Entering in the legal domain, specific regulations should be taken into account such as the GDPR, which implication could slow down the API adoption. It is also mentioned the economic perspective, in particular the greater cost of APIs solution compared to plain data exchange as well as the long-term commitment that API systems require are a barrier to APIs spreading.

After drivers, enablers and barriers a number of risks are identified and grouped into technical, organizational, legal and economic risks. Within the technical risks the major threat is cybersecurity, in fact, APIs must be properly secured against cyberattacks. Other technical risks are technical sustainability and the risk of producing APIs that either will not scale or prove to be unstable in the future when technical changes or updates occur. A possible mitigation measure is to analyze, identify and propose the right set of existing standards that can be used to implement government APIs. Related to organizational risks, organizational change and a lack of political support seemed to be particularly relevant. As a mitigation measure, the creation of a central 'innovation agency' is proposed, that can support and inform IT departments, particularly in terms of communication and coordination. Competing initiatives, for example the adoption of APIs without common guidelines and governance, are identified as risks. In order to reduce these risks, iterative and continuous development approaches should be considered, also for the strategy itself. Legal risks mainly concern breach of the data privacy of people and organizations. In this context protection mechanisms from possible access and misuse of these data must be considered as a primary goal. In the end, economic risks identified in the authors research include many aspects, such as the risk of low usage of APIs, the loss of visibility of government activities on the web and business models becoming endangered by specific agencies of a PA delivering their data via traditional channels.

For the most part, APIs involve the movement of sensitive data which often regards citizens private information. This poses some challenges for the government that wants to implement and adopt this solution. Williams (2018) group these challenges into 3 groups:

- Security: APIs expose data, services, and transactions in order to build new services. For this reason, APIs must be appropriately secured to ensure data privacy and to ensure citizen confidence in the service delivery channel. A number of security solutions exist such as OAuth and Certificate based authentication, which are used as components within a wider cyber security strategy and cryptography.

- Regulation: APIs play a significant role in favoring government transparency and they are considered the core technology to support transparency principles. Therefore, APIs must adhere and support any ruling and regulation aiming to foster transparency. In addition, other regulations that deals to data sharing through any type of interface are the General Data Privacy Regulation (GDPR)<sup>3</sup>, the Payment Services Directive (PSD2)<sup>4</sup> and the Public Sector Information Directive (PSI). APIs must be adherent to these regulations as well.
- Specifications or Standards: several standards for APIs are available. However, many organizations are developing APIs based on an agreed internal specification or style guide to promote consistency, rather than adhering to what is normally recognized as a de facto 'standard'.

#### 2.2.2.5. Need for APIs standardization

The objective of the EU to ensure interoperability has as the final goal the creation of an EU common data space for a thriving data-driven economy. In this context, APIs' architecture and design have been identified as crucial enablers for the development and flourishing of the common EU data space (Borgogno, Colangelo, 2019).

However, despite their importance and the potential benefits APIs can provide, a consensus and a clear view regarding who should define APIs, how they should define them and whether to standardize their creation is still lacking (Borgogno, Colangelo, 2019). In order to change this, EU institutions encourage to use open, standardized and well-documented API more broadly, by providing technical guidelines and best practices for companies and public sector bodies (European Commission, 2017). This effort of favoring a *"broader use of open, standardized and well-documented APIs"* (European Commission, 2017) could include making data available in machine-readable formats and the provision of associated metadata (Borgogno, Colangelo, 2019). In this direction, the European Commission also started advocating the adoption of standardized and *"shared formats and protocols for gathering and processing data from different sources in a coherent and interoperable manner across sectors and vertical markets"* in order to establish a pro-competitive environment where machine-generated and readable data are shared, aggregated and reused.

An issue, in this regard, is that private companies are basically free to design their own APIs according to their business objectives, which might not be aligned with the underlying regulation of open, standardized and well-documented APIs. Therefore, the concern stemming from this scenario is that firms will try to comply in autonomous and non-standardized ways with new regulatory data sharing obligations, thereby ultimately precluding a sound free flow of data within the Internal Market (Borgogno,

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<sup>3</sup> <https://www.gdpr.eu>

<sup>4</sup> [https://ec.europa.eu/info/law/payment-services-psd-2-directive-eu-2015-2366\\_en](https://ec.europa.eu/info/law/payment-services-psd-2-directive-eu-2015-2366_en)

Colangelo, 2019). On top of that, there is a strong risk that incumbents could systematically develop and adopt APIs designed as to prevent full interoperability with competitors' interfaces (Borgogno, Colangelo, 2019).

In light of these concerns, there is the need for the EU institutions to define the process of the creation of a set of standardized APIs that also private companies could deploy and adopt as a shared language (Borgogno, Colangelo, 2019).

The need for common data formats to facilitate data gathering and processing, and the necessity to develop and use more broadly standardized and open API, is an issue that does not tackle only the private sector but the public sector as well. PAs and other relevant agencies exchange data in different ways and thus, different APIs are needed. For this reason, a common data model is necessary (Stani *et al.*, 2020). A common data model is built on uniquely defined building components and is the basis for different applications, resulting in a common way of describing data. In this way, API providers can then build APIs based on common reusable components (Stani *et al.*, 2020).

The need of a common data model is also concluded in the study on APIs done by the Joint Research Centre (JRC) of the European Commission (Williams, 2018). Here, it is given the example of the UK Government Digital Service which recognizes that all departments were developing APIs using different tools, platforms and approaches<sup>5</sup>, and create a set of principles and guidelines on how developers working with any UK public sector organization should build APIs to ensure consistency<sup>6</sup>.

Another example to understand the benefits of a common data model, is the Single Digital Gateway. Its purpose is to collect the descriptions and all the information about the public services from European PAs in one single portal. The Single Digital Gateway should provide a repository of links towards the different public services provided by the Member States. The goal is to allow citizens and companies moving across EU borders, to easily find out what rules and assistance services apply in their new residency (Stani *et al.*, 2020).

Automation of this process, of collection of public service descriptions, could be done by implementing an API between the different European catalogue of services (Figure 10) (Stani *et al.*, 2020).

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<sup>5</sup> <https://technology.blog.gov.uk/>

<sup>6</sup> <https://www.gov.uk/guidance/gds-api-technical-and-data-standards>



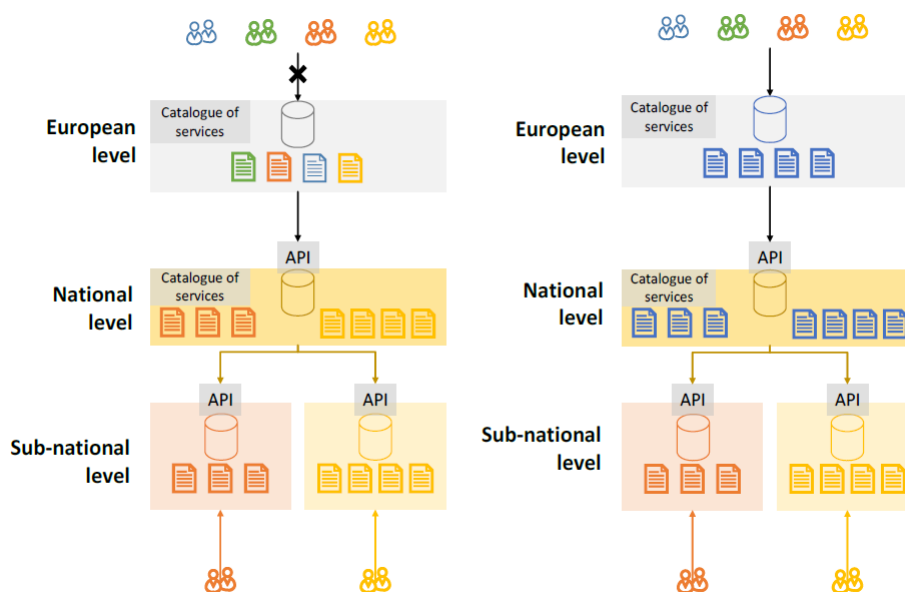


Figure 10: Example of automation of data collection process from service catalogues at different level. Left model without a common data model and right model with a common data model (Stani *et al.*, 2020).

In the left schema there is not a common data model while in the right schema there is (e.g., CPSV-AP). The data descriptions or metadata of the public services are stored in the catalogues of services databases at sub-national level and, for each of these databases, there is an API exposing the descriptions to the related catalogue of services or to any other catalogue of services, in this case the national level. The same relationship exists between the national and the European level, which is the level of the portal of the Single Digital Gateway. Without a common way of describing public services (left schema), at the European level there would be the need for a different API (highlighted in different colors) for each catalogue published at the national level. The solution (right schema) consists in combining the network of APIs with a common data model which would enable each PA to directly describe his services in a harmonized way, improving the quality of the information retrieved and the process for retrieving it, thus increasing interoperability.

A structured data model can be reused within the PAs and by others and consequently information systems based on APIs can reuse the common data model to have a common interface to exchange data. As we saw, by developing a common data model across organizations allows that a single API can be used to communicate between entities, ensuring the interoperability. Additionally, it allows to publish information on single portals (e.g., the Digital Single Gateway) in a more efficient and interoperable way (Stani *et al.*, 2020).

In the model above, the CPSV-AP is proposed as common data model, since it is already used by many Member States and, therefore, its implementation in the APIs

at national level would be beneficial at European level because it allows to have a unique API.

The Core Public Service Vocabulary Application Profile (CPSV-AP) is a common data model provided by ISA<sup>2</sup> Programme, which is a part of a European Programme to supports the development digital solutions that enable Member States to create interoperable solutions for public services<sup>7</sup>. The CPSV-AP data model allows PAs to provide public services in a user-centric way, grouped logically around businesses or life events (Stani *et al.*, 2020), which were the basic characteristics of the proactive service provision. Again, another proof of the necessary condition that interoperability plays within the provision of proactive services.

The CPSV-AP consists of multiple classes of which only two are mandatory a public service and a public organization responsible for such public service. Examples of other classes to enrich the data model are Contact Point, Output and Evidence.

Concluding, despite the advantages that APIs could give in terms of interoperability both in the private and public sector, there is still the need to standardize APIs and their creation in order to really achieve successful results. The EU started moving in this direction by incentivizing the usage of open and standardized APIs but the definition of the creation process of standardized APIs is still lacking (Borgogno, Colangelo, 2019). In this respect, it was found that definition of a common data model to facilitate the data gathering and sharing, like the proposed CPSV-AV, leads to speeding up the creation of APIs as reusable data structures (Stani *et al.*, 2020).

#### 2.2.2.6. API use cases

Williams in the JRC's study on APIs for the European Commission (2018), presents a selection of APIs case studies, diversified in terms of countries and also in terms of dimensions of the projects which span from a specific API, or API as part of a wider platform/ecosystem to an API strategy. Each case is analyzed against different dimensions of the API, ecosystem of strategy:

- Functionality and general characteristics
- Governance
- Usage
- Technical Architecture
- Enablers for development and success
- Barriers/Risks
- Cost and Benefits

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<sup>7</sup> [https://ec.europa.eu/isa2/isa2\\_en/](https://ec.europa.eu/isa2/isa2_en/)

For our research purposes, we focused more on the cases related to API as part of a wider platform or ecosystems. This choice is justified by the fact that these cases seem the most related to the concept of API as a tool to support interoperability, exchange of data and integration between PAs, which are the core of this literature review. At the contrary, specific APIs and API strategy cases do not deal directly with interoperability in its holistic view, rather with a narrow perspective the former and with a superficial approach the latter.

Following, we report firstly, a general description and functionality of each case and secondly, a brief analysis of the other dimensions (governance, usage, technical architecture, enablers for development and success, barriers and risks, cost and benefits).

#### *Estonian's X-Road*

X-Road is a government API framework developed by the Estonian government.

*"The X-Road software-based solution is the backbone of e-Estonia. Invisible yet crucial, it allows the nation's various public and private sector e-service information systems to link up and function in harmony."*

*(e-Estonia, 2022)*

In the Estonian environment every service and every agency have its own information system and retain its own databases for use within the service delivery process, however they all rely on X-Road API management layer. X-Road includes an API gateway to provide consistency and simplification when sharing data (Williams, 2018). An API gateway is an API management tool between a client and a collection of back-end services<sup>8</sup>. It makes it possible to decouple the API proxy (the node by which consumers logically interact with the service) from the underlying application for which the actual service is being implemented (Williams, 2018). The API gateway hides implementation details, accepts all APIs calls, aggregates and automatically call the various services to fulfil the more requests and return appropriate result (Stani *et al.*, 2020). X-Road also ensures secure data transfers: all outgoing data is digitally signed and encrypted, and all the incoming data is authenticated and logged. The system has developed into a tool that can also write to multiple information systems, transmit large data sets and perform searches across several information systems simultaneously<sup>9</sup>. X-Road enables data to be held in one system to be readily and securely available to another without significant and expensive development effort (Williams, 2018).

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<sup>8</sup> <https://www.redhat.com/en/topics/api>

<sup>9</sup> <https://e-estonia.com/solutions/interoperability-services/x-road>

### *Amsterdam's City Data*

The Amsterdam's City Data<sup>10</sup> portal is "the starting point of Amsterdam's data". It is a single portal that provides access to Amsterdam's open data and some non-public classified data with controlled access for authorized city employees (Williams, 2018). The data provided are for example, data about public space, buildings and plots of land, traffic, healthcare, the environment livability, permits, or subsidies. The portal contains big data collections, like the basic records, which include all addresses of Amsterdam, topographical data, cadastral data<sup>11</sup>. It enables users and developers to query data and have it showed in a map, download data as data sets or use API to gather data to be added to another system. The architecture is loosely coupled and uses REST APIs to deliver data to the front-end portal. It is also used by civil servants to query data across departments (Williams, 2018).

### *Denmark's 'Adressers' Web API' (DAWA)*

Denmark's Adressers Web API (DAWA)<sup>12</sup> displays data and functionality regarding Denmark's addresses, access addresses, road names, and zip codes (Williams, 2018). DAWA is used to establish address functionality in IT systems. The target audience are developers who want to integrate address functionality into their IT systems. Besides addresses, DAWA contains also data and functionalities related to areas strictly connected to addresses. These concerns, for example, the areas of Denmark's Administrative Geographical Division (DAGI), the cadastral map, the Building and Housing Register and Danish Place Names.

DAWA has a lot of functionality that can be used in connection with addresses, such as functionality for searching with many different parameters, address entry with autocomplete, data mask of addresses, reverse geocoding and more. It is used by citizens, businesses and the government itself. DAWA is part of the AWS Suite (Williams, 2018).

DAWA belongs to a larger platform which is the Denmark's Dataforsyningen<sup>13</sup> (Data supply) powered by the Board of Data Supply and Infrastructure. It is a gateway for the provision of open geodata through access to maps, web services, web application and APIs (including DAWA).

### *FIWARE Next Generation Service Interface v2 (NGSI)*

FIWARE is a public-private partnership funded by the EU, corporate members and venture capitalists to develop:

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<sup>10</sup> <https://data.amsterdam.nl/>

<sup>11</sup> <https://amsterdamsmartcity.com/updates/news/city-data-a-treasure-full-of-data-about-the-city>

<sup>12</sup> <https://dawadocs.dataforsyningen.dk/>

<sup>13</sup> <https://dataforsyningen.dk/>

- A scalable open-source platform to access and manage heterogeneous context information through open APIs.
- A standard for the exchange of context information: FIWARE-NGSI (Next Generation Service Interface).
- Generic Enablers and Solutions to provide Smart Services with the FIWARE Context Broker as main component.

The FIWARE Next Generation Service Interface (NGSI) API provides the transport layer (i.e., it provides the mechanism for data exchange) between a large amount of contextual information (static and dynamic) to a solution, for example parking space availability in a multitude of car parks to a mobile phone app (Williams, 2018).

### *Madrid Mobility Labs*

MobilityLabs<sup>14</sup> is an open and interoperable platform. It is both an ecosystem of APIs and a portal bringing information and data to citizens through multiple channels and applications for transportation related APIs such as Buses, Parking, Public bicycle, Traffic, City Hall Sensors, Third-party sensors and data (Williams, 2018). Within the platform it is possible to find every tool needed to obtain data and information: resources, data, repositories, forums and documentation. MobilityLabs allows the exchange, not only of data but also of ideas and initiatives in an open manner aimed at enriching information.

As anticipated earlier, hereinafter a brief description of the other dimensions listed in the JRC's study on APIs is provided:

### *Governance*

For what concern the governance of the systems, most of the APIs are owned and provided by a central authority. Additionally, they each, apart from DAWA, have user community-based forums to assist with prioritizing updates.

The Estonian X-Road is managed by the Estonian Government ISA (Information Services Team), which are the product owners, and they manage feature development and the ecosystem (Williams, 2018). It is also present also a user community group comprising of representatives from the agencies and companies that use the service. Each API owner is responsible for their API access point (Williams, 2018).

FIWARE Foundation instead is open: anybody can join contributing to a transparent governance of FIWARE activities. The community comprehend both individuals and organization and not only contributors of the technology but also those who contribute to build the FIWARE ecosystem and making it sustainable over time. A Technical Steering Committee and a Mission Support Committee are present. The first governs

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<sup>14</sup> <https://mobilitylabs.emtmadrid.es/en>

the technical direction of the platform and of the community's activity, while the second oversee the rest of the activities carried out by the members of the community.

In the City Data the governance is more fragmented. There is a government governance for the strategic and tactical planning activities. The business owners have the power to requests new requirements to the City Data Team and lastly the organization providing the data grant the APIs access when the access is controlled (Williams, 2018).

Concerning DAWA, there is no official roadmap for the API, although there is monitoring of the solution, but operation and development is managed by AWS (Williams, 2018).

MobilityLABs is private but 100% of the shares are public (Municipality of Madrid), therefore it is subject to the control and decision of public sector. Forums, and contact forms are open for input from the external developers (Williams, 2018).

### *Usage*

The main end users or consumer of the systems includes the citizen, the government, sharing information between agencies, business and developers that leverage the large amount of data to create products and application.

### *Technical Architecture*

For the most examples, the architecture specification is moving toward RESTful type of architecture, or it was already originally developed as such. Then, the majority of the API are public and open, but the adoption of standards such as OpenAPI for documenting APIs is only present in the Amsterdam City Data case (Williams, 2018). This is due to the fact that adhering to a standard entails significant extra burden to be fully compliant and often it is not needed when following a known specification and providing all the information open source. In addition, ecosystems prefer to provide APIs that best suits their needs instead of being constraint by a standard (Williams, 2018).

### *Enablers for development and success*

One of the most consistent enablers is government policy, motivated by the desire to provide citizens, the government itself and businesses, with accurate data, and a single source of truth avoiding inefficiency and increasing transparency (Williams, 2018). It is likely that these motivations were driven by the EU directives on digitalization, interoperability and e-Government like those of the Tallin Declaration or of the European Interoperability Framework.

Another enabler is the adoption of Agile development methodologies. They enable both the Amsterdam and Denmark cases to respond dynamically to changing needs.

### *Barriers and Risks*

The barriers are several, the risk that the API or the ecosystem is not used, allocation of a dedicated budget of the maintenance of the system, difficulty in the implementation. The most common risks and concerns are related to security and privacy in particular for the cases that deal with personal data which are worried for potential unauthorized access to private data. Therefore, investments to secure the APIs are always a priority.

### *Cost and Benefits*

In the report of the Joint Research Center, it is argued that the API case studies analyzed have in common a high return on investment. The organizations are able to deliver benefits that lead to significant efficiency savings in public service delivery and inform citizens and business in a way that can further lead to time and money savings.

It is stated that, some of these benefits are related to Smart City API adoption: at the local government level, several APIs initiatives have been observed to facilitate smart city initiatives. For example, they provide a technological environment that fosters the adoption of smart solutions and incentivizes innovation, or they lead to more efficient and data-driven public services that enables better decisions, through very accessible APIs, for PAs, citizens and business.

The interesting benefits are those in relation to the achieving of EU principles. A peculiar example are the cases of Estonia, Amsterdam and Denmark which enable the respective governments to address the EU commitments to be digital-by-default, inclusive and accessible, seek citizen and business data 'once-only', be trustworthy and secure, open and transparent, and interoperable by default. Indeed, each of the cases provide API based access to accurate data that is collected once only by government from citizens, and business, and it is shared securely. On top of this, making accurate data available for government reduces the time that civil servants need to spend for some tasks, such as validating the accuracy of claims for permits or subsidies. Accurate data requested once only and already validated (rather than requesting it every time when needed), enable also to enhance the service quality because this base data can be relied upon. Time savings are also experienced by the citizens when submitting applications for example, since APIs can be used to pre-fill forms using personal data on record. Lastly, a strong benefit given is interoperability, it is best demonstrated by the Estonian X-Road solution which enables to share and exchange data between PAs departments.

### 2.2.3. European guidelines: European Interoperability Framework

The objective of the EU is to ensure well-coordinated efforts to digitize the public sector at European and national levels to avoid digital fragmentation of services and data and to help the EU's digital single market to work smoothly.

In this context, the reference for EU strategy towards digitalization of public services and interoperability is the European Interoperability Framework (EIF). The EIF is a commonly agreed approach to the delivery of European public services in an interoperable manner. In particular, it provides guidelines to PAs on how to improve governance of the interoperability activities, establish cross-organizational relationships, streamline processes supporting end-to-end digital services, and ensure that existing and new legislation do not compromise interoperability efforts. Summarizing, the purposes of the EIF are:

- Pushing European PAs in their effort to design and deliver seamless European public services which should be digital-by-default (i.e., providing services and data preferably via digital channels), cross-border-by-default (i.e., accessible for all citizens in the EU) and open-by-default (i.e., enabling reuse, participation/access and transparency).
- Provide guidance to PAs on the design and update of National Interoperability Frameworks (NIFs), national policies, strategies and guidelines promoting interoperability.
- Favoring the establishment of the digital single market by developing and improving cross-border and cross-sectoral interoperability.

It should be intended as a general framework applicable by all European PAs, which lays out basic conditions for achieving interoperability, steering all national initiatives to create a European interoperability environment. EU and national policies (NIFs), as well as domain-specific interoperability frameworks (DIFs) are expected to be based on the EIF.

The EIF's structure is composed of the following elements:

- A set of 12 underlying principles intended to establish general behaviors on interoperability.
- A layered interoperability model that organizes in layers the different interoperability aspects to be addressed when designing European public services.
- A conceptual model for interoperable public services. The model is aligned with the interoperability principles and promotes the idea of 'interoperability by design' as a standard approach for the design and operation of European public services.



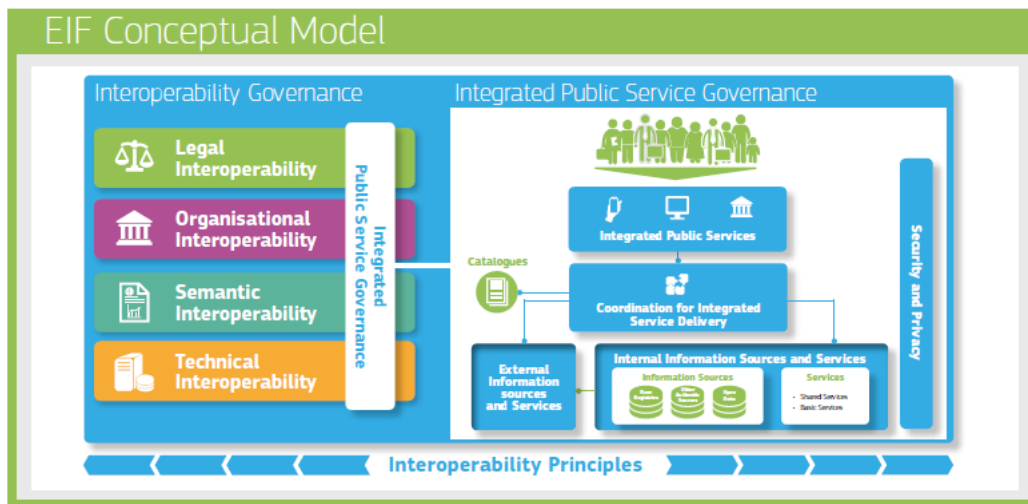


Figure 11: EIF conceptual model relations (European Commission, 2017)

#### 2.2.4. Underlying principles

The interoperability principles are fundamental behavioral aspects to drive interoperability actions, they are relevant to the process of establishing interoperable European public services describing the context in which these services are designed and implemented.

##### *Underlying principle 1: subsidiarity and proportionality*

The subsidiarity principle requires that the EU does not take action unless this is more effective than the same action taken at national level. The proportionality principle limits EU actions to what is necessary to achieve the objectives of the Treaties.

Indeed, the EIF sets just a common ground for interoperability policies in Member States. Then the Member States have enough freedom to translate the EIF general guidelines and develop their own NIFs which should be tailored in such a way that national differences and specificities are properly addressed.

##### *Underlying principle 2: openness*

In the context of interoperable public services, the concept of openness mainly relates to data, specifications and software. Open data are all public data that can and should be freely available for use and reuse by others, unless restrictions apply (e.g., for protection of personal data, confidentiality, or intellectual property rights). Openness is an enabler of the underlying EIF principle on reusability, which will be further discussed later and that relates to exploit solutions (data, services, IT solutions...) that have proven their value elsewhere to solve new problems that arise. This requires the PAs to apply openness principle, sharing solutions wherever they are needed.

*Underlying principle 3: transparency*

Transparency in the EIF context refers to:

- Enabling visibility inside the administrative environment of a PA. This is about allowing other PAs, citizens and businesses to view and understand administrative rules, processes, data, services and decision-making.
- Ensuring availability of interfaces with internal information systems of the PAs and the data they handle allowing for their reuse and integration into larger systems.
- Securing the right to the protection of personal data

*Underlying principle 4: reusability*

Reuse means that PAs confronted with a specific problem seek to benefit from the work of others and where appropriate, adopting solutions that have proven their value elsewhere. This requires the PA to be open to sharing its interoperability solutions, concepts, frameworks, specifications, tools and components with others. Reusability of IT solutions (e.g., software components, Application Programming Interfaces, standards), information and data, is an enabler of interoperability.

*Underlying principle 5: technological neutrality and data portability*

Technological neutrality means that PAs, when establishing public services at European or national level, should focus on functional needs and not on technological solutions. PA should provide for access and reuse of their public services and data irrespective of specific technologies or products.

Interoperability requires data to be easily transferable among different systems, this is the data portability requirement.

*Underlying principle 6: user-centricity*

Users' needs and requirements should guide the design and development of public services, in accordance with the following expectations:

- A multi-channel service delivery approach, meaning the availability of alternative channels (e.g., physical and digital) to access a service, is an important part of public service design.
- A single point of contact should be made available to users, to hide internal administrative complexity and facilitate access to public services (e.g., when more PA are involved in the public service delivery)
- Users' feedback should be systematically collected and used to improve the current service and develop new ones.
- Users should be able to provide data once only and administrations should be able to retrieve and share this data to serve the user.

- Users should be asked to provide only the information that is absolutely necessary to obtain a given public service

*Underlying principle 7: inclusion and accessibility*

Inclusion and accessibility must be part of the whole development lifecycle of a European public service, from the design to the delivery.

*Underlying principle 8: security and privacy*

Citizens and business must be guaranteed with secure and trustworthy interactions with PAs. In addition, PA must guarantee to citizens and businesses privacy of the information.

*Underlying principle 9: multilingualism*

European public services can potentially be used by anyone in any Member State. So, multilingualism needs to be carefully considered when designing them. A good balance, to avoid great expenditure in translation to all EU languages, should be that European public services are available in the languages of the expected end-users.

*Underlying principle 10: administrative simplification*

Where possible, PAs should seek to streamline and simplify their administrative processes, reducing in this way the administrative burden of complying with EU legislation or national obligations for citizens and businesses. Likewise, PAs should introduce European public services supported by electronic means, including their interactions with other PAs, citizens and businesses. Digitization of public services should take place in accordance with the following concepts:

- Digital-by-default: which means that there should be at least one digital channel available for accessing and using a given European public service.
- Digital-first: which means that priority is given to using public services via digital channels while applying the multi-channel delivery concept namely, physical and digital channels co-exist.

*Underlying principle 11: preservation of information*

Legislation requires that decisions and data are stored and can be accessed for a specified time. Therefore, records and information in electronic form, must be preserved and be converted, where necessary, to new media when old media become obsolete. The goal is to ensure that records and information keep their legibility, reliability and integrity and can be accessed as long as needed.

*Underlying principle 12: assessment of effectiveness and efficiency*

Different technological options should be evaluated for the interoperability solutions, when striving to ensure the effectiveness and efficiency of a European public service.

### 2.2.4.1. Layered interoperability model

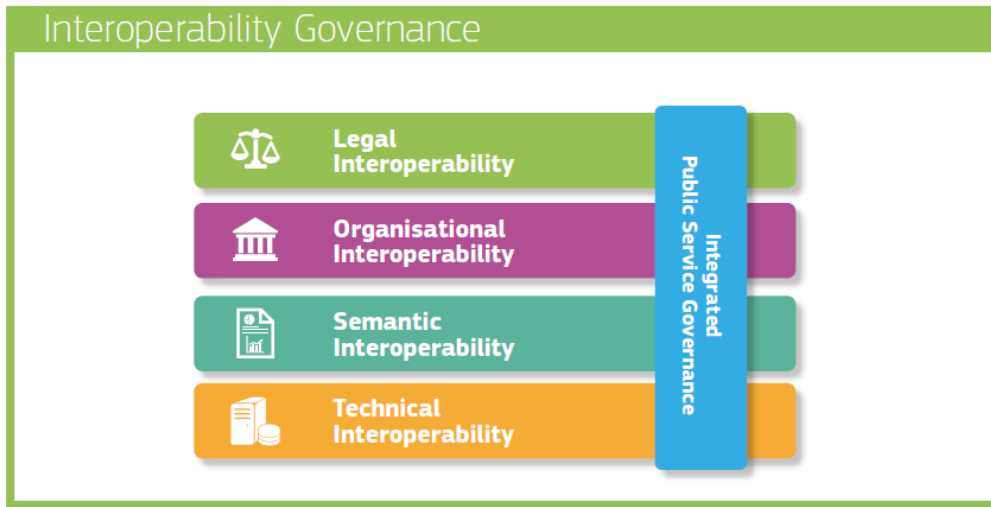


Figure 12: Interoperability model (European Commission, 2017)

The model is structured in four layers of interoperability, combined with a cross-cutting component and a background layer, unfolded below:

- The four layers are:
  - Legal Interoperability which concerns the ability of organizations that operates under different legal frameworks, policies and strategies to be able pull together. The first necessary step is to examine the existing legislation in order to identify any possible barriers. The second step is to undergo a 'digital check' since the European public services are meant to be delivered from digital channels. This check will ease exchange of information and the communication between public services.
  - Organizational Interoperability which refers to how PAs can harmonize their business purposes, responsibilities and expectations to achieve the set objectives. The aim of organizational interoperability is to make services available in the best way to meet the citizens expectations. To do so is important to document the business processes using commonly accepted modelling techniques and to formalize the relationships between service providers and consumers.
  - Semantic Interoperability which relates to the format (syntactic aspect) and meaning (semantic aspect) of exchange data and information, it needs to be understood and preserved during transactions and exchanges. To achieve semantic interoperability is very important to implement an information management system coordinated at a high level in order to avoid fragmentation. This layer

is complicated by the differences in terms of language and culture, but it is crucial to reach a high semantic interoperability in order to grant seamless information exchange.

- Technical Interoperability which is about applications and infrastructure linking systems and services. The main problem of interoperability regards the way in which applications and information systems were built in the past, particularly they were built in order to solve domain specific and local problem, and this caused the creation of fragmented ICT islands which are hard to interoperate. To reach technical interoperability is necessary to use formal technical specifications.
- The cross-cutting component is Integrated Public Service Governance which should include at least the definition of organizational structures, roles & responsibilities and the decision-making process for the stakeholders involved, the impositions of requirements for aspects of interoperability and external information/services, a change management plan and a business continuity/disaster recovery plan. In addition, the Integrated Public Service Governance should include formal arrangements for cooperation through interoperability agreements.
- The background layer is Interoperability Governance and refers to the way in which interoperability is managed at National and EU level. The management of interoperability refers to the decisions that are made in terms of interoperability frameworks, institutional arrangements, organizational structures, roles and responsibilities, policies, and agreements.

#### 2.2.4.2. Model for interoperable public services

The EIF, after having described the underlying principles and the layers of interoperability, proposes a conceptual model for integrated public services to guide their planning, development, operation and maintenance by Member States. The model is relevant for all governmental levels, from local governments to the European Union.

The conceptual model promotes the idea of interoperability by design, meaning that the public service should be designed using this model and with interoperability and reusability requirements in mind. The model also promotes reusability as a driver for interoperability, recognizing that the European public services should reuse information and services that already exist.

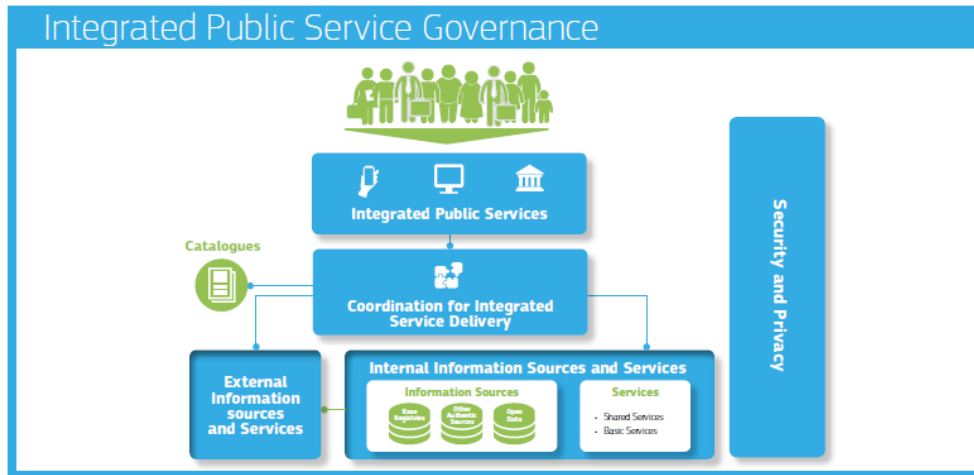


Figure 13: Conceptual Model for Integrated Public Services (European Commission, 2017)

The basic components of the model are the following:

- **Coordination Function:** it ensures that needs are identified, and appropriate services are invoked and orchestrated to provide a European public service. This function should select the appropriate sources and services and integrate them in order to remove complexity for the end user. This process's phases (need identification, planning, execution, evaluation) are part of the Integrated Service Delivery.
- **Internal Information Sources and Services:** PAs produce and make available a large number of services, while they maintain and manage a huge number and variety of information sources. These information sources are often unknown outside the boundaries of a particular administration. The result is duplication of effort and under-exploitation of available resources and solutions. PAs should promote policies to favor sharing of services and information source by reusing, publishing (make them available) and aggregating them to create an integrated service provision process.
- **Base Registries:** it is a trusted and authoritative source of information which can and should be digitally reused by others, where one organization, called information steward, is responsible and accountable for the collection, use, updating and preservation of information. For centralized registries a single organizational entity is responsible and accountable for data quality and for ensuring correctness of data. In case of distributed registries, a single organizational entity is responsible and accountable for every part of the registry. Also, a single entity is responsible and accountable for the coordination of all parts of the distributed registry.
- **Open Data:** this concept is related to the possibility of reusing the public sector data and information. The focus is on releasing machine-readable data

for use by others to stimulate transparency, fair competition, innovation and a data-driven economy.

- Catalogues: they help others to find reusable resources (e.g., services, data, software, data models).
- External Information Sources and Services: PAs need to exploit services delivered outside their organizational boundaries by third parties, such as payment services provided by financial institutions or connectivity services provided by telecommunications providers. The same stands for exploiting external information sources like open data, data from international organizations, IoT data or social media data.
- Security and Privacy: these are primary concerns when dealing with public service provision. The PA should ensure that they follow the privacy and secure-by design approach, that services are not vulnerable to attacks and in general their compliance with privacy and data protection legislations. It must be ensured also the security and the protection of information during transmission, processing and storage.

## 2.2.5. Italian strategy

### 2.2.5.1. Piano Triennale per l'informatica nella Pubblica Amministrazione overview

The Piano Triennale is the main instrument that promotes the digital transformation of the Italian PA. In particular, the latest version of the plan (2021-2023) was drafted after the outbreak of the Covid-19 pandemic, and this means that it considers the changes that it has brought to the social and professional spheres. Additionally, during the pandemic, the Italian PA went through an expedited digital transformation process that is essential to maintain in order to innovate the entire PA. The plan is aligned with the first component of the first mission of the PNRR, further developed later, in order to comply with the objectives set by the EU and, as a consequence, to obtain the funds.

The Piano Triennale is based on some guide principles, which are aligned to the EU guidelines articulated in their frameworks and strategies (e.g., Tallin Declaration on eGovernment and Interoperability Framework):

- Digital & mobile first: PAs need to create mainly digital services.
- Digital identity only: PAs need to adopt only digital identity systems defined by the regulation.
- Cloud first: PAs when defining a new project need to adopt mainly the cloud.
- Inclusive and accessible services: PAs need to design public inclusive and accessible services in order to satisfy everyone's needs.

- Public data, a common good: the PAs information asset is fundamental for the development of Italy and needs to be made available to citizens and businesses in an open and interoperable way.
- Interoperable by design: public services need to be planned in order to work in an integrated way and without interruptions exposing the right APIs.
- Security and privacy by design: digital services need to be planned and provided in secure way and have to grant data protection.
- User centric, data driven and agile: PAs have to plan digital services fostering agile modalities in order to pursue continuous improvement of the user experience.
- Once only: PAs have to avoid asking citizens and businesses information already provided by them.
- Cross-border by design: PAs have to make available relevant digital public services at a cross-border level.
- Open code: PAs have to favor the usage of open code software and if the code is developed by the PA its source code needs to be made available.

The plan is then articulated in six thematic chapters, each of which contains a description, the strategic and regulatory context, and the objective and expected results. In addition, there is a chapter focused on the governance that deepens the innovation levers and the management of digital transformation and displays some indications for the PAs.

### *Services*

The focus is on the enhancement of digital public services quality in order to increase their usage by citizens, businesses and PAs, because a service, in order to be used, needs to have a clear value for the user. To achieve this goal, it is important to simplify internal PA processes applying multidisciplinary methodologies and interoperable techniques. The norms proposed are aligned with the EU Single Digital Gateway following the once only principle.

### *Data*

Value the public information asset is a strategic objective to face the new challenges of our data-based economy. For this purpose, the PA needs to define a data governance strategy that is aligned with the EU one, in order to comply with the objectives and reforms stated in the PNRR. APIs are suggested tools, with directives on their usage both at national and European level. They are fundamental to value data since they avoid their waste. The goal of this chapter is to guarantee a higher effectiveness of the administrative work in data related processes and to increase the data reuse in accordance with the open data paradigm and the once only principle.



### *Platforms*

In the plan the platforms are defined as technological platforms that offer fundamental cross-sectional functionalities, enabling reusability in processes and services digitalization. Platforms favor the creation of distributed services and the standardization of data flow between different administrations, in addition platforms allow to create digital services that are easier and more homogeneous.

### *Infrastructure*

The development of digital infrastructure is part and parcel of the modernization strategy of the public sector. Infrastructures need to be reliable, secure, energy efficient and economically affordable, in addition the technology evolution has brought new risks and nowadays infrastructures need also to be able to protect personal data. The Italian infrastructure situation, as detected by AGID (Agenzia per l'Italia Digitale), is difficult since the security and reliability requirements are generally not met. To achieve the desired state of the digital infrastructure the Department for Digital Transformation and the Agency for cybersecurity have published the "Cloud Italia Strategy" which integrates the Piano Triennale and contains guidelines for PAs that want to migrate to the cloud.

### *Interoperability*

Interoperability is key to allow collaboration and data transmission between PAs, citizens and businesses. The European Interoperability Framework is at the base of the suggestion of the Piano Triennale, which recommends APIs implementation to increase interoperability and to comply with the once only principle. APIs need to be conformed and have to be registered on the API Catalogue that Piattaforma Digitale Nazionale Dati provided. Additionally, to help PAs in the adoption of the interoperability model proposed, the Department for Digital Transformation plans and coordinates support initiatives.

### *Cybersecurity*

The PNNR states that cybersecurity issue is at the foundation of the PA digitalization. To achieve the desired level of cybersecurity, technological platforms and infrastructures are required, so in this chapter are proposed themes related to Cyber Security Awareness and some concrete actions to avoid cyber-attacks are outlined.

### *Governance*

The governance chapter highlights digital competences, models and instruments as the main levers to consider concerning innovation:

- Digital competences are fundamental for citizens to fully exercise their citizenship rights. For this reason, Italy has developed the "Strategia nazionale per le competenze digitali" that is focused on four steps: developing digital competences during higher education, strengthening and

development of workforce digital competences, develop specialized ICT skills to incentivize citizens to work in the jobs of the future and enhancement of digital competences to allow every citizen to exercise their citizenship rights and participate to the democratic dialogue.

- Instruments and models for innovation: innovation procurement and open innovation are becoming key instruments to expedite the digital transformation of the PA and to create new innovative markets. Innovation procurement is fundamental to increase competitive participation in the market while open innovation increases participation. Additionally, the concept of smart community is gaining importance, putting the municipalities at the center of the innovation process. Smart communities can increase citizens' quality of life, innovate the entrepreneurship local context and build a relevant impact on the PA efficiency.

#### 2.2.5.2. Piano Nazionale di Ripresa e Resilienza overview

The shock that the Covid-19 pandemic has brought to the European and, for the purpose of our research, particularly the Italian economy, was taken as an opportunity from the EU to incentive the Member States in pursuing ambitious reforms in regard to environmental transition, digital transformation, sustainable and intelligent growth, social and territorial cohesion, economic social and institutional health and resilience and policies for new generations.

As any EU Member State, Italy has drafted its plan for the definition and implementation of the reforms that need to be put in practice in order to achieve the aspiring goals set by the EU. The plan is the "Piano Nazionale di Ripresa e Resilienza" (PNRR) and is structured in 16 Components grouped in 6 Missions, listed below:

Mission 1	Digitalization, innovation, competitiveness, culture and tourism
Component 1	Digitalization, innovation and security in PA
Component 2	Digitalization, innovation and competitiveness in the productive system
Component 3	Tourism and culture 4.0
Mission 2	Green revolution and ecological transition

Component 1	Sustainable agriculture and circular economy
Component 2	Renewable energy, hydrogen, network and sustainable mobility
Component 3	Energy efficiency and buildings redevelopment
Component 4	Land and water resource protection
Mission 3	Infrastructures for a sustainable mobility
Component 1	Rail network investments
Component 2	Inter-modality and integrated logistics
Mission 4	Education and research
Component 1	Strengthening of the education services offering: from daycare to university
Component 2	From research to business
Mission 5	Cohesion and inclusion
Component 1	Working policies
Component 2	Social infrastructure, families, community and third sector
Component 3	Special intervention for the territorial cohesion
Mission 6	Healthcare
Component 1	Proximity networking, facilities, and telemedicine for territorial healthcare
Component 2	Innovation, research, and digitalization of the national healthcare system

Table 1: PNRR missions and components

For the purpose of this thesis the focus will be mainly on Mission 1, which is the second mission in terms of allocated funds. As detailed in Table 1, the mission is composed of three components. The first one, “Digitalization, innovation and security in PA”, states that the digitalization of the Italian PA needs to be deployed through technological interventions together with structural reforms through the migration of central and local PA to the cloud, the grant of a complete interoperability of PA data, the digitalization of procedures and user interfaces, the offering of digital services to citizens, the increase of cybersecurity, the strengthening of citizens’ digital competences and the innovation of the regulatory framework to speed up ICT contracts.

More specifically the PNRR states that the digitalization of PA services and technological infrastructure is the only solution that can shorten the distance between public entities and citizens, drastically reducing the bureaucracy times. In order to reach this ambitious objective seven investments are stated, and we will deepen each of them hereafter.

#### *Investment 1: Digital infrastructures*

A “cloud first” approach will be taken into consideration for the digital transformation of the Italian PA: data and computer application will be migrated to the cloud to increase security, reliability, processing capacity and efficiency. Two complementary models will be made available for the central administrations, a dedicated cloud infrastructure (Polo Strategico Nazionale) and a public cloud.

#### *Investment 2: Enablement and facilitation of the PA migration to the cloud*

Local PA will be supported in the migration to the cloud to complete the transferring of databases and applications. PA will be proposed complete packages comprising both technical and financial competences, the logic that will be followed is a “migration as a service” one. To facilitate this initiative an ad hoc team will be built, and its purpose will be to survey and certify all the suitable suppliers, and subsequently to set up all the packages that will be proposed to the PA.

#### *Investment 3: Data and interoperability*

The digital transformation has the objective of changing the architecture and the way in which the PA databases are connected with each other, in order to realize the “once only” principle. This will allow citizens to reduce their interactions with PA having the opportunity to communicate a certain information one time and then having the possibility to take for granted that the PA will have it. Being able to realize the “once only” principle will reduce time and costs related to the information retrieval. The objective is to create the “Piattaforma Nazionale Dati” that will offer to the PA a catalogue of Application Programming Interfaces (API) that will be available and accessible. The realization of the “Piattaforma Nazionale Dati” is in line with the European initiative of the “Single Digital Gateway”.

*Investment 4: Digital services and digital citizenship*

The transformation of the PA's digital architecture will be accompanied with the investments aimed at enhancing digital services for citizens. The focus will be on the diffusion of digital services national platforms: PagoPA and app "IO" above all. Other services will be introduced with the objective of moving most of the interactions to digital channels. In addition, to allow the new digital infrastructure to work, the system of digital identity will be reinforced and interventions to upgrade the user experience will be carried out.

*Investment 5: Cybersecurity*

Since digitalization increases the society vulnerability to cyber threats, the PA's digital transformation will contain strengthening measures in terms of cybersecurity. The investment will be four:

- The front-line garrisons will be reinforced allowing a better alert and risk event management.
- Evaluation technical capacities are strengthened and a continuous auditing on technical devices and application security is put in practice.
- New personnel will be entered in the public security and judicial police with a role focused on prevention and investigation of cybercrimes.
- The asset and the cyber units will be strengthened to increase the national security protection.

*Investment 6: Digitalization of big central administrations*

The digitalization of the PA also needs to go through some "vertical" interventions with the purpose of redesign and digitalizing the main services necessary to deliver digital services to citizens. These interventions are huge and involve various PA areas, amongst all, Justice, Labor, Defense, and Interior.

*Investment 7: Basic digital competences*

The infrastructure digital transformation will be complemented with interventions supporting citizens digital competences, in order to grant assistance to the route of digital literacy. These interventions will target the population groups more prone to suffer the digital divide and citizens will have the chance to enjoy them through educational platforms, education, and job placement services. Lastly, the PNNR will promote the territorial network digital support and the digital civil service.

Additionally, to make effective the just outlined investment, the PNNR proposes three key reforms:

*Reform 1: ICT buying process*

This reform has the goal of renewing the buying process of ICT services, reducing the time and resources spent. A “white list” of suppliers will be drafted, a “fast track” path for ICT purchases and a service to allow a fast selection and comparison between suppliers will be introduced.

*Reform 2: Support to the local PA transformation*

A support facility will be built in order to intermediate the relation between local PA and their suppliers. Different local PA will be aggregated in order to create critical mass for the migration to the cloud and a new company will be created with the goal of supporting central PA in this critical phase, helping to strengthen the currently fragmented technological competences.

*Reform 3: Introduction of guidelines for the “cloud first” approach and interoperability*

The goal of this reform is to facilitate digitalization interventions through the facilitation and innovation of the regulatory environment. To implement the defined “cloud first” approach some disincentives will be introduced for the administration that will not migrate and a revision of the accounting rules will be implemented to facilitate the “translation” of the ICT costs from capex to opex. Lastly, the procedures will be facilitated in order to achieve a complete interoperability between different PA.

**2.2.5.3. Conclusions on the Italian strategy**

In conclusion, Italy, in order to be aligned with the EU objectives, has drafted its own strategy. The main documents that are necessary to consider are the “Piano Triennale per l’informatica nella Pubblica Amministrazione” and the “Piano Nazionale di Ripresa e Resilienza” (PNRR) extensively discussed before. In particular, focusing more on the topics of the literature review, some of the goal set in the Italian strategy documents are precisely focused on facilitating interoperability between PA. Firstly, the “cloud first” approach that will incentivize PAs to migrate to the cloud, in this way interoperability will increase and data, needed to provide services to citizens, will be no more located in different siloed databases, but they will all be accessible through the cloud. Secondly, investments will be made in order to facilitate the PA migration to the cloud in order to actually put in practice the “cloud first” approach. Thirdly, the “once only” principle will be followed, avoiding asking citizens for the data that the PA already owns. In order to reach the once only principle the “Piattaforma Nazionale Dati” will be created, and API will be catalogued and made available and accessible by PA.

Additionally, to guide local and central PA the Agenzia per l’Italia Digitale (AGID) drafted some guidelines for PA technical interoperability. The guidelines identify the way in which PA have to implement the API in order to reach the interoperability needed to grant e-services to PA, citizens and companies. From the moment that

interoperability will be built on APIs the key elements necessary to increase the Quality of Service (QoS) are listed:

- Availability: probability that an API will be available and functioning in a random moment.
- Accessibility: API's capacity to be reachable in any moment of time.
- Performance: measure based on the throughput rate, number of satisfied requests in a certain time frame, and latency, amount of time that passed from the sending of a request to the receipt of an answer.
- Reliability: capacity of an API to function in a correct and consistent way. It is generally expressed in failures in a given time period.
- Scalability: the ability to serve in an efficient, consistent and performing way an increasing number of requests.
- Security: that relates to confidentiality, integrity, authorization and authentication aspects.
- Transactional: which is about assuring the transactional execution of an operation.

With the objective of facilitating PA to use API, the guidelines propose a catalogue of APIs which is a unique and central component that contains all the available APIs and their service level. Thanks to the aforementioned catalogue, interoperability will be facilitated, the public expenditure will be reduced due to the elimination of API replication, the service level objectives of the supplier will be declared and the service level agreements between supplier and consumer will be showed.

Additionally, the guidelines identify the interoperability patterns and the interoperability profiles:

- The interoperability pattern is the definition of a solution for a problem of messages and information exchanges, declined in a specific technology. They can be interaction pattern, which highlight technical modalities to exchange messages and that are needed for the interaction of information systems of suppliers and consumers, and security pattern, which identify technical modalities to assure that the interaction patterns respect needs in terms of security during the exchanges.
- The interoperability profiles are a combination of patterns that is necessary to describe specific needs in terms of interoperability.

The AGID will have the responsibility to transpose the needs in terms of interoperability of PA and, if needed, formalize new interoperability patterns and profiles and coordinate their definition process. Moreover, they will have also the role to make the API catalogue available through a single interface and to request the adoption of the defined interoperability patterns and profiles to implement API.

### 2.3. Research questions

Through the literature review focused on proactive services and interoperability, we understood that the latter is essential for the former. In the first chapter we deepened what a proactive service is, focusing on the characteristics necessary to grant the citizens proactive services, then we investigated the preconditions required to reach a proactive service provision in the public sector analyzing the service design principles through which is possible building proactive services, extensively defining the concept of moments of life and focusing of the one-stop shop and no-stop shop approaches. Thanks to the literature review conducted on the topic of proactive services we recognized that at the base of proactive service provision there is interoperability and for this reason we decided to focus our second chapter of the literature review on this topic. We started from the definitions of interoperability, then exploring techniques to actually achieve it, focusing on APIs and lastly deepening interoperability frameworks proposed by the scientific community.

At the end of the literature review we explored the EIF, which states the EU guidelines in regard to interoperability, and the Italian strategy in this matter deepening the Piano Triennale and the PNRR in order to understand the regulatory framework.

The conducted literature review provides important contributions concerning the multisectoral characteristic of interoperability by taking a systematic and holistic point of view and analyzing all the perspectives (layers) involved when dealing with interoperability: from the political and legal perspectives to the technical and organizational ones. Additionally, the literature address in a comprehensive manner the most important frameworks and models supporting countries' PA in the challenging task of introducing or increasing interoperability in their public sector. For reaching this purpose the frameworks focus on providing guiding principles, recommendations and service design models, as the European Interoperability Framework does. Despite these contributions, these models, and generally the literature, do not deeply investigate and propose some practical steps and strategies that a digital society has to take and design to introduce or enhance interoperability in its public sector.

To complement the literature and fill this gap, the purpose of our research is to investigate the most effective ways to actually implement interoperability, and therefore the guidelines and framework proposed by the EU in the EIF. Our work supports, by suggesting practical guidelines, those countries, like Italy, that are striving to introduce interoperability and achieve a robust e-government structure.

Hereafter the research questions are listed:

- *RQ1: What are the interventions undertaken by virtuous countries to increase the e-Governance quality?*



- *RQ2: Which are the steps to follow to provide and/or increase interoperability in the public sector?*
- *RQ3: How can the Italian PA provide a higher e-Government service quality to the citizens?*
  - *RQ3.1: Which is the current level of digitalization and interoperability of the local PA in Italy?*
  - *RQ3.2: Which are the interventions that Italy can implement?*



## 3 Interoperability in the Italian public sector

Italy, despite being the third largest economy in EU, it does not have one of the most advanced digital public sector. According to the eGovernment Benchmark 2022, Italy has a “non-consolidated eGovernment” and places itself below the EU average for three out of four policy priorities, namely transparency, key enablers, cross-border services, scoring a good result only in user centricity. Moreover, it is ranked 18<sup>th</sup> in the Digital Economy and Social Index of 2022. However, according to DESI 2022, if we consider the improvements across the last five years, Italy is catching up, demonstrating the importance gained by the digital issue in the Italian government and public sector.

### 3.1. Public sector and interoperability: Italian overview

The Italian Recovery and Resilience Plan, the largest in Europe, is a great opportunity for the Italian government to endow the digital transformation of the country and its PA. With this respect, the Piano Triennale per l’informatica nella Pubblica Amministrazione, previously analyzed, is the most recent instrument promoting digital transformation in the Italian PA. Particularly, it details more in depth the first component of the first mission of the Italian Recovery and Resilience Plan. Aligned with the EU guidelines, the plan is based on some guiding principles among which interoperability by design states that public services need to be designed in order to work in an integrated way exposing the right APIs.

Concerning interoperability, the Interoperability Model is the foundation for the deployment of the Piano Triennale, making possible the collaboration between PAs and between the latter and third parties (citizens and businesses). This framework, designed coherently with the European Interoperability Framework principles, has the goal of creating a PA information system that ensures the exchange of information and the fulfillment of the once only principle, without ad hoc integrations. The Interoperability Model defines standards and guidelines and their application methods that PAs use to ensure communication between their own information systems and the systems of other actors. From the technical perspective, it is encouraged the definition and the design of APIs, in order to expose digital services, and the adoption, for their creation, of REST and SOAP standards, consolidated also

in the EU context. The model additionally, does not establish the creation of a centralized middleware that manages the access to PAs services but establishes an API Catalogue, in which the APIs and the related service level agreements are published. The Interoperability Model therefore identifies the standards that favor the flourishing of technological solutions upon which building the API economy of the Italian PA. Additionally, the model, enables the development and diffusion of new applications and digital services for PA users, ensures the communication within the ecosystem (e.g., sectoral area of the public sector, such as agriculture, healthcare, education) and across ecosystems, governs the usage of the major Platform components regulating sharing and publishing mechanisms and lastly ensures access to PA data in compliance with privacy rights.

### 3.1.1. Enabling platforms

The Platforms are a fundamental component of the Interoperability model and of the Italian public sector in general. They are the solution that offers fundamental, transversal, re-usable functionalities for the digitalization of PA processes, making uniform these processes supply. Thanks to these systems, the PAs refrain from creating from scratch certain functionalities reducing the time and the cost for service development. Among these platforms, that are actually available, there are:

- SPID: is the Italian digital identity for the public sector, enabling citizens to access to PA's online services.
- pagoPA: is a payment system enabling citizens and companies to make electronic payments to the PAs.
- CIE: is the digital evolution of the identity card, it is an electronic identification system.
- ANPR: is the National Civil Registry which maintains all the registry and address data. It represents the reference archive for any other PA's system.

Among the other platforms that are in the design, implementation or evolution phase there are, for example:

- Public e-procurement national system: it aims to digitalize the procurement process for the Italian PA.
- Siope+: is a system that keeps track of all cash receipts and payments made by the PAs.
- NoiPA: is a system managing all the salary services for the PA employees.
- Conservation points: are data archive systems conserving documents, database, e-mails coming from complex information systems, the web, or social media. These systems are crucial since they are able to ensure the authenticity and accessibility of documents in the long term.

- SDGP: is a system managing administrative proceedings, whose aim is to ensure uniformity and interoperability, at the national level, of the flow of document related to the PA proceedings. It is a platform essential for the achievement of digitalization and simplification objectives for the PA and its realization needs to be seen as a step forward to digitalization of administrative documents and development of conservation centers national network.

One of the most important enabling instruments for the diffusion of digital services is the IO app, which was developed to be a one-stop shop for Italian citizens. It favors the access to digital public services both from central and local PA and allow citizens to receive communications from the PA and to make payments related to public services. IO app will be further developed and integrated with the enabling Platforms in order to directly bring their simplification potential to the citizen.

Now the objective for the Italian PA, in particular for the agencies for digitalization, is to further develop these bases that had been set, in particular by promoting the usage of SPID and CIE, as the only access mean to PA digital services, pagoPA and enhancing the digitalization process in order to deliver, eventually, all services through the IO app.

## 3.2. Overview on municipalities

To complement the analysis of the Italian context in regard to interoperability and, consequently, e-government development, we are going to analyze the results of a questionnaire focused on digitalization developed by the Digital Agenda Observatory and submitted to the municipalities between August and October 2022. The questionnaire was proposed to all the Italian municipalities and 952 of them answered. We will analyze the answers to the questions focused on interoperability and the reduction of administrative burden.

We will study and compare the results clustering them in five different population ranges. The ranges and the number of respondents for each range are shown in the following graph (Figure 14).

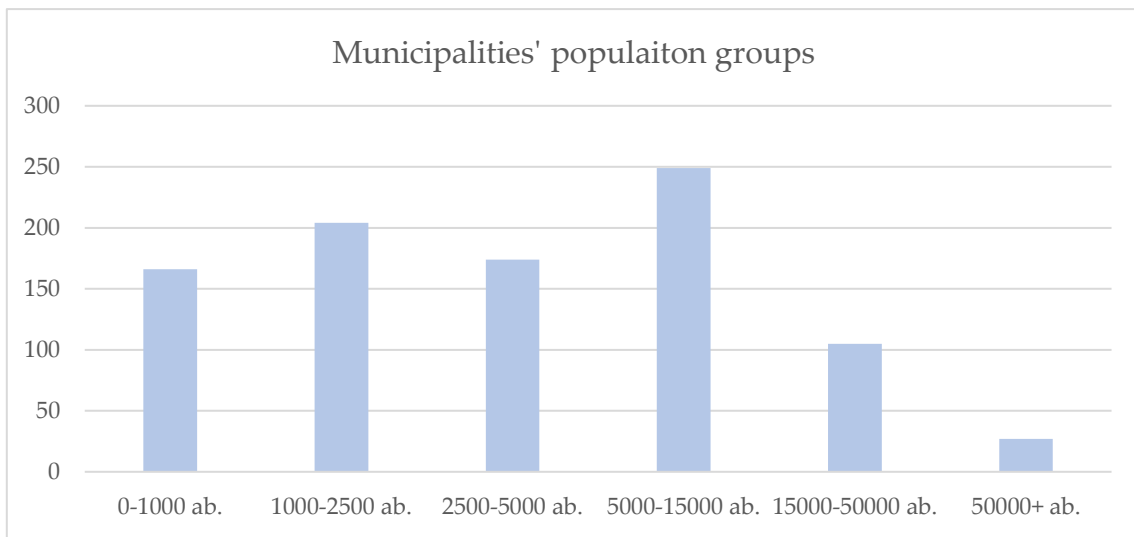


Figure 14: Municipalities population groups

### 3.2.1. Internal interoperability

With respect to internal interoperability, namely interoperability between different organizational units of the same municipality, around 80% of the municipalities answered affirmatively, implying the actuation of internal interoperability projects. As Figure 15 shows, even though the vast majority of municipalities has integrated its internal databases, the smaller municipalities are the less integrated.

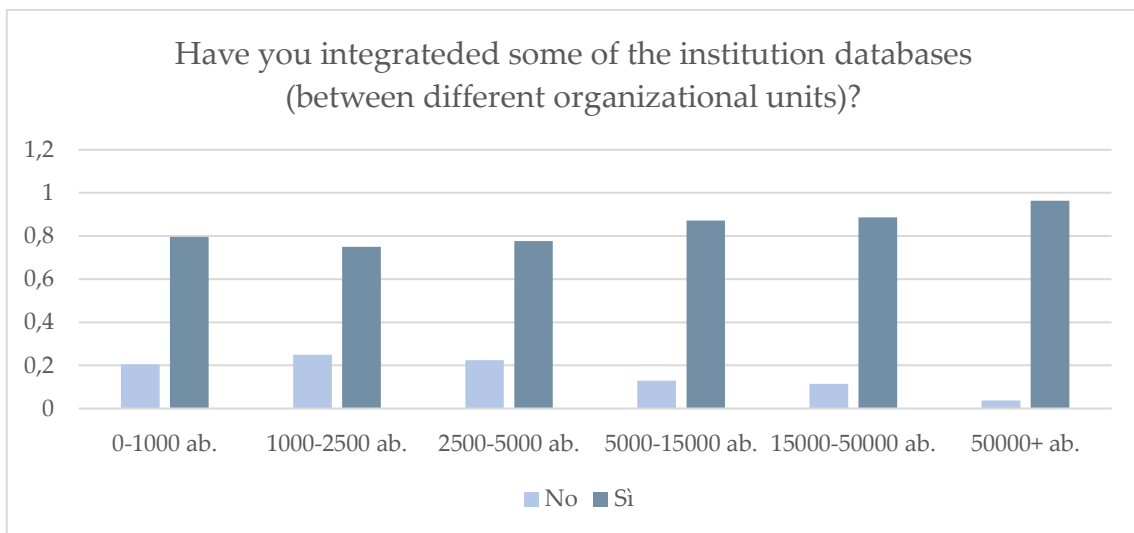


Figure 15: Internal integration - %

The typologies of data, that the vast majority municipalities, regardless of their size, has integrated, are personal and tax data. Additionally, more than the half of bigger municipalities has worked on the integration of more data typologies such as productive activities, territorial, geographical, and human resources (in relation to civil servants) data.

### 3.2.1.1. Criticalities

The municipalities that integrated internally were presented with some possible criticalities concerning the realization of integration between organizational units and they had the possibility to rate from one (no criticality) to five (maximum criticality) each criticality based on its impact. Hereafter a detailed description of the preferences, clustered based on the population ranges, is presented:

- Municipalities with 0-1000 residents: the high project costs, the difficulty to keep up to date the databases, the excessive effort necessary for data cleansing and the lack of internal competences.
- Municipalities with 1000-2500 residents: the high project costs, the difficulty to keep up to date the databases, the excessive effort necessary for data cleansing and the lack of internal competences.
- Municipalities with 2500-5000 residents: the lack of internal competences, the high project costs and the excessive effort necessary for data cleansing.
- Municipalities with 5000-15000 residents: the lack of internal competences, the internal personnel opposition and the high project costs.
- Municipalities with 15000-50000 residents: the internal personnel opposition, the difficulty of collaboration between the involved organizational units, the excessive effort necessary for data cleansing and the lack of internal competences.
- Municipalities with 50000+ residents: the excessive effort necessary for data cleansing, the difficulty of collaboration between the involved organizational units, the internal personnel opposition and the senior management opposition.

The lack of internal competences has been highlighted as major problem by everyone, meaning that some interventions, regarding digital education, are necessary. The excessive effort necessary for data cleansing is also a common major problem highlighted, therefore interventions, aimed to increase data quality, are necessary in order to reduce the required efforts. Also, the high project costs are highlighted as a major problem by almost everyone, apart from bigger municipalities that generally have a bigger budget, this shows the necessity to allocate more funds for the implementation of interoperability projects. Lastly it is worth noticing that only bigger municipalities have pointed out the difficulty of collaboration between the involved organizational units and the internal personnel opposition, meaning that when the size of the municipality increases other problems arise and that different strategies have to be implemented in order to increase interoperability.

### 3.2.1.2. Reasons for non-integration

The causes for not integrating were also investigated through the questionnaire by proposing to the municipalities, that did not integrate internally, some possible reasons for non-integration, which need to be rated from one (insignificant) to five (very relevant). Below are reported the most common reasons for non-integration per different population range:

- Municipalities with 0-1000 residents: the lack of proper economic resources, the lack of internal competences and the lack of adequate technical solutions.
- Municipalities with 1000-2500 residents: the lack of internal competences, the difficulty of collaboration between organizational units, the difficulty to keep up to date the databases and the excessive effort necessary for data cleansing.
- Municipalities with 2500-5000 residents: the high project costs, the lack of internal competences, the difficulty to extract data, the excessive effort necessary for data cleansing and the lack of adequate technical solutions.
- Municipalities with 5000-15000 residents: the shortage of personnel to dedicate to the project, the lack of proper economic resources and the high project costs.
- Municipalities with 15000-50000 residents: the difficulty of collaboration and interaction between organizational units, the shortage of personnel to dedicate to the project and the internal personnel opposition.

Due to the lack of a sufficient amount of data, for the municipalities with 50000+ residents it is not possible to extract an aggregated result, since the majority of respondents from this cluster have integrated internally and therefore did not answer this question.

The shortage of personnel to dedicate to the project is mentioned as one of the main reasons for non-integration, meaning that in order to realize interoperability projects new trained personnel needs to be hired. The lack of internal competences is also, mentioned as one of the main reasons for non-integration, hence highlighting the necessity to train the public servants in order to have them as allies in the integration process. Lastly, as highlighted in the criticalities chapter, the high projects costs are stated as main reason for non-integration, therefore the realization of integration processes necessitates a bigger funds allocation.

### 3.2.2. External interoperability

Regarding external interoperability, hence interoperability between the municipality and other external agencies, less than 50% of the municipalities answered affirmatively, implying the actuation of external interoperability projects. Particularly, in Figure 16 is shown that more than 80% of municipalities with 50000+ residents, while for all the others less than 50%.



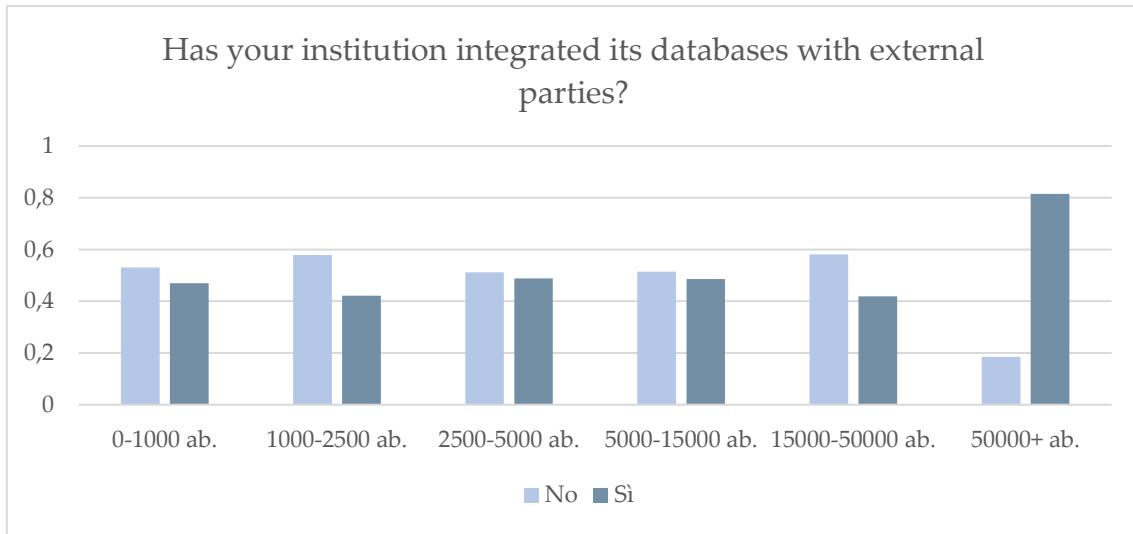


Figure 16: External integration - %

The typologies of data that the vast majority municipalities, regardless of their size, has integrated are personal, productive activities, fiscal and tax data. Additionally smaller and medium municipalities integrated also statistical and territorial data, while bigger municipalities focus on the integration of a much broader set of data, among which cultural, geographical, mobility, security, social and statistical data.

### 3.2.2.1. Criticalities

As for the internal integration, to the municipalities that integrated externally were proposed some possible criticalities concerning the realization of integration with external actors and they had the possibility to rate from one (no criticality) to five (maximum criticality) each criticality based on its impact. The preferences, divided per population range are reported herein:

- Municipalities with 0-1000 residents: the high project costs and the difficulty to collaborate with the entities involved.
- Municipalities with 1000-2500 residents: the high project costs, the excessive effort necessary for data cleansing and the difficulty to keep up to date the databases.
- Municipalities with 2500-5000 residents: the high project costs, the difficulty to collaborate with the entities involved, the internal personnel opposition and the lack of internal competences.
- Municipalities with 5000-15000 residents: the high project costs, the lack of internal competences and the difficulty to collaborate with the entities involved.
- Municipalities with 15000-50000 residents: the high project costs, the excessive effort necessary for data cleansing and the difficulty to keep up to date the databases.

- Municipalities with 50000+ residents: the excessive effort necessary for data cleansing, the difficulty with the entities involved, the lack of internal competences and the internal personnel opposition.

The high project costs have been highlighted by all municipalities, apart from bigger ones that generally have a bigger budget available also for integration projects, pointing out the necessity to increase the funding for integration processes. The excessive effort necessary for data cleansing has been frequently indicated as a criticality, evidencing the necessity to increase data quality in order to reduce the municipalities' efforts in data cleaning. Also, the difficulty of collaboration with other entities involved has been widely indicated as a criticality, meaning that efforts to facilitate collaboration between different entities is necessary. Lastly, the lack of internal competencies, has been frequently pointed out and need to be solved through proper training of civil servants.

#### 3.2.2.2. Reasons for non-integration

The municipalities that did not integrate externally were presented with some possible reasons for non-integration that they needed to rate from one (insignificant) to five (very relevant). Hereunder the most rated reasons for non-integration per population range are reported:

- Municipalities with 0-1000 residents: the lack of proper economic resources, the shortage of personnel to dedicate to the project and the high project costs.
- Municipalities with 1000-2500 residents: the lack of proper economic resources, the high project costs, the difficulty of data extraction and the lack of adequate technical solution.
- Municipalities with 2500-5000 residents: the shortage of personnel to dedicate to the project, the high project costs, the lack of proper economic resources and the lack of internal competences.
- Municipalities with 5000-15000 residents: the shortage of personnel to dedicate to the project, the lack of proper economic resources and the difficulty to collaborate with the entities involved.
- Municipalities with 15000-50000 residents: the shortage of personnel to dedicate to the project, the realization of integration between organizational units, the difficulty to collaborate with the entities involved and the high project costs.

Due to the lack of a sufficient amount of data, for the municipalities with 50000+ residents it is not possible to extract an aggregated result since the majority of respondents from this cluster have integrated externally and therefore did not answer this question.

The shortage of personnel to dedicate to the project is mentioned as one of the main reasons for non-integration, meaning that in order to realize interoperability projects new trained personnel needs to be hired. The high projects costs and the lack of proper economic resources are stated as main reasons for non-integration, therefore the realization of integration processes necessitates bigger funds and a better allocation.

### 3.2.3. Future integration projects

Less than the half of the respondents stated that in the next 12 months will start integration projects. Particularly, looking at Figure 17 the difference between very big municipalities (50000+ residents) and the others is clear. The majority of the bigger municipalities, around 70%, will implement new integration projects that may be internal or external.

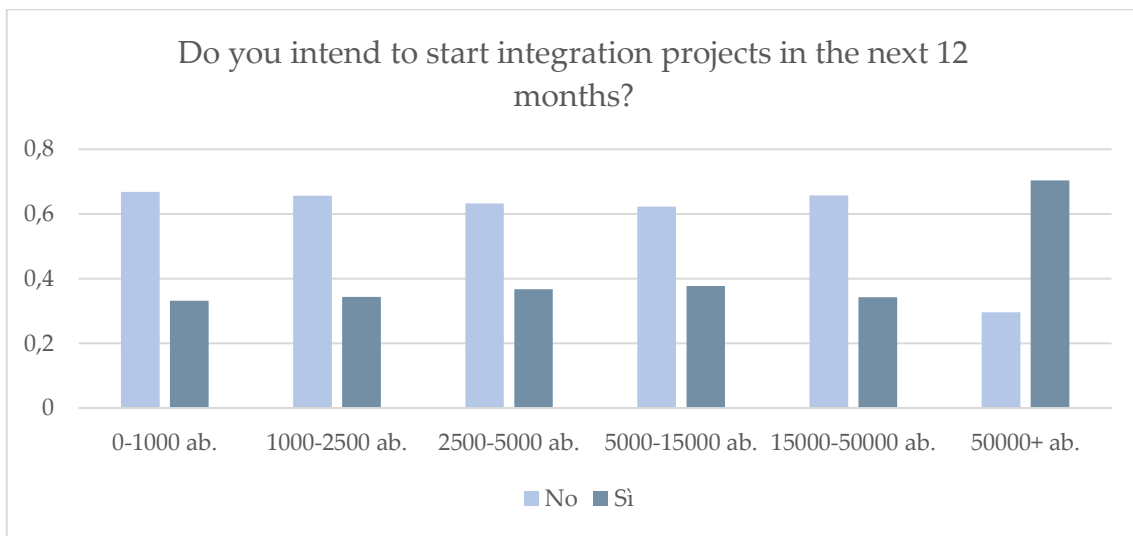


Figure 17: Planned integration projects

### 3.2.4. Reduction of administrative burden

The questionnaire includes also questions concerning the solution implemented to reduce the administrative burden, for businesses and citizens, related to services provided by the municipality, which could be considered a first form of proactivity.

50% of the municipalities answered that, when the deadline for a fulfillment is close, they notify the citizens with a reminder. Additionally, 28% of the respondents activated automatic pre-compilation of forms, while less than 5% are able to eliminate the intervention of the citizen in the service or fulfillment thanks to the data owned by the municipality, which can be seen as the intervention that introduces the highest level of proactivity.

As integration of this question, a question concerning the obstacles in the introduction of new procedures to reduce the fulfillments of citizens and businesses is presented. The obstacles most selected for each range of population are:

- Municipalities with 0-1000 residents: the lack of personnel, the unavailability of economic resources and the lack of interest for citizens and business to communicate with the municipality through digital channels.
- Municipalities with 1000-2500 residents: the lack of personnel, the unavailability of economic resources and the lack of internal competences.
- Municipalities with 2500-5000 residents: the lack of personnel, the lack of internal competences and the unavailability of economic resources.
- Municipalities with 5000-15000 residents: the lack of personnel, the lack of internal competences and the unavailability of economic resources.
- Municipalities with 15000-50000 residents: the lack of personnel, the resistance from affected municipality personnel, the lack of internal competences and the unavailability of economic resources.
- Municipalities with 50000+ residents: the resistance from affected municipality personnel, the lack of personnel and the inadequate regulation.

Lack of personnel and lack of internal competences have been scored as the highest obstacles in the majority of municipalities, highlighting the need of qualified personnel with digital competences and experience in these kinds of projects. Additionally, the economic perspective cannot be neglected, indeed unavailability of funds in order to finance these interventions is one of the most selected obstacles especially for the smaller municipalities. Concerning organizational and cultural problems related to resistance to change of the personnel are pointed out only by the largest municipalities. This issue could be talked by giving proper training and highlighting the benefits that this change could bring to the society. The regulation issue is raised by the bigger municipalities highlighting how also the legal part needs to be taken care of.

### 3.2.5. Conclusions

Looking at the questionnaire responses about database integration, it is possible to conclude that interoperability, in the Italian municipalities context, is a quite diffuse practice. This is demonstrated by the overall results of about 82% of respondents that integrate some internal databases and almost 50% that integrate with external organizations. This is a good starting point but still some improvements are needed.

As expected, while interoperability, especially of internal database, is a concern for many municipalities, it is still too early for the diffusion of solutions and practices aiming at reducing the administrative burden that citizens have to bear in performing administrative fulfillments. Indeed, forms of proactivity are limited to sending

notifications in proximity of specific deadlines, demonstrate the necessity to improve and facilitate further interoperability both at the local and national level.

Related to this, the analyses of the criticalities and reasons of non-integration allow us to reason on the necessary interventions to facilitate interoperability. What stands out is that the majority of municipalities does not recognize only the technical aspect as an obstacle in the integration project realization. On the contrary problems related to the personnel are highlighted, in regard to lack of knowledge, shortage of personnel and difficulty of coordination. These problems are related to the organizational interoperability, previously mentioned in the literature, and to be solved necessitate more harmonization between business processes, responsibility and expectation, in order to be able to work together in the same direction and achieve the set objectives. It is important to act in order to solve the problems of shortage of personnel and the lack of knowledge with targeted interventions. Furthermore, the municipalities mentioned issues related to data cleansing which are strictly related to semantic interoperability. Through the implementation of semantic interoperability, the standardization of data formats and meanings, the efforts required by the different municipalities to clean the data will be reduced, since the initial data quality will be higher.

Concluding, through the analysis of the questionnaire responses we have been able to highlight how the different layers of interoperability explained in the EIF and in the Piano Triennale, are conducive for interoperability.



## 4 E-government and interoperability: case studies from EU countries

With the aim of answering the aforementioned research questions, e-government experts from various countries with an advanced digital public sector have been interviewed. The chosen countries are Denmark, Estonia, the Netherlands, and Sweden. In this chapter, we will present the evidence arose from these interviews as case study analysis for each country, and afterwards the most important findings are gathered in order to highlight the necessary steps that a country needs to undergo in order to increase the interoperability in its public sector and, as a consequence, improve the e-government.

### 4.1. Worldwide e-government assessment

Digital government is gaining every year more importance both at European and international level, and this is evidenced by the wide range of reports produced by national and international institutions. We will make an overview of the results presented by the several reports, particularly focusing on the European context and on the countries with whose expert we performed the interviews, with the purpose of contextualizing the empirical analyses performed. We are going to compare the results of three international reports: the “Digital Economy and Society Index (DESI) 2022” produced by the European Commission, the “eGovernment Benchmark 2022” produced by the European Commission and the “E-Government Survey 2022” produced by the United Nations.

#### 4.1.1. Digital Economy and Society Index (DESI) 2022

The European Commission publishes data about the Digital Economy and Society Index (DESI) since 2014. The DESI report helps the different European Union Member States pinpoint the most overriding actions needed. The DESI is the result of the average of four dimensions’ values:

- Human capital
- Connectivity
- Integration of digital technology
- Digital public services

Each of the different dimensions, which will be further discussed later, is composed of sub-dimensions and indicators.

#### *Human capital*

This dimension refers to the digital skills possessed by the citizens. The sub-dimensions and their indicators are:

- Internet user skills
  - At least basic digital skills
  - Above basic digital skills
  - At least basic digital content creation skills
- Advanced skills and development
  - ICT specialists
  - Female ICT specialists
  - Enterprises providing ICT
  - ICT graduates

#### *Connectivity*

This dimension focuses on connectivity technologies and other fundamental technologies necessary to enact the digital transformation, such as semiconductors. The sub-dimensions and their indicators are:

- Fixed broadband take-up:
  - Overall fixed broadband take-up
  - At least 100 Mbps fixed broadband take-up
  - At least 1 Gbps take-up
- Fixed broadband coverage
  - Fast broadband (NGA) coverage
  - Fixed Very High Capacity Network (VHCN) coverage
  - Fibre to the Premises (FTTP) coverage
- Mobile broadband
  - 5G spectrum
  - 5G coverage NA
  - Mobile broadband take-up
- Broadband prices
  - Broadband price index



*Integration of digital technologies*

This dimension performs an analysis about the different digital technologies that are key enablers of the public sector digitalization. The sub-dimensions and their indicators are:

- Digital intensity
  - SMEs with at least a basic level of digital intensity
- Digital technologies for business
  - Electronic information sharing
  - Social media
  - Big data
  - Cloud
  - AI
  - ICT for environmental sustainability
  - e-Invoices
- e-Commerce
  - SMEs selling online
  - e-Commerce turnover
  - Selling online cross-border

*Digital public services*

This dimension analyzes the different public services available and their availability. Only one sub-dimension is present, and its indicators try to highlight the typologies and target users of the different services:

- e-Government
  - e-Government users
  - Pre-filled forms
  - Digital public services for citizens
  - Digital public services for businesses
  - Open data

Looking at the DESI results Finland, Denmark, the Netherlands and Sweden keep on being the EU frontrunners.

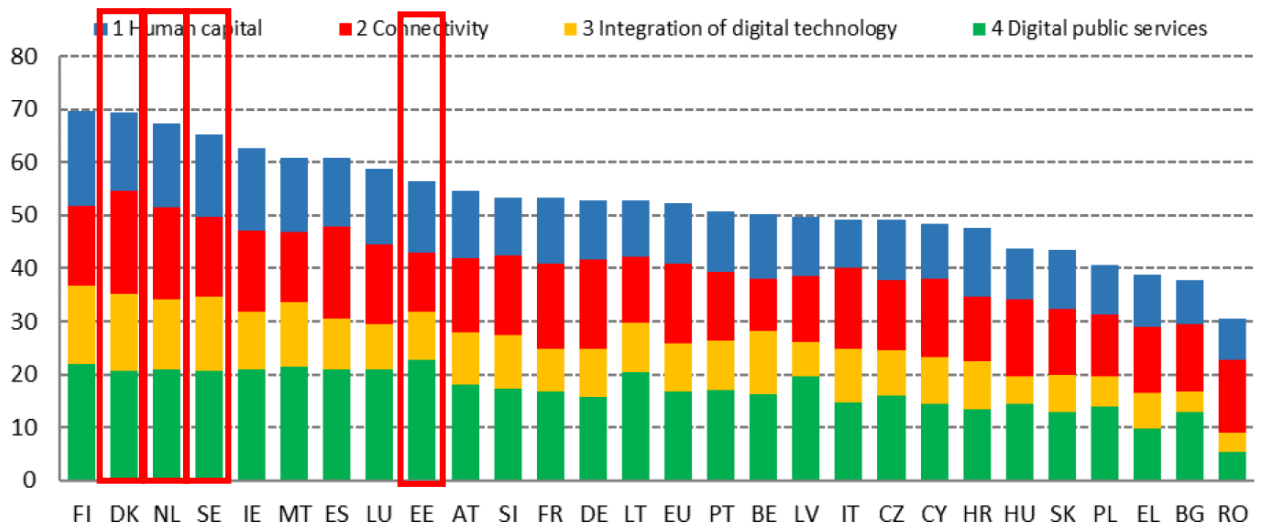


Figure 18: Digital Economy and Society Index, 2022

Figure 18 highlights the EU results, particularly in red are highlighted the countries with whose experts we have conducted interviews. We will briefly discuss their results.

Denmark ranks 2<sup>nd</sup> in the DESI, performing greatly in all the dimensions going above the EU average. The Danish ranks per dimensions are: 5<sup>th</sup> in Human capital, 1<sup>st</sup> in Connectivity, 2<sup>nd</sup> in Integration of digital technology and 8<sup>th</sup> in Digital public services. To maintain this good performance and keep on improving its e-government, Denmark has to pay attention to its lack of IT specialists.

Estonia ranks 9<sup>th</sup> in the DESI, particularly places itself 8<sup>th</sup> in Human Capital, 26<sup>th</sup> in Connectivity, 15<sup>th</sup> in Integration of digital technologies and 1<sup>st</sup> in Digital public services. Estonia in order to meet its 2030 goals has to work on connectivity improvements and continue to foster its digital specialists.

The Netherlands rank 3<sup>rd</sup> in the DESI going above the EU average in each dimension scoring: 2<sup>nd</sup> in Human capital, 2<sup>nd</sup> in Connectivity, 4<sup>th</sup> in Integration of digital technologies and 4<sup>th</sup> in Digital public services. To keep on maintaining the same position the Netherlands need to increase the % of ICT graduates over the total of graduates since right now in this indicator they are below the EU average (3.9%), scoring 3.4%.

Sweden ranks 4<sup>th</sup> in the DESI, particularly places 4<sup>th</sup> in Human capital, 9<sup>th</sup> in Connectivity, 3<sup>rd</sup> in Integration of digital technologies and 9<sup>th</sup> in Digital public services. Sweden values highly digital skills, looking at them as the key to reduce digital divide. However, it is really fundamental for Sweden to increase the number of ICT specialists as well as improving connectivity to face future challenges.

#### 4.1.2. eGovernment Benchmark 2022

The European Commission monitors the e-government development of European countries through the eGovernment Benchmark, in order to check their improvements in relation to the EU aim of providing all key public services online by 2030.

The eGovernment Benchmark evaluates online public services based on four dimensions each of which depends on different underlying indicators:

- User Centricity
  - Online Availability
  - Mobile Friendliness
  - User Support
- Transparency
  - Service Delivery
  - Personal Data
  - Service Design
- Key Enablers
  - eID
  - eDocuments
  - Authentic Sources
  - Digital Post
- Cross Border Services
  - Online Availability
  - User Support
  - eID
  - eDocuments

The performances of the different underlying indicators are the result of a survey made of 48 questions submitted to citizens from the participating countries, after having given them access to 14,252 websites: 8,491 websites and 804 portals from their own governments, as well as 4,155 cross-border websites and 802 portals from other European countries. The study spans 2,852 PAs: 1,188 central, 426 regional and 1,238 local government bodies.

It is worth mentioning that this eGovernment Benchmark edition catches the digital transformation of governments in 2021 and 2020, during the pandemic that has brought unexpected change in our society.

The score assigned to each country is between 0% and 100% and the average European result is 68%. As shown in Figure 19 the European leaders are Malta (96%) and Estonia (90%), but also other countries scored very high: Luxembourg (87%), Iceland (86%), the Netherlands (85%), Finland (85%), Denmark (84%), Lithuania (83%), Latvia (80%), Norway (79%), Spain (79%) and Portugal (78%).

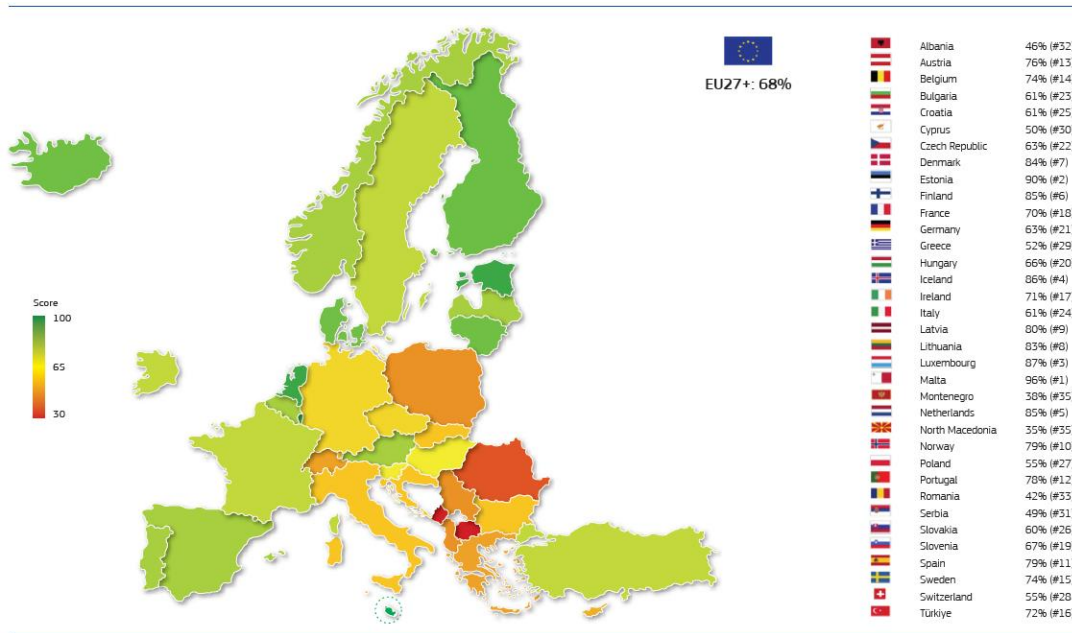


Figure 19: Country overall eGovernment maturity (EU27+ biennial average) (eGovernment Benchmark, 2022)

In Table 2 are highlighted the scores of Denmark, Estonia, Italy, the Netherlands and Sweden, in comparison to the European average:

Country	Score
Italy	61%
Denmark	84%
Estonia	90%
The Netherlands	85%
Sweden	74%
European average	68%

Table 2: eGovernment Benchmark focus on Denmark, Estonia, Italy, the Netherlands and Sweden (eGovernment Benchmark, 2022)

The Italian score is below the European average and significantly lower than Denmark, Estonia, the Netherlands and Sweden, meaning that Italy has still work to do in order to increase its digital public service provision quality.

### 4.1.3. E-Government Survey 2022

The United Nations measure the E-Government Development Index (EGDI) every two years and in 2022 they have published their latest version. The EDGI index results as the weighted average between three independent components:

- Online Services Index (OSI), which is additionally made up of five subindices:
  - Institutional framework (IF)
  - Services provision (SP)
  - Content provision (CP)
  - Technology (TEC)
  - E-participation (EPI)
- Telecommunications Infrastructure Index (TII)
- Human Capital Index (HCI)

The EDGI, consequently to the calculation of the index itself, clusters the different countries in four groups low, middle, high and very high, according to the index value. To highlight even further the differences between countries all the four groups are divided in four subgroups: low (L1, L2, L3 AND LM), middle (M1, M2, M3 AND MH), high (H1, H2, H3 AND HV), and very high (V1, V2, V3 AND VH).

Giving a worldwide glance the average EGDI has increased from the previous analysis, performed in 2020, rising from 0.5988 to 0.6102, due to development in the telecommunication infrastructure.

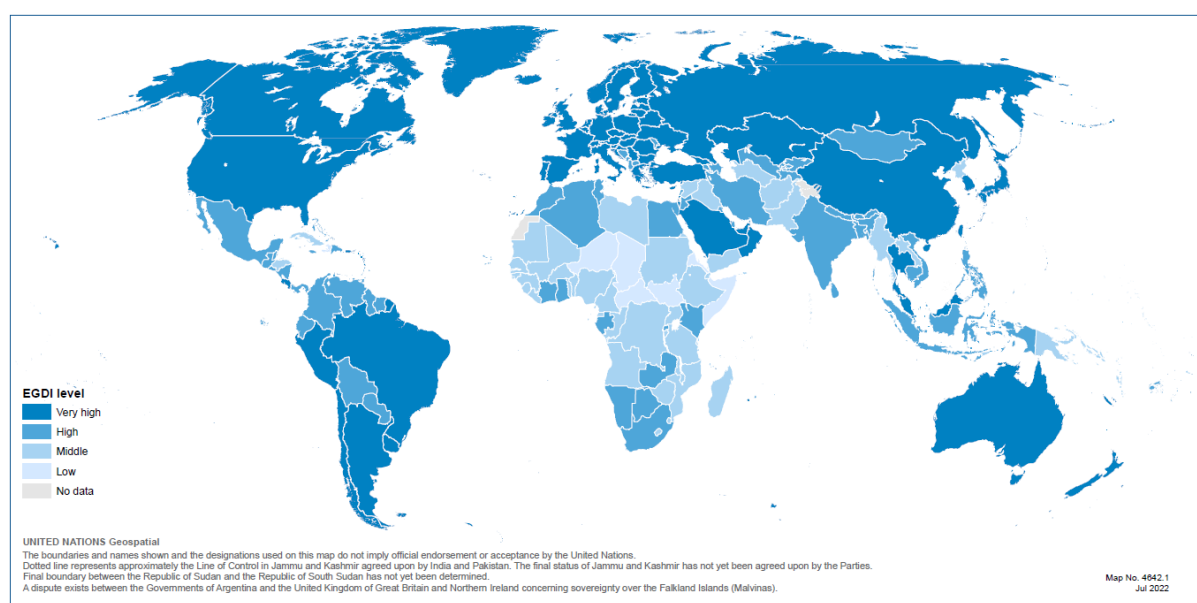


Figure 20: Geographical distribution of the four EGDI groups (E-government Survey, 2022)

Starting the reduction of data aggregation, it is possible to highlight the level of EGDI per continent:

- Europe: 0.8305
- Asia: 0.6493
- The Americas: 0.6438
- Oceania: 0.5081
- Africa: 0.4054

Since our empirical analysis has the objective of identifying a possible path that Italy could follow to increase its interoperability and we performed interviews with experts from Denmark, Estonia, Netherlands, and Sweden, we will further analyze data from Europe with a special focus on these four countries, whose EGDI results are highlighted in red in Figure 21.

Europe, as stated before has the highest average EGDI value (0.8602), as well as the highest average values of HCI, equal to 0.9030, and TII, equal to 0.8648. The survey was submitted to 43 European countries and 35 of them are ranked in the very high EGDI group, furthermore eight of them, as shown in Figure 21, are in the VH subgroup rating class and are among the global leaders in e-government development:

Country name	Rating class	Region	OSI	HCI	TII	EGDI (2022)	EGDI (2020)
Denmark	VH	Europe	0.9797	0.9559	0.9795	0.9717	0.9758
Finland	VH	Europe	0.9833	0.9640	0.9127	0.9533	0.9452
Republic of Korea	VH	Asia	0.9826	0.9087	0.9674	0.9529	0.9560
New Zealand	VH	Oceania	0.9579	0.9823	0.8896	0.9432	0.9339
Sweden	VH	Europe	0.9002	0.9649	0.9580	0.9410	0.9365
Iceland	VH	Europe	0.8867	0.9657	0.9705	0.9410	0.9101
Australia	VH	Oceania	0.9380	1.0000	0.8836	0.9405	0.9432
Estonia	VH	Europe	1.0000	0.9231	0.8949	0.9393	0.9473
Netherlands	VH	Europe	0.9026	0.9506	0.9620	0.9384	0.9228
United States of America	VH	Americas	0.9304	0.9276	0.8874	0.9151	0.9297
United Kingdom of Great Britain and Northern Ireland	VH	Europe	0.8859	0.9369	0.9186	0.9138	0.9358
Singapore	VH	Asia	0.9620	0.9021	0.8758	0.9133	0.9150
United Arab Emirates	VH	Asia	0.9014	0.8711	0.9306	0.9010	0.8555
Japan	VH	Asia	0.9094	0.8765	0.9147	0.9002	0.8989
Malta	VH	Europe	0.8849	0.8734	0.9245	0.8943	0.8547

Figure 21: Leading countries in e-government development (E-government Survey, 2022)

It is worth mentioning that Denmark has ranked in the first position for the third consecutive Survey, that Sweden has achieved a 10% increase for the OSI and the Netherlands has reached a 4.4% increase for the TII.

## 4.2. Denmark

*“Denmark has just been awarded as a leading digital country in the world by the UN.”*

*(Chief Consultant and Chief Architect for Federal Digital Architecture - FDA,  
Agency for Digital Government)*

The Danish e-government is really advanced. Its development started in 2001 when the central, regional and local governments started a collaboration process. Throughout the last 20 years Denmark managed to create the solid digital infrastructure necessary for the public service provision.

### 4.2.1. Joint Government Digital Strategy

The Denmark’s Digital Journey started about 20 years ago, in 2001. Since then, all levels of the government institutions, namely state (national level), regions (5 regions in Denmark) and municipalities (98 municipalities) have cooperated to create the foundation for the Danish digital public sector. The collaboration across all levels was based on common comprehensive digital strategies for the public sector in the form of multi-annual agreements about the direction of development of digital government in Denmark, called Joint Government Digital Strategies.

*“What we do have in place is a very good collaboration between state, regions and municipalities”*

*(Chief Consultant and Chief Architect for Federal Digital Architecture - FDA,  
Agency for Digital Government)*

*“For the past 20 years in Denmark we have had joint public sector strategies that is all levels of government that together formulate a strategy and then collaboratively work on the digitalization of the public sector as a whole, in order to facilitate the interoperability”*

*(Team Lead Division for Analysis and Policies, Agency for Digital Government)*

Within the Joint Government Digital Strategy there is the upper governance board consisting of representatives from the different levels of the government, from which comes the collaborative nature of the decisions for the public digitalization and interoperability. Indeed, the government’s digital strategies concern public authorities at all levels of government, including administrative institutions such as ministries, agencies, municipal, and regional administrations, as well as self-governing public institutions, such as the universities.

*“[Digital initiatives] are formulated in those Joint Strategies, they’re co-formulated, co-created. There are political discussions on them, they are created and then taken down. [...] this government framework consisting of the national, the regional and the municipality level of government, they set out these common standards and ambitions and goals and so on”*

*(Team Lead Division for Analysis and Policies, Agency for Digital Government)*

The government’s Joint Digital Strategies are not alone in ensuring that the public sector is well prepared to seize the opportunities of digital development. Indeed, below the upper body, the strategy, guidelines and goal are taken by the steering committees consisting of authorities and ministries that are specialized in one area and have responsibility to harness the digital potential within its own purview.

*“Below that upper body there are steering committees, consisting [...] of my agency and other ministries, [...] if you have something related to education you would have the ministry of education, the ministry of higher education and so on, being in those steering committees to have this governance body set up.”*

*(Team Lead Division for Analysis and Policies, Agency for Digital Government)*

Therefore, in parallel with joint public sector efforts, there are institutional level specific digital projects and strategies, for example municipal and regional digital strategies. This approach to the digital development of the public sector provides a good balance between common strategic targets and local adaptation and priorities.

The strategic and collaborative approach to digital initiatives makes it possible for the Danish public sector to make joint investments in areas which are particularly complex and in which there are interdependencies across different authorities, sectors, and levels of government. The collaborative attitude is also present in the financial system of the initiatives with co-financing mechanisms between different levels (central, regional and municipalities) for the biggest infrastructural projects that involve many sectors of the government.

*“The finance structure of the [...] big public infrastructure solutions is that the government pays 40%, the municipalities pay 40% and the regions pay 20%. [...] That’s the current financial structure, so it is co-financed. Also, they are run from my agency, but it is a common responsibility.”*

*(Team Lead Division for Analysis and Policies, Agency for Digital Government)*

Going back to the Joint Digital Strategies, the current Joint Government Digital Strategy runs from 2022 until 2025 and it includes initiatives that will accommodate



some of the greatest challenges that the Danish society is facing, including labor shortage, climate change mitigation, and digital inclusion. The Strategy, among its 28 initiatives, introduces two new solutions. Firstly, a new infrastructure component that will allow users to grant and rescind permissions for authorities to use their personalized data. Secondly, digital powers of attorney will pave the way for allowing people to let their relatives manage their digital contact with the public sector.

#### 4.2.2. National Strategy for Digitalization

On top of the Joint Government Digital Strategy, the Danish Government, in March 2021 set up a digitalization partnership, consisting of 28 representatives from Danish businesses, the research communities, civil society, and local and regional governments, with the purpose of advising the government on how to harness the opportunities provided by digital technologies. Their work resulted, in October 2021, with the release of 46 recommendations to be put in place for progressing towards a better digital future.

In May 2022, based on these contributions from the Digitalisation Partnership, the Danish Government presented the National Strategy for Digitalisation. The strategy's ambitions are to maintain Denmark as one of the main digital frontrunners by boosting the growth through digitalization, strengthening common welfare and making sure that everyone could use and benefit from digital services. Since the aim is to create digital solutions that benefit everyone, the strategy covers both private and public sector and calls for broad collaboration between public, private and civil society actors.

*"Digitalisation should not be undertaken just for the sake of it, but to solve challenges and develop society for the better. The government's National Strategy for Digitalisation is therefore based on 9 visions that set the direction for where digital solutions should be deployed to solve concrete societal problems and create value for citizens and businesses."*

*(National Strategy for Digitalization (2022), Danish Government Ministry of Finance)*

The strategy contains nine visions for the next steps in Denmark's digital development:

- Vision 1 Strengthened cyber and information security
- Vision 2 Coherent service for citizens and businesses
- Vision 3 More time for welfare through increased use of new technology
- Vision 4 Increased growth and digital SMEs
- Vision 5 The digital healthcare of the future
- Vision 6 Acceleration of the green transition through digital solutions

- Vision 7 A strong, ethical, and responsible digital foundation
- Vision 8 Denmark at the centre of international digitalization
- Vision 9 A population ready for a digital future

From the visions it is possible to see that the strategy covers many sectors and areas, from the healthcare (Vision 5) and green transition (Vision 6) to digital SMEs (Vision 4) and digital skills (Vision 9).

A strong emphasis is posed on maintaining and investing in the Denmark's digital foundation (Vision 7) to ensure and maintain the development of digital public services for the benefits of citizens and business. This applies to data, maintenance of IT systems, coherent and expanded digital architecture and standards across solutions and ensuring a clear legal framework for digitalization.

On top of this, there is the strong commitment of offering public services with a focus on the individual citizen and business (Vision 2). In this sense, digital public service and solutions must be coherent, user-friendly, accessible to all and based on the individual user's needs and situation.

The people welfare is taken into account as well (Vision 3). Technology and digital solutions should be an integral part of the way in which the public and private sectors work and perform their tasks in general, especially in areas where it is expected that labor shortages will remain high in the future. Every technological solution adopted should create value for citizens, businesses and society, and support employees in carrying out their tasks.

Making Denmark digitally secured is a priority (Vision 1) since, with a high level of digitalization also comes the vulnerability to cyber-attacks which are one of the most serious threats. For this reason, a dedicated strategy was created, the National Strategy for Cyber and Information Security 2022-2024 which covers all possible issues for government, citizens and businesses and proposes to strengthen cyber security and Denmark's participation in the international cooperation to combat cyber threat.

The strategy also covers the role at the EU level that Denmark needs to have, as digital pioneer and leader both in public and private sector, in setting and influencing the digital agenda and in providing digital solutions and competence to other countries (Vision 8).

### 4.2.3. Denmark's Digital Journey

The Danish Digital Journey started in 2001 with the Danish national government, municipalities, and regions that have been working closely together to build a strong common digital infrastructure that serves as the foundation for public services for residents and businesses in Denmark.

*“Since 2001 we have had strong collaboration, we made a common framework for architecture, started making standards and reference architecture and building common solution and have common implementation projects”*

*(Chief Consultant and Chief Architect for Federal Digital Architecture - FDA,  
Agency for Digital Government)*

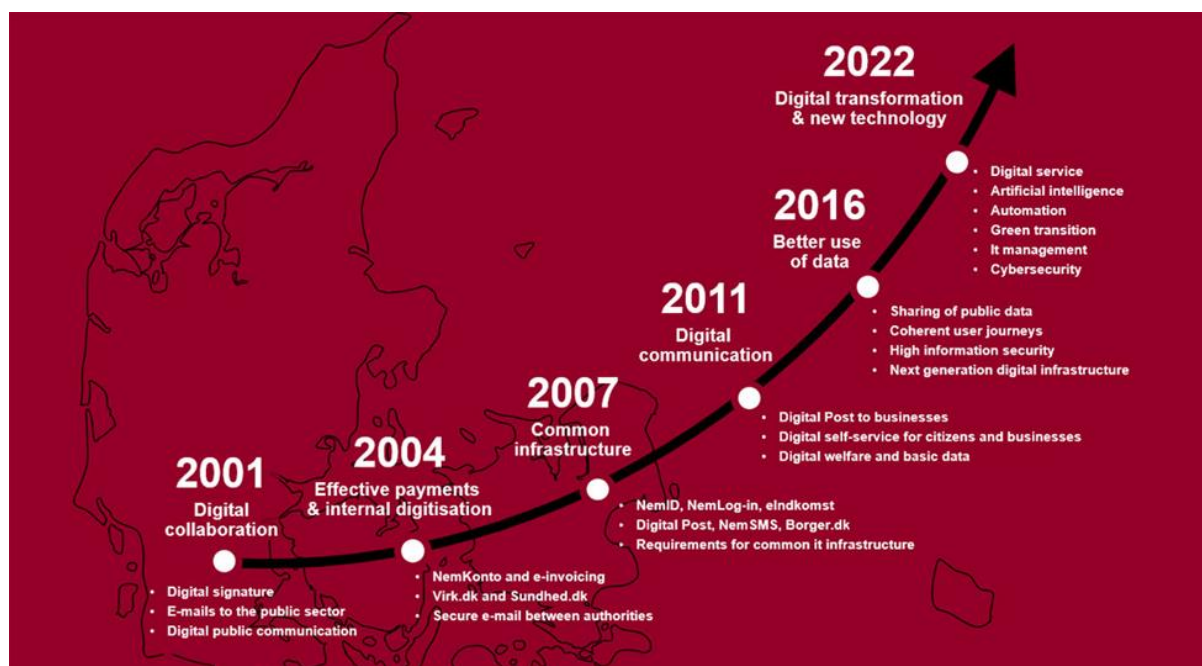


Figure 22: Danish Digital Journey (Agency for Digital Government, 2022)

In the first years the focus was on internal specific digitalization projects, with digital signature and digital e-mail, and on effective payments, with e-Invoicing and NemKonto (the Danish National Account Register), which is a solution that supports easy and automatic payments between public authorities and both citizens and companies.

Later, the focus shifted on building a common infrastructure by defining core architectural and cross sectoral components for enriching the digital government infrastructure and enabling interoperability. For instance, the second-generation e-ID, called NemID, (the third and current generation is called MitID) and NemLog-In which is the portal giving access to the public authority self-service solutions. They developed Digital Post, a part of the digital service infrastructure enabling public authorities to communicate securely and digitally with citizens and businesses, which later was made mandatory as well as some self-services in various areas. In addition, it was introduced the National Citizen Portal called Borger.dk, a structural part of the Denmark common infrastructure that represents the single point of access for citizens for online services and information about the public sector. Other interventions

concerned standard requirements as key component of the common infrastructure. For instance, it was developed a reference architecture for Cases and Documents handling. This was created as a family of public sector standards, mostly used by municipalities, in order to support the case and document handling systems.

From 2016 the focus shifted to the public data sharing with a continuous upgrade of the infrastructure and the expansion of the Basic Data Program already started in 2011.

Denmark followed a holistic and comprehensive approach in its Digital Journey without focusing on some specific administrations or areas of the public sector. The centralized efforts were mostly cross sectoral and directed to the digital infrastructure common to all public areas.

*“Today we have modelling rules that are more or less used across the public sector, we have a number of standards specifications that are used across the public sector [...] I always worked in the center of the whole thing, [...] what we are doing is doing stuff across domains. E-procurement is across domains, e-ID and payment are across domains, citizen portal is across domains, case and documents is across domains, organizational data and basic data are across domains”.*

*(Chief Consultant and Chief Architect for Federal Digital Architecture - FDA,  
Agency for Digital Government)*

The major cross-sectoral digital interventions put in place and mentioned before (MitID, Digital Post, National Citizen Portal, standards for document handling, ...) represent the backbone of the Danish Digital Government. The aforementioned interventions are the components at the base of the same common architecture and infrastructure that enables Denmark to reach such level of interoperability.

*“So, the approach to that is sort of link all [these components] together and the main attraction of that is of course to make it easier for citizens and also promote interoperability because these systems have to be linked up”*

*(Team Lead Division for Analysis and Policies, Agency for Digital Government)*

In the following paragraphs the most important digital interventions, conducive to interoperability, will be analyzed.

#### 4.2.3.1 Danish National eID

The Danish National eID, called MitID, is key to digital Denmark. Introduced in 2022 as evolution of the second generation eID (NemID), the MitID is the digital ID that citizens use across the whole public sector to access to services and portals or more generally, in situations where it is essential to document their identity electronically.

*“Then we have this approach where we develop this central infrastructure component that is the national e-ID, here in Denmark we have one e-ID, which is the same that you use across the public and private sector”*

*(Team Lead Division for Analysis and Policies, Agency for Digital Government)*

The digital identity is one of the central components upon which the digital infrastructure and interoperability are based. MitID enhances the scope of communication between citizens and the public sector and helps the public sector to offer better services to citizens and businesses.

The switch to digital-first was enabled by the rollout of Denmark’s second-generation national eID (NemID) in 2010. MitID is the result of a well-established and unique collaboration between the public and financial sector. Public sector and banks worked closely together to issue a unique digital identity that represents a shared solution across businesses, persons, and authorities.

*“It was developed in a collaboration between the different levels of government and the finance sector so the banks. They collaboratively have developed the system and so this made it so that you have to use only one [eID].”*

*(Team Lead Division for Analysis and Policies, Agency for Digital Government)*

MitID serves as a communal login for public and private self-service solutions and online banking, as well as National Digital Post system.

#### 4.2.3.2 Digital Post

A key component and cornerstone of the cross-governmental digital service infrastructure in Denmark, is the National Digital Post. It aims to support and strengthen the public services for citizens and businesses as well as public authorities, by establishing a secure and digital communication between public authorities and citizens and business. Therefore, as part of the Danish national digital service infrastructure, Digital Post is used to communicate securely between public authorities (municipal, regional and state authorities), residents, and businesses in Denmark.

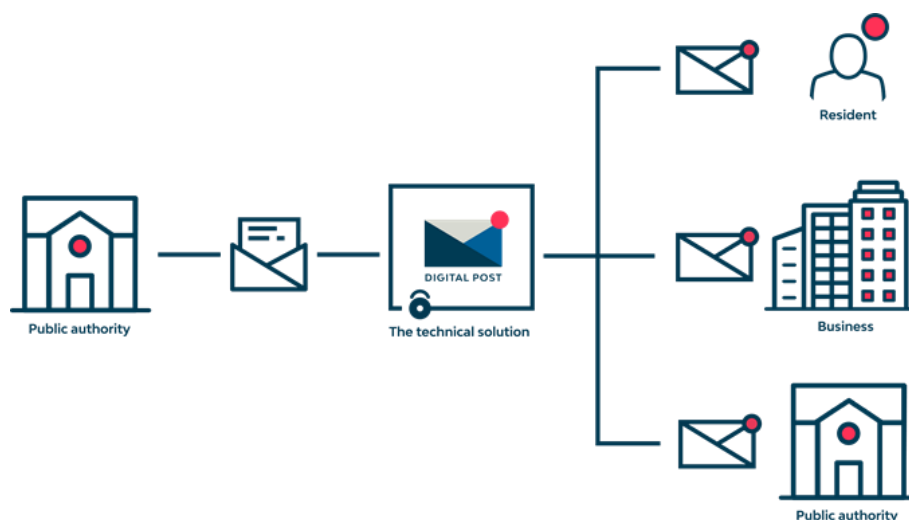


Figure 23: Digital Post in Denmark (Agency for Digital Government, 2022)

*“It is mandatory to use Digital Post in Denmark for authorities communicating with citizens”*

*(Chief Consultant and Chief Architect for Federal Digital Architecture - FDA, Agency for Digital Government)*

The current legislation, passed in June 2012, enables public authorities to send digital messages and documents with legal effect and, consequently, made mandatory for all citizens and business not exempt to be able to receive and read Digital Post from public senders. Danish authorities must in turn provide help and guidance to those who have trouble accessing their Digital Post. The correspondence received through this digital service has legal affect and it is just as binding as contracts and signed documents sent on paper with a stamp. Digital Post communications from public authorities may include for instance letters from the hospital, information about student grant (SU), changes in housing benefits, assignment of day-care facility place, letters from the Central Customs and Tax Administration (SKAT) etc.

To support Digital Post messages management, the MeMo Format was developed.

*“To make input and output management of Digital Post we made a common format, MeMo Format, which carries some metadata, so you can sort of route the mail messages in the authorities’ systems, in this case the handling system”*

*(Chief Consultant and Chief Architect for Federal Digital Architecture - FDA, Agency for Digital Government)*

So, Digital Post enables authorities to:

- Use their own professional systems such as Outlook, EDMS to send and receive personal data and information from citizens and businesses, compliant with the General Data Protection Regulation (GDPR).
- Communicate securely and legally to a specific personal identification number (CPR) or a Central Business Register number (VAT), with no need to establish and update a register of recipients.
- Enhance their digital communication with citizens and businesses by using the public sector's shared MeMo format. The format supports public authorities in marking up Digital Post and enables them for instance to help recipients with automatic calendar invitations direct links to self-service solutions.

#### 4.2.3.3 Basic Data Programme

*"Our main example of interoperability is regarding basic data and we are very mature in Denmark regarding basic data"*

*(Chief Consultant and Chief Architect for Federal Digital Architecture (FDA),  
Agency for Digital Government)*

Basic Data Programme is a cross-institutional program, launched in 2012, in which central, regional and local governments collaborated to improve Basic Data quality and access to central registers in Denmark. This provides the foundation for more efficient and effective public sector administration. Basic data is fundamental information included in day-to-day case processing by the authorities. Basic data may comprehend data about individuals (e.g., Civil Registration System number), companies (business registration number), addresses, real estate properties (e.g., cadastral numbers) and geography (e.g., digital maps).

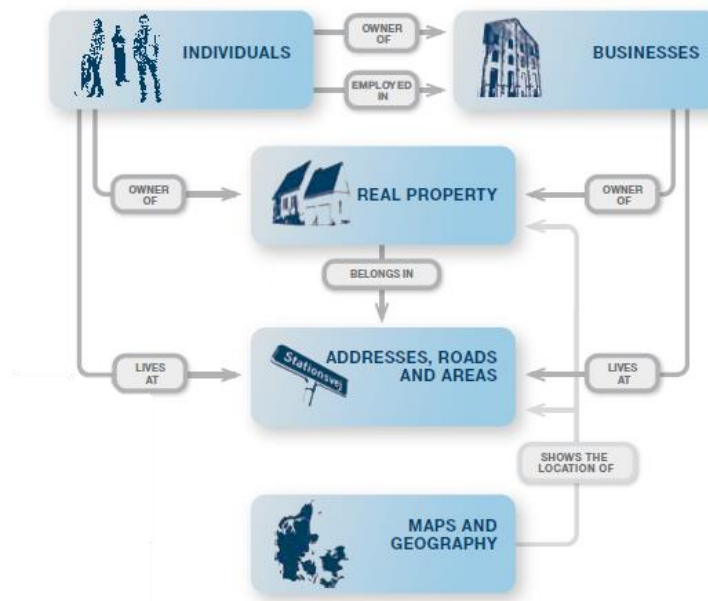


Figure 24: Basic Data (Agency for Digital Government, 2012)

The aim of the Basic Data Programme is to enable full display of combined basic data, incentivizing, data sharing, open data flow and data re-use across the whole public and private sector. This was achieved by creating cohesion across the widely used basic data registries, so that all basic data is structured in accordance with one joint data model, and by creating a common data distribution solution. This allows the users of public sector data to retrieve better and more cohesive basic data about properties, persons, businesses, addresses and geography from a single Data Distributor.

In order to enable a smooth exchange and re-use of data, thus interoperability of basic data, two main interventions were needed: creating a common format for basic data and creating a common infrastructure for their distribution.

*"[...] we have common specifications for basic data, we have a common infrastructure with data distribution solution for basic data which covers all kind of basic data in one distribution node called Data Distributor"*

*(Chief Consultant and Chief Architect for Federal Digital Architecture - FDA,  
Agency for Digital Government)*

The common specification and technical format for basic data were created in order to harmonize them and making possible to combine data in different registers. Moreover, a Common Public-Sector Data Distributor was used to accommodate the need to retrieve data rapidly, easily and reliably, and as cheaply as possible.



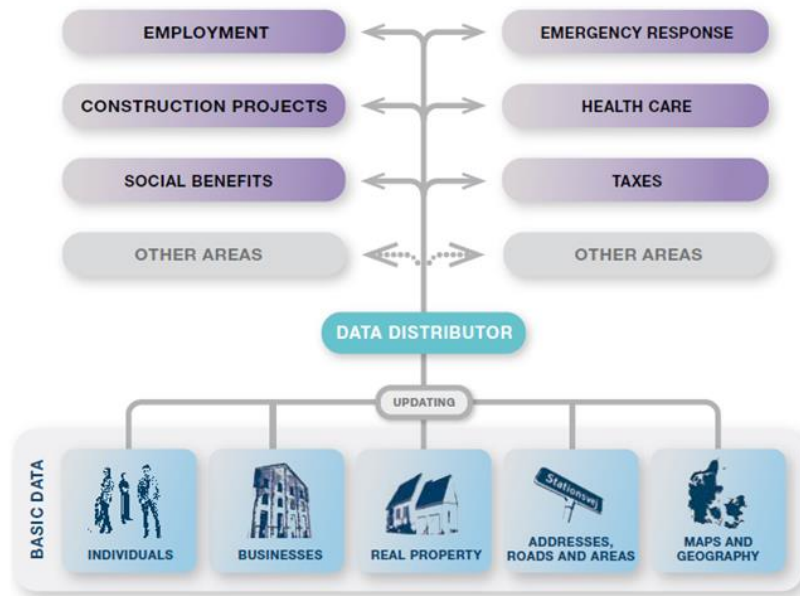


Figure 25: Basic data infrastructure (Agency for Digital Government, 2012)

In this way, by distributing data via a single common channel rather than via several different channels, the authorities responsible for the registers will save resources, as they will no longer have to modernize a host of different distribution solutions individually. Over the years more and more registries were included on the Data Distributor such as the Central Business Register, the Business Register, the Danish Cadastral Register, the Civil Registration System, the Denmark’s Address Register, the Danish Building and Dwelling Register, the Place Name and Information Register and the Danish Administrative Units register (DAGI) among others.

There is a strong connection between basic data about, for instance, an individual and the presence of a good and cross-sectoral digital identification, since it is necessary to link personal information to the right and single citizen. For this reason, a consistent personal identification tool has been considered as a key enabler and prerequisite of the basic data initiative:

*“It is important to understand that for many basic data a personal identificatory is a key thing. We have good basic data in Denmark and one of the key enablers is that we have the personal identification number and it is used across all the public sector”*

*(Chief Consultant and Chief Architect for Federal Digital Architecture (FDA),  
Agency for Digital Government)*

The Basic Data Programme is supporting the foundation of a cohesive public sector by providing access to reliable and up-to-date basic data. The benefits of open and improved basic data are several. Since this information is shared and re-used

throughout the public sector, citizens and businesses no longer have to submit the same information to the public sector several times over, in compliance with the once only principle discussed before. Additionally, this eases the compilation of online forms for citizens, since they are filled automatically with the relevant and fully updated basic data. Furthermore, basic data and its re-usage enable the public authorities to carry out their tasks properly and efficiently across units, administrations, and sectors. Indeed, public authorities use basic data for many different tasks: collecting land tax, paying social benefits, planning climate change adaptation, for emergency services, etc. When data that has already been recorded is shared across institutions and is included directly in case processing, as for the Basic Data case, the result is that citizens and businesses are provided a better and more efficient public service.

#### 4.2.3.4 Borger.dk - National Citizen Portal

*“In Denmark we have also a website called citizen.dk (borger.dk) where you can access all the different services you want, you have only one point of entry. If you have to move or sign up your kids to school or a relative died or anything, you have this one-stop shop where you go in there, click and it redirects you to the municipality or the government agency.”*

*(Team Lead Division for Analysis and Policies, Agency for Digital Government)*

Borger.dk is the Danish public sector’s common portal, launched in 2007 as a single point of access to information about public authorities and their online services. The purpose of the portal is to allow people to find information about the public sector online and digital services easily, having usability as key aspect in developing and operating borger.dk.

The pages on borger.dk are organized for categories, for instance work, unemployment benefits and holidays, schools and education, finances, tax and student grants. The portal contains and provides information for residents about the public sector, administrative procedures, as well as rights and responsibilities and each public authority has the responsibility to ensure that all information on borger.dk, within their area of responsibility, is relevant, correct, and updated.

In addition to the information pages, the National Citizen Portal also includes about 2,000 online services across the public sector, regardless of whether the service is offered by a national agency or by the local municipality. Using borger.dk, citizens can enroll their children for daycare, report a change of address, apply for child benefits, change general practitioner, complete their tax return, and much more.

The borger.dk portal comprehends lifeindenmark.dk, which contains information in English for people who are about to move to Denmark or who have recently moved.

It is part of Your Europe, an EU portal designed exactly to help European citizens do things (e.g., moving, living, studying, working, or simply travelling within the Union) in other European countries and avoid unnecessary inconveniences and red tape. In particular, Your Europe provides information on citizens' basic rights under EU law and access to information on how EU rules apply in each EU country for cross-border users (in compliance with the Single Digital Gateway Regulation).

In 2018, the borger.dk portal was expanded with the first version of My Overview.

*“One of the projects we have been working with is “My Overview” which is the citizens overview [within the] national citizen portal. [Citizens] can go into My Overview and then they can see their personal data, not all, but a lot. [...] a citizens can go and see status information related to their cases on that portal across all public sector and municipalities. In this overview we are including more information also about for instance payments and debts and sort of basic data for the citizens.”*

*(Chief Consultant and Chief Architect for Federal Digital Architecture (FDA),  
Agency for Digital Government)*

Basically, the purpose of My Overview is to provide each resident with a personal page on the National Citizen Portal, borger.dk, to access some of the information public authorities hold on them in one place. Currently, the overview provides information on tax, pensions, outstanding debt to public authorities, student grants, and housing, as well as status on benefits and ongoing cases with public authorities, upcoming agreements, and deadlines.

The development of My Overview is part of a joint-public political vision for creating transparency for residents, and better and more coherent provision of digital services across the public sector. The implementation of the platform requires a very complex digital infrastructure and, the collaboration between the 98 municipalities, the five regions and the 20 ministries, is necessary to provide the overview. The development and implementation of My Overview started in 2019 and will continue in stages till 2026 adding every stage more information that the platform can retrieve from the different authorities.

My Overview is an example where standards are necessary since data needs to have the same formats in order to submit them in a structured way to the citizens. The architecture for the platform is made up of 4 layers:

- Data sources layer: where data are collected with their own structure which can vary.
- Integration layer: the data is transformed, and it is ready to be submitted for the presentation.

- Orchestration layer: this is the component that actually takes the data, transforms, orchestrates and puts them together for the presentation to the citizen.
- Presentation layer: it is the presentation of structured data to the citizens.

Thanks to this architecture, when a citizen goes to My Overview, the portal can ask for the orchestration component developed for data from different sources which are then put up, transformed and orchestrated for the presentation to the citizens. It is clear that a strong enabler was the collaboration between the government levels, who have to make available the data they hold about the citizens.

*“This was possible because we asked everybody to give the data they have and then transformed them according to a common specification.”*

*(Chief Consultant and Chief Architect for Federal Digital Architecture - FDA,  
Agency for Digital Government)*

## 4.3. Estonia

Estonia is the world's most advanced digital society.

*"After 50 years of foreign domination, Estonia returns to the map of Europe with limited legacy technology systems and virtually no resources of which to speak. Yet policy makers discover that starting from scratch presents a rare opportunity."*

*(e-Estonia website)*

As stated in the e-Estonia website and by all the interviewees Estonia started the digitalization of the public sector in 1991 after gaining independence. In 30 years, Estonia managed to build the most advanced digital society starting in the 90s to work on interoperability and managing in the last years to provide proactive public services to citizens.

### 4.3.1. The Estonian public sector

*"There was the recognition also from the very beginning that the government can't do everything alone."*

*(Digital transformation advisor, e-Estonia)*

When Estonia started to build its e-government infrastructure, realized that a government cannot employ all the skill, technological skills in this case, necessary. For this reason, since the very beginning there was a strict collaboration between the public and private sector and Estonia managed to build an open, transparent, and anti-corruption public procurement process.

There are some big IT companies that have built, throughout the years, different technological solutions, however also a lot of smaller companies participated to the development of the Estonian e-government infrastructure. Private companies are also the users of public services; hence they can look at the service they are developing with a user perspective and build the best high quality functioning solutions.

One key element to keep in mind about the Estonian public sector is that the majority of the public services are provided by the federal government. Therefore, it has been fairly easy for Estonia to convince the major public institutions to adhere to the common infrastructure, called X-Road, increase interoperability between different information system and, as a result, provide high quality public services to the Estonian population.

### 4.3.2. Estonia's Digital Journey

In the 90s, when the public sector digitalization process started, Estonia was in an economic complicated situation and did not have enough money to construct the entire public governance. For this reason, they had to find a smart option and decided to share the different systems that they had. Thanks to this choice the Estonian government managed to set up a consolidated system.

*"The change in our PA happened because new people brought new skills, they were familiar with IT and PCs, this pushed to move forwards very quickly."*

*(Senior expert on electronic democracy, e-Governance Academy)*

Additionally, Estonia realized that technology was not enough and that there was the necessity to have regulation to ensure interoperability: in the early 2000 the government passed the e-ID Act and the Public Information Act. The latter serves as legal basis for secondary legislation and contains the principles upon which the Estonia e-government is based on. For instance, the act prohibits to duplicate datasets of already existing data, meaning that it is not allowed to extract some data and save it in the local servers, there is the original point of collection which is a key registry that contains a particular typology of data. This norm is beneficial mainly for two reasons: firstly, it reduces the possibility to have an indefinite number of copies of a specific data and consequently the possibility to have a leak; secondly, it eases the data update since it has to be changed only in one place.

*"You created the tech interoperability possibility but now you also need quality data, cleaned data that could be well exchanged between different registries that you could actually make this process usable."*

*(Digital transformation advisor, e-Estonia)*

Estonia worked a lot on the communication between different systems in order to allow the exchange of information but in parallel put a lot of effort also in the data itself, in order to increase their quality and incentive the different public entities to reuse it.

In 2001 X-Road, a distributed data exchange layer for registers and information systems, was introduced in the Estonian public sector. The purpose of X-Road was, and still is, to bring together the different spheres of government, and for this reason it was made mandatory for all the public organizations to be compatible with it. The mandatory request, to all public agencies, to join X-Road came after the issuing of a law that stated that the ownership of the data lies with the citizens and not with the holder of the information. This regulation gave legitimacy to the request, made to all

public agencies, of adhering to X-Road and, as a consequence, to share all the information they hold about citizens.

In Estonia the digitalization of the public sector, and, in parallel, the increase of interoperability between different public agencies, have been step by step processes.

*“You always have to keep in mind, in constructing the digital services, not only what the government wants to digitalize, but also how it would be beneficial for the user and what is simpler to start using. And then, moving to more complex services that require more interoperability. This is growing with the society in general. You can’t introduce all the digital services from day one, it is not how it goes.”*

*(Digital transformation advisor, e-Estonia)*

Estonia started its digitalization process with banks and telcos in 1996, since they wanted to digitalize their services. The desire of digitalization both from the businesses, that wanted to reach also clients from rural areas, and the citizens, who were able to access banking services easily from their home, resulted in the creation of high-quality e-banking services and with the increase of people using online services, embracing e-government and helping in the rise in the use of e-ID in 2002.

In the year 2000 m-parking was introduced. This service enables citizens to pay for city parking via their mobile phone. The choice fell on the mobile payment service due to their everyday usage by the citizens. Additionally, in the same year the digital tax declaration service was launched.

*“The tax declaration was a very smart move to start the digitalizing from because citizens could still do the service in the office but if they declare the taxes digitally then it is simple, it takes only 3 min to do it and you can do it from your sofa. They get the money, excess tax, in 5 to 10 days, doing it on paper they would have to wait from 3 to 6 months.”*

*(Digital transformation advisor, e-Estonia)*

The service gave a lot of benefits to the citizens, and for this reason it has been a great success: nowadays 98% of the Estonian population declares their income electronically.

In 2003 Estonia introduced Eesti.ee which is the national one-stop shop that allows the citizens to stay in contact with the government and benefit from all the e-services available without having to waste time in searching them.

In 2005 i-Voting was developed with the goal of maximizing accessibility to local and general elections. The Estonian government allows the citizens to vote wherever they

are and during the last elections around one third of the votes were casted online. In 2008 the e-Health system was created thanks to a nationwide system that integrates data from Estonian's healthcare providers. The introduction of electronic health records for each patient, drove Estonia towards the reduction of bureaucracy and of time wasted in the searching of patients' information.

The Estonian digital journey has continued and in the last years the government has been able to provide proactive services to the citizens reacting to their life events and reducing even more the efforts that every citizen has to put in place in order to obtain a public service.

In the following paragraphs, some examples of the main digital services, developed by the Estonian PA to simplify their fruition from the citizens, are provided.

#### 4.2.3.1 e-Banking

The e-Banking system was developed in 1996 due to a collaboration between the government and the banking sector. Banks welcomed the e-ID system contributing to its spreading and usage by almost every Estonian citizen. Additionally, they helped the population to move online thanks to the high-quality internet banking services, facilitating the development of digital services in different fields. As of today, 99% of the banking transactions happen online, due to the friendly user interfaces and the 24/7 service availability.

*"Estonia's e-banking system is simple, secure, and practically instantaneous."*

*(e-Estonia website)*

Since 2017 it is also possible to open a bank account through e-ID, accompanied by a video interview and facial recognition technology, and banks are working hard to develop technical solutions that will allow them to welcome clients from anywhere without a face-to-face meeting by enhancing the security of customer identification.

#### 4.2.3.2 e-Tax

The Estonian electronic file system, e-Tax, simplified the citizen's life allowing them to perform in few minutes an action that otherwise would have required them different ours of their time. Around 98% of the tax declarations in Estonia are filed electronically. The system allows the citizens to: file an enterprise's declarations for income tax, social tax, unemployment insurance, and contributions to the mandatory pension fund; request value-added tax returns; request alcohol excise, tobacco excise, fuel excise, and packaging excise duty returns; file customs declarations; file personal income tax declarations.



#### 4.2.3.3 e-ID

*“All Estonians, no matter where they happen to live, have a state-issued digital identity.”*

*(e-Estonia website)*

In Estonia the electronic identity system exists since 2002 for Estonia citizens and from 2014 also for residents. The e-ID is part of any citizen's daily transaction, both in the public and the private sectors. For this reason, the ID card is used in Estonia for multiple purposes: as a legal travel ID for Estonian citizens travelling within the EU; as a national health insurance card; as proof of identification when logging into bank accounts, for digital signatures, for i-Voting, to check medical records, submit tax claims; to use the e-Prescription service.

#### 4.2.3.4 i-Voting

Estonia is the only country in the world that allows its citizens to vote at the elections on the internet. The i-Voting system has been achieved thanks to the fact that the vast majority of the Estonian population has access to a secure digital authentication and signature. The system was introduced in 2005 and in 2019 over the 40% of the population has favored the i-Voting system method in comparison to the in person one.

#### 4.2.3.5 e-Health Record and e-Prescription

Estonia has implemented innovative e-solutions in the healthcare field. Particularly, the Electronic Health Record is a system that integrates the data from the different providers in the Estonian health sector. Every patient can access his own e-Health Record online. The e-Health Records function similarly to a national database but it fetches data when needed from different providers. This system simplifies the doctor's work allowing them to find all the patient's information in a single digital place. The totality of patients has a digital record. Furthermore, e-Prescription, a centralized paperless system issuing and managing medical prescriptions, has been developed. The system functions through the ID-card system, practically when citizens go to the pharmacy, they have to show their ID-card to the pharmacist and the latter will be able to see the patients' prescriptions and provide them the right medicines. Since data are retrieved from the national health insurance fund the pharmacist will also know if the patient is entitled to a discount and will automatically apply it. Today, 99% of all prescriptions in the country are issued electronically.

### 4.3.3. X-Road

*“X-Road is this intermediate level that brings together all the government entities.”*

*(Digital transformation advisor, e-Estonia)*

As anticipated before X-Road is a centrally managed distributed data exchange layer between information systems that provides a standardized and secure way to produce and consume services. The system implements a set of standard features to support data exchange and ensure interoperability between different information systems.

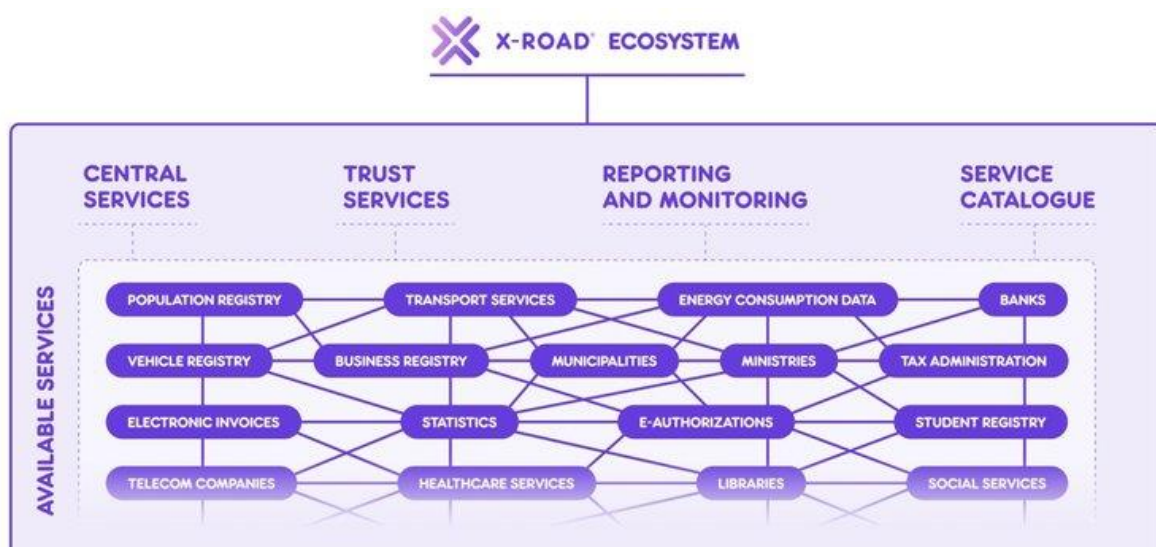


Figure 26: X-Road ecosystem (X-Road, 2022)

The X-Road ecosystem is composed of the different organizations that joined the platform. The ecosystem is managed and run by The Nordic Institute for Interoperability Solutions (NIIS), a non-profit association who is responsible for security matters, for the ecosystem functioning and for ensuring a smooth communication between different agencies. As we already mentioned, every Estonian public agency must adhere to the X-Road ecosystem, but no strict guidelines regarding specific technologies exists, in fact every public agency can construct freely its technological capabilities in the form of APIs, with the only constraint to be compatible with the network. The just explained concept is the technological neutrality principle that together with the once only one is at the base of the X-Road ecosystem.

*“Invisible yet crucial, it allows the nation’s various public and private sector e-service information systems to link up and function in harmony.”*

*(e-Estonia website)*

The X-Road software is open-source meaning that can be freely accessed by any country or organization that wants to use it, but at the same time in order to join the ecosystem an onboarding process is scheduled.

X-Road supplies monitoring services that can be used to track information from the ecosystem and use it to improve the service provided to the citizens. Usage of individual services, understanding dependencies and relationships between different information systems and services can be monitored.

#### X-ROAD ECOSYSTEM

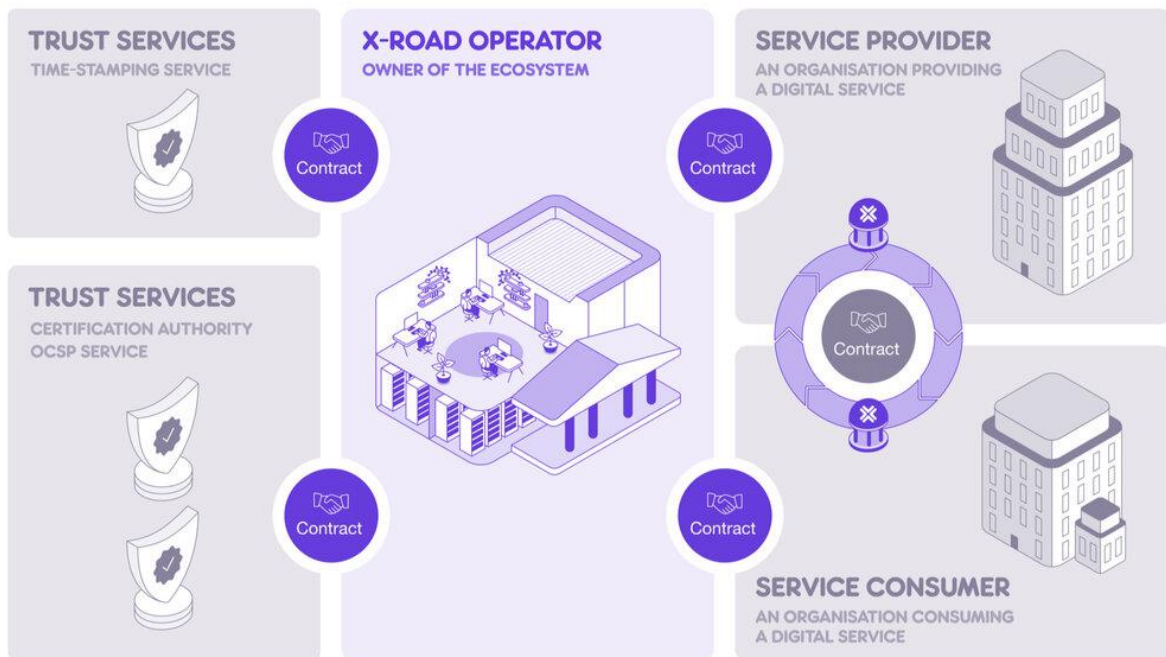


Figure 27: X-Road ecosystem organizational model (X-Road, 2022)

The X-Road ecosystem, as visually described in Figure 27, allows the service consumer to be in touch with the service provider. In addition, there are other three ecosystem blocks: the X-Road operator that has to define regulations and practices, accept new members, provide support for Members, and operate the central components of the X-Road software; the time stamping authority and the certification authority which have the role to provide trust services.

Nowadays in Estonia, thanks to X-Road, most of the databases and systems are interconnected and, as a consequence, a very high level of interoperability is in place.

*"It was a long process in Estonia, we did not use a big single database, but we were able to let different databases to talk to each other and work together."*

*(Senior expert on electronic democracy, e-Governance Academy)*

Concluding, every public service provider in Estonia relies on X-Road to transmit large data sets and perform searches across several information systems simultaneously. X-Road was designed with growth in mind, so it can be scaled up as new e-services and new platforms come online. Furthermore X-Road ecosystems can be also joined together or federated, and in 2018 the Estonian and Finnish X-Road ecosystems were federated, implementing the aspired cross boarder interoperability.

#### 4.3.4. RIHA

Estonia worked also on the semantic interoperability with RIHA, which is the central state information system and a technology platform where every agency can register its system description.

RIHA is a repository of the different state information systems and data, it contains also sharing standards, for different typologies of platforms, that describe interface formats: the public agencies can take these standard building blocks and integrate them into their system. The different public agencies, in order to integrate, do not have to change anything in their back end, they just need to be compatible and, through APIs, connect to the national platform. It is worth noticing that RIHA coordinators check the conformity of every new database and/or IT system evaluating whether the requirements are respected.

The role of RIHA is to maintain the state information system registries, allow the evaluation of the different information systems, publish and update the actual information system state and ensure a smooth communication between information system owners and evaluators.

Additionally, the central state information system trains administrators of ministries, institutions, and municipalities. To give supplementary help to municipalities, that are generally smaller than federal agencies, specialized portals where support in the development of the technology is offered were created.

#### 4.3.5. The regulatory process

Since the very beginning of the digitalization process, Estonia realized that, even though the technology is fundamental to improve interoperability, regulation has to go apace with the technological development. In 2001 was enacted the “Public Information Act” that stated the legal bases of the Estonian e-government.

*“The purpose of this Act is to ensure that the public and every person has the opportunity to access information intended for public use, based on the principles of a democratic and social rule of law and an open society, and to create opportunities for the public to monitor the performance of public duties.”*

*(Public Information Act)*

The act focuses on the reuse of public information stating the principles at the core of the grant of access to the public information. It highlights and describes the different actors that can hold information: the state, local government agencies and citizens; and the way in which data ownerships is managed. Indications about how to register databases are specified, rules regarding which typologies of information are subject to disclosure and the way in which information has to be disclosed are listed.

The Public Information Act has been updated regularly throughout the years through legal acts and the latest update dates back to March 2022.

Estonia continued to complement the technological developments with legal acts. In 1999 the “Identity Documents Act” was enacted in order to provide legal requirements for the e-ID. In 2017 the “Procurement Act” was passed to regulate the public procurement, setting rights and obligations for the people involved. In 2018 the “Personal Data Protection Act” was issued to let the Estonia e-Government comply with the GDPR.

#### 4.3.6. Estonia’s Digital Agenda 2030

In 2021 the Estonian Ministry for Economic Affairs and Communications published the Estonia’s Digital Agenda 2030 which includes a program regarding the digital development of the Estonian society. The vision is “Estonia, empowered by digitalization” and it is based on seven principles:

1. We protect and promote the fundamental rights of people.
2. We preserve the Estonian language and culture.
3. We maintain our reliability.
4. We are technology-neutral.
5. We build our digital society together.
6. We are innovative.
7. We are climate and environmentally friendly.

Estonia, keeping in mind the vision and the just stated principles, has the goal to have a digital government that ensures the best experience possible to the user (citizens and businesses), the availability a high-speed internet connection and the safety and reliability of its cyberspace. To achieve these goals three sub-objectives are specified:

##### *Digital government*

Estonia wants to provide the best digital government experience by 2030 to its citizens. To achieve this objective the Estonian government has to act in two different directions: on the one hand has to take the digital government to the next level, by developing new solutions; on the other hand, has to maintain the already existing solutions up to date and sustainable. The next steps highlighted are:

- Switch to life and business event based and proactive services
- AI-powered government
- Human-centric digital government
- Green digital government

#### *Connectivity*

Estonia wants to reach ultrafast, reliable and affordable telecommunications connections by 2030, allowing every citizen to access and use innovative services regardless of their location. The set activities are to: promote investments in the development of communication infrastructure and supervise the market itself; improve the development of very high-capacity access network for rural area in order to provide connectivity also in areas where telecommunication companies are not incentivized to invest; sustain the development of 5G in specific residential and business areas and prepare the context for the future adoption of 6G; sustain the development of innovative services, in particular the ones that arouse citizens' interest.

#### *Cyber security*

The Estonian purpose is to make its cyberspace safe and reliable. Service providers have to achieve the cybersecurity requisite, in compliance with the Estonian Cybersecurity Act. Moreover, in the 2030 desirable situation no service has ever not been used due to the existence of a security risk. Estonia has set the relevant activities to perform:

- Set-up a relevant national cyber security
- Develop an analysis capacity for trends, risks and impacts
- Increase the capacity for maintaining cyber security

## 4.4. Netherlands

The Netherlands is one of the leading countries concerning eGovernment, and they are far ahead in the digitalization process. Digitalization is considered both a force for fundamental change in our society and an essential factor in keeping that same society up and running. The digitalization process that the Netherlands has undertaken is seen as a huge opportunity to make the governmental digital service smarter, more accessible, and more personal.

*“The world is changing at a fast pace. The Netherlands is going digital and that offers huge opportunities to do things in a smarter way. We as the national and decentral government, wish to grasp those opportunities. At the same time, it is vitally important that we respect the autonomy of the individual citizen.”*

*(NL DIGIbeter Digital Government Agenda, NL Digital Government)*

At the same time, from a social perspective, the point of view of individual citizens and entrepreneurs still needs to be taken great care of. The digitalization process has to be directed in such a way that is inclusive, understandable and intended for everyone, continuing to ensure the protection of fundamental rights and public values.

*“Through innovation, the Dutch government wishes to take the lead in the use of new digital technology. At the same time, we in government want to protect all citizens and entrepreneurs and their rights if they are threatened by new developments.”*

*(NL DIGIbeter Digital Government Agenda, NL Digital Government)*

### 4.4.1. The Dutch public sector

The Dutch public sector revolves around the so-called domains. They are areas of the public sector responsible for matters and public services strictly belonging to their area of competence. Basically, the domains are sectors where the government provides services to citizens and businesses, emerged organically in recent decades due to the evolving needs from society. The domains are several in the Dutch public sector and cover many topics such as finance, healthcare, education, benefits and allowances, economy justice, work and career, water, agriculture, immigration, transports and many more.

The public services provided in each domain are generally anchored in laws and regulations specific of each domain. Indeed, the domain approach in the public sector in the Netherlands is pushed by the complexity to oversee a huge number of laws and regulations and the impossibility to introduce legislation with a general “top down”

impact. In this context, therefore, the domains are quite independent in re-arranging their regulation and using building blocks and standards.

Another important component, which is the clear expression of interoperability between services in the Dutch public sector, are the so-called chains or architectural chains, for example taxation chain or social security chain. These are a set of organizations that together collaborate to deliver a certain service.

*“There are a number of organizational units, tax, social security services, employment services, they form a kind of chain where they need to work together.”*

*(Senior Advisor for Digital Services & Transformation, ICTU)*

The starting point of the service delivery and digital interventions are the single domains. The process is triggered by specific societal issues, or some needs of the citizens within a particular domain. The ministries of each domain are charged each Cabinet term, by the Parliament, with a set of tasks and goals based on the needs and issues of citizens and business.

*“The political decision making starts for example in healthcare or in social security, they start to ask how can they help people. So, our Parliament says we need to help the people that, for example, are getting older, they need money, and they need better healthcare. These policies are translated in legislation and there starts the service delivery.”*

*(Program Manager of NORA and Strategic Advisor at ICTU)*

Therefore, it is the Parliament that gives the direction in terms of policies and legislation. Based on this, each domain undertakes the digital interventions, starts the service delivery, or designs new services.

*“This is the legal part, the parliament starts with the direction [with policies and legislation] then civil servants and architects of each domain translate it into services and then we help them to design the services.”*

*(Program Manager of NORA and ICTU Strategic Advisor)*

Over the years, many architectures have emerged to design and improve services in those domains and with it, just as many expert groups and communities to share their knowledge about it.

In this context, the Netherlands developed a Governmental Reference Architecture, the Nederlandse Overheid Referentie Architectuur (NORA), which is the high-level reference architecture where all the national matters concerning interoperability,



service delivery, architecture and agreements are described. The NORA, by gathering knowledge from several experts in the design of digital services, supports the service delivery and the creation of domain-specific architectures with information such as architecture principles, themes for new developments, standards, specifications and useful building blocks. The principles, agreements and specifications of the NORA are the base and the conditions that the domains' architecture and the architectural chains have to be compliant with. So, once the Parliament gives the direction for each domain, the work in terms of service delivery, development of the domains' architecture and of the chains, needs to be compliant with the NORA.

*"It starts at some organizational units, they cooperate and at a certain moment in time they have to check whether the architecture is compliant with the NORA. Later, it can also happen that they come to us and ask if the chain meets the reference architecture of NORA. This is the way how we make sure that such chain is built according to NORA. [...] In the end there is a sort of closed loop and in the end NORA will be in the picture when the chains are created."*

*(Senior Advisor for Digital Services & Transformation, ICTU)*

The service delivery, the domains architecture development and the creation of the chains starts from the domains, they are not done from the NORA. NORA has a support role by providing guidance and a reference framework as a base, upon which architects of each domain can develop the services, architectures and chains.

*"Everything starts with the domains [...]. Service delivery is taking place in the domain, not in the NORA because it is theoretical [...]. We start thinking about service delivery in the domains, they have their own architectural print and they are based on the national agreement present in the NORA. So, if there are international agreements we put them in the Nora, and they can develop from that point, in the specific domains, how to make the service delivery more specific for that domain. [...] We are not doing it from the NORA but it is done from the architects in the different domains, they are making the services for healthcare, for education..."*

*(Program Manager of NORA and ICTU Strategic Advisor)*

In this ecosystem composed by domains, chains and Reference Architecture (NORA) upon which the first two needs to be based, collaboration and community are crucial for the success. About 5 times a year the domains come together, and the people of these community collaborate, exchanging experience, discussing some common problems they have in the different domains, talking about specific projects and

thinking which could be the next step to take to improve the NORA, interoperability and service delivery.

*“We have a large community of people from those domains, they get together in quarterly meetings where people share knowledge and country specific issues are being discussed and they talk about progress of projects. The community is a fundamental element in the NORA success.”*

*(Senior Advisor for Digital Services & Transformation, ICTU)*

Additionally in these meetings, the domains discuss about some common problems concerning some “themes” (for example APIs, security or privacy) and try to find solutions, which are then included in the NORA. This is how the NORA Reference Architecture is improved.

*“All these domains come together and [...] discuss about common problems and specific themes [...] We put these themes in the NORA, with also the solution for some problems. [...] This is what is done in the national interoperability framework. [...] All the national things are written in NORA and all the specific domain things are written down in the domain areas.”*

*(Program Manager of NORA and ICTU Strategic Advisor)*

Another important building block of the Dutch public sector is represented by interface and the relationship with the citizens. Concerning this, the Netherlands is aligned with many other European public sectors having developed a digital identification system, the DigID, through which individuals are able to identify themselves and arrange their affairs digitally with the government. Additionally, in order to support citizens in requesting digital services and to provide a complete view of all the information held by the government authorities, MijnOverheid is used. It represents a one-stop shop for the citizen to keep an eye on all pending matters with the government and it is a single point of contact for receiving messages from Dutch authorities.

#### 4.4.2. NORA: the Dutch Government Reference Architecture

As already anticipated, the Nederlandse Overheid Referentie Architectuur or NORA is the National Governmental Reference Architecture for the Netherlands. It is an inter-administrative system of agreements, mandated by the Digital Society directorate of the Ministry of the Interior and Kingdom Relations, while management and further development have been entrusted to ICTU since 2011.

NORA has the form of an online platform which gathers knowledge from several experts in the digital services design to support the digital work in the domains and in

the whole Dutch public sector, through information and descriptions of architecture principles, national agreements, framework, themes for new developments, standards, specifications and useful building blocks. In 2008, the usage of NORA became mandatory for all governmental organizations which, from that moment on, had to comply to the binding principles and agreements of the Reference Architecture, while the other parts of NORA, such as the list of Standards and the substantive themes, are for information and inspiration.

NORA started as a set of agreements to enable and improve digital services in the public sector. The binding agreements on interoperability and quality of service are still the core of NORA and they are expressed in 10 Basic Principles and 38 Derivative Principles. Over the years, a community grew around this core in which the knowledge and experience of architects, project leaders, policy advisors and specialists come together. These groups of people are related to the various public sector's domains such as education, healthcare and social security.

Therefore, the NORA was built and is improved, through collaboration and meetings between the several actors involved. The representatives of the domain-specific architectures, the domains architects and the different communities, meet every few months as part of an architecture council. The main objective of the meetings is to agree on what should be shared on the platform to foster better service design and interoperability within the public sector. In addition, at these meetings, the representatives of NORA make proposals for future developments.

NORA assumes a national perspective focusing on the Dutch public sector as a whole and, therefore, it applies to all the government domains which, at the same time, still have their own reference architecture. Agreements in NORA make collaboration and information exchange possible across administrative layers, chains and domains. But at the same time, in the Netherlands it is also perceived as useful to make agreements about cooperation and information exchange within a chain, a domain, a level of government or an organization. In this context, the so-called NORA Family, in which all agreements systems can participate, is crucial since it prevents agreements in one chain from making exchange with another chain more difficult.

#### 4.4.2.1. NORA's binding agreements

The NORA's core is a set of government-wide agreements or principles aimed at enabling and improving digital services and guiding government organizations in implementing changes and executing projects. The agreements are binding on all government organizations under the Apply or Explain regime, which means that deviations are allowed if they are substantiated with good arguments or reasons, and recorded, so that they can be returned to at a later time.

There are two types of binding agreements or principles:

- **Basic Principles:** NORA's 10 Basic Principles are statements that describe the quality of government services from the perspective of the wishes of society, citizens and companies (the what). These are ten values that have to be taken into account in every new service and in every further development in order to be able to provide a good service. In practice, it will be difficult for a government organization to fully comply with all the Basic Principles because these are wishes and goals that change over time. As explained in the NORA, what matters is that a government organization that subscribes to these goals, cooperates with other organizations to that end, commits itself to the Basic Principles and actively aims to comply with the principles wherever possible. The Basic Principles are therefore primarily a guideline and offer room for interpretation. As such, they are usually not verifiable in an absolute sense.
- **Derivative Principles:** NORA's 36 Derivative Principles give more concrete substance to the basic principles. If the Basic Principles described "the what", the Derivative Principles describe "the how". Therefore, they can be regarded as a checklist of quality characteristics of government services and provide guidelines for the operational level through their elaboration into concrete implications.

The Basic Principles are:

1. **Proactive (Customers get the service they need):** Governments are expected to be proactive when it comes to providing services to citizens, businesses, and local authorities, meaning that the right services, including information or data, are delivered to the right party at the right time.
2. **Findable (Customers can easily find the service):** citizens and companies can easily and independently find the services and information that are important to them in a single place (e.g., one portal) so that everyone can find as much as possible in one place and arrange what is needed.
3. **Accessible (Customers have easy access to the service):** the government with this principle has agreed to offer services easily accessible to everyone, meaning that no one should be left out, including who is not digitally skilled or who wants to avoid digital channels for other reasons. For these reasons, services are user-friendly, via multiple channels and at all desired times.
4. **Uniform (Customers experience uniformity in service through the use of standard solutions):** the government should ensure uniformity in the services, regardless of who provides and receives the service itself. In order to achieve this uniformity, agreements have been made about collaboration and the use of standards in organizations, processes, and systems.

5. Bundled (Customers are offered related services bundled): services should be provided as bundled as possible by the government, appropriate to the situation of the requester, because this makes the service more accessible and clearer for citizens and businesses. This saves time and makes it possible to offer all relevant information as a whole, even if it comes from different government sources.
6. Transparent (Customers have access to information relevant to them): the government should be as transparent as possible. Being transparent means that it is clear what services are involved, under what conditions and in what form they are provided. This enhances the equality of the service experienced by citizens and businesses because it increases their trust in the government itself.
7. Necessary (Customers are not confronted with unnecessary questions): the government should be able to use as much as possible what is already known and therefore to ask only for the information that is strictly necessary for the service provision. In this way, the perception of good service increases and the chance of errors also decreases.
8. Confidential (Customers can rest assured that information will not be misused): the government that receives, uses and stores information, from citizens and business, has the obligation to take the necessary measures to guarantee confidentiality. In this way, citizens and companies are able to rely on the fact that their information is handled with care.
9. Reliable (Customers can rely on the service provider to keep to agreements): this principle is one of the most important. Basically, it states that the government will always adhere to all the other agreements or principles and the citizen or company can rely on this.
10. Feedback (Customers can provide input about the service): better service is achieved when the provider or the government is receptive to possible feedbacks. This implies that, as part of the service provision, the government will offer opportunities to citizens or companies to give feedbacks which are then used to improve the service provision.

In the table below all the Derivative Principles are reported.

1 - Services are reusable	10 - One-time inquiry	19 - No wrong door	28 - PDCA cycle in control quality
2 - Disconnect with services	11 - Source registrations are leading	20 - Automatic service	29 - Control quality at the highest level
3 - Position the service	12 - Report back to source holder	21 - Proactive offer	30 - Baseline quality services
4 - Accurate service description	13 - Target binding	22 - Transparent service	31 - Accountability for quality control
5 - Use the rural building blocks	14 - Information objects systematically described	23 - Customer has access	32 - Indisputability
6 - Use open standards	15 - Spatial information via location	24 - A responsible organization	33 - Availability
7 - Internet Preferred Channel	16 - User Perspective	25 - Appointments recorded	34 - Integrity
8 - Additional Channel	17 - Personal approach	26 - The service provider complies with the standard	35 - Confidentiality
9 - Equivalent result regardless of channel	18 - Bundling of services	27 - Accountability for service delivery possible	36 - Verifiability

Table 3: Derivative Principles (NORA, 2022)

#### 4.4.2.2. NORA Family

The NORA Family is the place where the national agreements meet the agreements in the domains and chains. The NORA itself represents a framework or standards for the government as a whole, therefore, its principles, especially the Basic Principles, are formulated in a fairly general way. For this reason, in practice, there is still the need in the specific domains, chains and organizations for an extra framework or reference architecture with its own set of agreements. These reference architectures are coordinated independently within each working area, but at the same time they follow the general NORA guidelines and are merged in the so-called NORA Family.

The NORA Family, therefore, is the set of all the architectures, which are in line with the NORA, created by the government for the Dutch Public sector services. Inside the

group, NORA is the most abstract, general reference architecture, which the other family members (i.e., the other reference architectures) re-use and give a more specific interpretation for a certain context (e.g., domain, chain, or sector). Therefore, each member has its own autonomy but, at the same time shares the same core values and DNA (i.e., policy, service quality goal, general features, architecture principles, standards, building blocks, themes and conceptual framework) and creates many relationships with the other members, since every service can transcend the boundaries of the organization. For example, the Personal Budget affects both the Healthcare domain and the Social domain, or the Wage Declaration Chain affects the Social domain and the Financial domain.

Following the community approach through which the NORA is updated and improved, the NORA Family, as well, represents a place where every member architecture can meet, exchange knowledge and share resources. This cooperation and collaboration between members of the NORA Family has several goals:

- Not having to reinvent everything from scratch in every domain or organization.
- Prevent agreements in one chain from contradicting those in the other chain.
- Using the knowledge from practice to improve the NORA agreements.
- Balancing the need for autonomy with the importance of cooperation.

#### 4.4.2.3. NORA Themes

As already anticipated, additionally to the principles and agreements, NORA offers a series of “Themes”. The themes (Table 4) are subjects that are related to the architecture and to things that are happening or should be done in the NORA community. Indeed, much of what is being developed in the themes has not yet been established or is more at the stage of questions than answers. Experts and organizations that have a lot to do with the problem share their experiences and tips and help the agencies personally if necessary. The themes are a place for architects, content experts or organizations that have a lot to do with that topic, to share their knowledge and exchange their experiences. At the same time other actors in need, such as projects leaders, policymakers, administrators and novice experts, could take advantage of that knowledge and experience and applying it to practice. By doing so, the themes contribute to create a concrete set of guidelines and best practices, which are freely available to the entire public sector.

AI & Algorithms	Sustainable Accessibility	Sandbox: Process management
-----------------	---------------------------	-----------------------------

API	Data management	Sandbox: formatting themes and topics
Purchase	Geo-information	Semantics
Architecture international	Booklet Connect	System of Key Registers
Business Rules Management (BRM)	Chain management	User experience
Security	Nodes	Agile Legislation
Business Process Management (BPM)	Mobile apps	Business-Oriented Working
Dates on the web	Privacy	Sustainability

Table 4: NORA Themes (NORA, 2022)

#### 3.4.2.4 Five-Layer Model

*“To make interoperability work in the Netherlands we adopted the 5 layers model.”*

*(Program Manager of NORA and ICTU Strategic Advisor)*

The Five Layer Model is a framework, described within the NORA, developed to support and guide digital interventions, service delivery or interoperability projects in the Netherlands. The purpose of the model is to be a reference framework for the architects in every type of projects that they are undertaking since it enables to analyze and visualize any project or social issue from these appealing layers. Each layer can be filled with several characteristics, which can be unique and specific aspects of the project, common aspects of the domain within which the project falls or the national agreements that were developed for the entire public sector. In this way, it provides an overview of all aspects that need to be taken into account, divided for each perspective (layer) of the projects.

The Dutch Five-Layer Model is derived by the European Interoperability Framework (EIF) and by the European Interoperability Reference Architecture (EIRA) which originally had 4 views: legal, organizational, semantic and technical. The Five-Layer Model instead is composed by:

- Foundations Layer: it contains all laws and regulations that may apply to our issues and projects.
- Organizational Layer: it deals with the organizations and processes to be able to deliver the agreed products and services from the government. This also includes the way in which the organizations apply the Service



Concept and the way in which the organizations set up their final operating procedures, on the basis of guidelines such as Business-Oriented Working theme.

- Information Layer: it is about the semantic of information and data. An important basis for cooperation is the sharing of language and concepts, so that everyone can understand each other and can exchange and reuse each other's information. However, there is not an exhaustive overview available of the information and data that are relevant to government information management yet. Typically, a separate data dictionary or data model is used for each system, organization, or domain. In the Netherlands, they are therefore working on the so-called National Semantic Level.

*"In the Netherlands we have the Nationaal Semantisch Vlak, the National Semantic Level, that addresses syntax and semantics of all kinds of information that is floating around in the Dutch services."*

*(Senior Advisor for Digital Services & Transformation, ICTU)*

The National Semantic Level is a collection of all terms that are relevant to Dutch government services and information management, with their definition, relationships and the context in which they are used. The definition refers to the description of the content of the term, which also indicates in which legislation the term is defined, the relationships to the connections between two or more concepts and the context refers to indicates where the terms are used.

- Application Layer: this layer includes registers and software functions. In the NORA an overview of all the 10 Basic Registers (deeply discussed in the following paragraph) and 144 Sector Registers present in the Dutch public sector can be found, as well as an overview of data sets that are made available in the context of Open Data. Concerning software functions, in the NORA, generic Building Blocks and Facilities that have been made available for reuse, are described.
- Network Layer: the layer includes the networks, middleware, nodes, and infrastructure needed to host systems and exchange data between those systems. Through this layer, NORA support architects in understanding which network, private or public, needs to be used and then which standard needs to be applied.

#### 4.4.3. System of Key Registers

An important infrastructure in the Dutch Public sector that contributes heavily to interoperability is the System of Key Registers. The System of Key Registers is the

collection of all agreements and facilities aimed at the effective and efficient management of a set of data, which are necessary for the performance of all government bodies tasks and duties. The basic registration system provides an indispensable government-wide, organization-independent data infrastructure with authentic data such as addresses, personal data, company names and geo-information. These data make use of common solutions necessary for the collection (data collections with legal basis called key, base or basic Registers), dissemination and use.

Information from the key registers is combined and used in government processes, for example emergency services or the efficient determination of entitlement to benefits, and in tackling social issues such as the energy transition or the fight against fraud. By sharing already known data within the government through the basic registration system, the Dutch government agencies can operate more efficiently and improve services. For example, a citizen or company does not have to supply certain data again and again, but only once.

The basic register is a collection of high-quality data required by all government institutions and its characteristics must meet a set of twelve requirements related to: the content of the registries, the responsibilities and procedures in managing the system, the transparency of the managing costs and the legislation around their usage. The registers contain authentic and non-authentic data, and when using the data, the privacy of the citizen must be guaranteed. The System of Basic Registers is formed by 10 basic registers, each of them with its own type of data collected, responsibility roles and relationship with other basic registers. The 10 registers are:

- Personal Records Database
- Trade Register
- Key Register Addresses and Buildings
- Key Register Topography
- Key Register Land Registry
- Basic Registration Vehicles
- Basic Registration Income
- Key Register of Real Estate Value
- Key Register of Large-Scale Topography
- Basic Registration Subsurface

The Minister of the Interior and Kingdom Relations is in charge and responsible for the proper functioning of the whole System of Key Registries, but many parties and stakeholders are involved in the system, each of them with a specific role:

- Client: is the ministry responsible for the basic registration, which is the client for the 'provider'.
- Supervisor: is the party responsible for ensuring that the basic registration operates in accordance with requirements, agreements and legislation.
- Source holder: is responsible for collecting and maintaining the data in a key register and for guaranteeing the data quality.
- Provider: is responsible for providing the data and also for facilitating the use of the data by providing knowledge and support.
- Customer: also called user, is a government organization or private party that purchases data from a basic registration for use in its own processes.

The same organization can be provider, source holder or customer. For example, the Netherlands Vehicle Authority maintains the vehicle registration register (source holder), provides it to other customers (provider) and at the same time is a customer of the Personal Records Database data.

On top of the roles, there are also nodes. A node is a facility or organization that facilitates the connection between the customers and the available data sources, including the system of basic registrations. The node acts as an intermediary or a broker between the holders of sources and the purchasing organizations, therefore, it makes easy for a customer to connect with data sources by managing the data logistics (integration, conversion and distribution) and managing the agreements and common facilities.

Since nodes can offer parties with access to data from basic registers, they should act carefully and transparently. Indeed, information security and privacy are a core part of the services provided by these nodes and for this reason, it is important that nodes set up their policies, processes and systems in such a way that the data is exchanged securely and that privacy rules are not violated. Some examples of nodes are PDOK (Public Services on the Map), that provides data services with GEO data, and BKWI (Bureau of Chain Computerization Work & Income), which shares data for government parties within the domain of work and income.

## 4.5. Sweden

*“People in Sweden are expecting a certain level of service, like the one present in the private sector, so it is important to make a transformation in the digital society.”*

*(Responsible, Swedish Association of Local Authorities and Region - SKR)*

Sweden is working hard on the e-government development. Due to the very decentralized public sector the Swedish international rankings are not always at the top, nevertheless the efforts put in place and the interoperability intervention are high quality ones.

### 4.5.1. The Swedish public sector

*“In Sweden there is a clear distinction between politics and administration. The public authorities are, at least theoretically, on a distant level from politics, the core executive. [...] We are proud of this system that focuses on efficiency and performance management and in that way the sort of distance between politics and administration is good, but when it comes to making cross functional things easier, it's not good.”*

*(Senior policy officer, Swedish National Financial Management Authority - ESV)*

For a complete understanding of the Swedish situation in terms of interoperability between public agencies is important to note that in Sweden there is a clear distinction between politics and administration, meaning that every public agency has to steer itself.

*“The Swedish government system is quite different from many other European countries, we are quite self-steering the different agencies, that's our main issue, it is up to every agency. It is something both good but sometimes bad, we have to have good incentives to make interoperability work.”*

*(Information architect, Swedish Agency for Digital Government - DIGG)*

Therefore, the different public agencies are formal organizations, and they can take autonomous decisions in regard to the choice of which database, program or software to use. On the one hand this self-government allows Sweden public sector to behave similarly to private sector agencies, and they are able to reach high level of efficiency. On the other hand, due to the fact that every public agency can make decisions by itself, the Swedish government in order to ensure interoperability has to work very hard offering very good incentives to the different public entities.

#### 4.5.2. Swedish framework for digital collaboration

DIGG, Agency for Digital Government, works to increase the pace of PA digitalization, its role is to assist the different PAs in digitalization providing knowledge and support in their service provision. Additionally, DIGG ensures that the digital public services are accessible to all citizens and in 2017 when the EIF was published, in collaboration with other state agencies, worked on the adaptability of the EIF to the Swedish context. It is called “Swedish framework for digital collaboration” and it has been built with the aim of allowing the public sector to exploit the digitalization opportunities.

*“Digital samverkan är förmågan hos organisationer att interagera i en gemensam riktning mot ömsesidigt fördelaktiga och överenskomna gemensamma mål. I dag är det komplicerat för organisationer och enskilda initiativ att fatta beslut och agera på ett sätt som bidrar till en gemensam riktning för samtliga aktörer.”*

*[“Digital collaboration is the ability of organizations to interact in a common direction towards mutually beneficial and agreed common goals. Today, it is complicated for organizations and individual initiatives to make decisions and act in a way that contributes to a common direction for all actors.”]*

*(DIGG – Agency for Digital Government website)*

As all the interviewees mentioned, the “Swedish framework for digital collaboration” is centered on collaboration between different public agencies. This is mentioned as fundamental in the framework in order to have the digital development implemented. Hence the cooperation is the first of the basic principles for digital collaboration, upon which the framework is built:

1. Cooperate as first choice: collaborate with other agencies has to be seen as an opportunity. The public sector as a whole should strengthen its capacity to act in a holistic perspective in order to create better benefits for the society.

Hereafter are listed the other principles:

2. Work actively with the law: since the different organizations have different legal prerequisites to comply with, it is important that the different public agencies participate together to the development of constitutional support in order to assist the digitalization of the services.
3. Open up: data is seen as a common resource that should be reused for different purposes than the original one. Open standards are recommended to facilitate the exchange of data, information and software components.

4. Create transparency to the internal management: public organizations' administrative rules, processes, services and decisions are made visible while protecting personal integrity.
5. Recycle from others: PAs have to use experiences from other organizations, existing solutions and products. They have to examine what is available and evaluate whether it is useful for their current need. Additionally, the different PAs must share their experiences taking care that data are open.
6. Ensure that information and data can be transferred: data needs to be easily transferred and reused between actors and technical systems.
7. Put the user at the center: the different needs and requirements of the users must be the reason for which services are developed. The user should have the chance to exercise their rights and fulfill their obligations in the public services in an easy way.
8. Make digital services accessible and inclusive: public organizations must follow generally accepted specifications for digital accessibility at national and international level.
9. Do it safely: private individuals and companies must be able to trust that operations and information processing in the public sector take place in a safe and reliable environment and in accordance with applicable regulations. Information security is therefore a necessary prerequisite for the digitization work.
10. Find the right balance for personal integrity: in the development of public services, private individuals and companies need to be given the opportunity to decide for themselves who receives their private information.
11. Use language that users understand: public organizations need to use a neat, simple and comprehensible language that is adapted to the users in order for public services to be comprehensible. Additionally, the services need to be developed considering multilingualism, in order to offer the service to every user in their favorite language.
12. Make administration simple: public organizations need to take advantage of digitalization and rationalize and simplify their administrative processes.
13. Have a holistic view of information management: data is a shared resource. To take advantage of the possibilities of digitalization, a holistic approach to information management and increased proactivity is needed. In order to guarantee the long-term preservation of information, public organizations need to choose formats that remain accessible even in the long term.

When the Swedish interoperability framework was ready the DIGG had, and still has, the role to monitor and support PAs both at national and regional level in the implementation of the interoperability framework. The adoption of the model from state public agencies is quite high while the adoption from regions and municipalities is lower.

Like at the EU level the “Swedish framework for digital collaboration” is not constraining but it is just a recommendation for the public agencies. On the other hand, Sweden is able to steer the different PAs through different programs that will be further described later.

In particular the EIF translation has been handled by DIGG through the eSam collaboration program. This program was made up in 2015 with the objective of allowing the members to collaborate on accessible and legally secure digital solutions. The focus is to facilitate the needs of citizens and companies to be able to carry out matters with authorities and municipalities.

The program has the responsibility to maintain a dialogue with the Swedish organizations that work in the digitalization arena: the DIGG and SKR that will be further explained later.

#### 4.5.3. Sweden’s interoperability interventions

Since the 90s Sweden has reasoned about the harmonization of basic data.

*“Basic data it’s a great need in the society and different areas and everybody has to reach the data.”*

*(Information architect, Swedish Agency for Digital Government - DIGG)*

At the time there was a governmental committee called “Basic Data Inquiry” that focused on three main domains: People, Companies and Geographical information. These three domains were chosen because they were considered as the ones in which more PAs had interests in. In the definition of this strategy, Sweden looked at the work done by Denmark and the Netherlands. More recently, in 2018, the framework about basic data has been drafted and the public agencies that are part of a certain domain are incentivized to use the same information model and to handle data in a similar way, thus increasing interoperability. During the last years, new areas of interest were affected by the work on basic data, particularly the Health domain and the Transport domain. In particular, the latter is needed since in Sweden there are six different transport agencies.

During the interviews emerged that the objective is to create some centralized models that will be applicable for every domain:

*“The purpose is to achieve interoperability not mainly between databases as such [...] but we want to create the possibility for mainly PA to reach the data at the same look and feel.”*

*(Information architect, Swedish Agency for Digital Government - DIGG)*

Sweden has developed a one-stop shop portal called Verksam.se, which is dedicated to entrepreneurs and enterprises and provided them the information and services they may need. Additionally, Skatteverket has been introduced to provide to both business and citizens general information concerning Swedish services.

Sweden has not yet reached the desired complete interoperability of formats and information models but has set the right path.

#### 4.5.3.1. ENA: Sweden's digital infrastructure

Sweden is currently working on the ENA which is the national digital infrastructure, that allows efficient and secure exchange of information between public agencies.

*“Istället för att varje offentlig aktör ska utveckla sina egna lösningar, på sitt eget sätt, vinner alla på att det finns en sammanhållen infrastruktur som kan användas för att lösa förvaltningsgemensamma grundläggande behov.”*

*[“Instead of each public actor having to develop their own solutions, in their own way, everyone benefits from the existence of a cohesive infrastructure that can be used to solve common administrative basic needs.”]*

*(DIGG – Agency for Digital Government website)*

On the ENA project are working different state agencies with the objective of creating a common digital infrastructure for all Swedish public agencies. The infrastructure is composed of different building blocks:

- Digital services: here there are elements that include services, models, standards and frameworks that promote a better and more efficient user interface. In this category are included e-mail services and the citizen's personal area.
- Exchange of information: here there are the common infrastructure services that ease the digital access and exchange of information. In this category are included address register and API management.
- Information management: here there are the elements that relates to standardized and machine-readable information. In this category are included indexing and metadata management.



- Trust and security: here there are the standardized digital functions for information exchange that help meet the needs of security. In this category are included authorization, identity, traceability and trust framework.

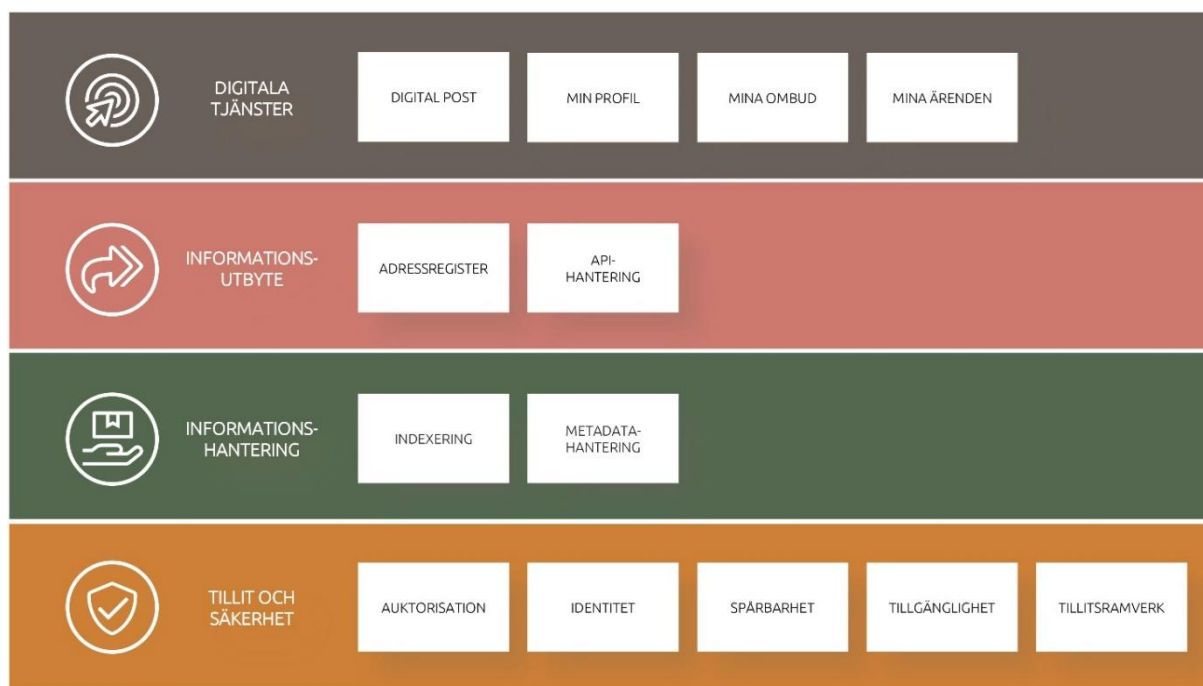


Figure 28: ENA building blocks (DIGG, 2022)

Some parts of the ENA digital infrastructure are already in use, and they are improved, while at the same time, some others are developed from scratch. Due to that fact that ENA is made of different building blocks it is possible for the coordinating agency, DIGG, to monitor the implementation progress and so to bind the new funds to the achievement of a certain milestone.

A crucial point that emerged during the interviews with Swedish experts is that avoiding duplication of efforts and work is fundamental and, in order to reach this objective, it is essential to cooperate.

*“The meaning is that common things that every PA needs should not be made within all the administrations, but we could make something together. That is the purpose and that is what DIGG funds with money.”*

*(Information architect, Swedish Agency for Digital Government - DIGG)*

This concept is closely linked to the once only principle that is present in the Tallin Declaration on eGovernment and Interoperability Framework. The principle refers to not asking citizens and business information that the PA already owns, while with the

ENA infrastructure the aim is to reduce the PAs' efforts in searching for solutions, since the solution is found together.

Looking at the ENA project we can see a practical example of the collaboration between the different public agencies: the work is coordinated by DIGG (Agency for Digital Government) together with the Employment Agency, the Swedish Companies Agency, the Swedish Courts Agency, the E-Health Agency, the Swedish Insurance Agency, the Land Survey, the Swedish National Archives, the Swedish Tax Agency, the Swedish Statistics Agency and the Swedish Transport Agency. Additionally, a large number of collaborative actors participate in the development of ENA.

#### 4.5.3.2. Sambruk initiatives

Sambruk is a Swedish non-profit organization, founded in 2002, that focuses on digital cooperation. Around 45% of the Swedish municipalities are member of the organization, particularly 60% of the Swedish population lives in a Sambruk member municipality. The organization teams with its members, thus the members are the ones that guide the organization to the future.

*"It is smarter to do things together instead to do it in each municipality, this is all about Sambruk, to actually join forces and actually do something about issues we have in the digital arena."*

*(Executive officer – Sambruk)*

The objective of the organization, as stated by the interviewee, is to bring municipalities together and try to coordinate them. As we mentioned before in Sweden the municipalities have the right to self-determination and do not have to answer to the central government, for this reason each municipality works in a different way, and this hampers the achievement of complete interoperability. Sambruk inserts itself in this context, developing project with the objective of aligning the way of working of the different municipalities, and accordingly increase interoperability. Hereinafter are listed some of the projects:

##### *Annual accounts and reports formats*

In Sambruk are defining the annual accounts and reports formats with the objective of demanding that reports and accounts that every public agency sends over the government, need to be drafted according to the web accessibility EU directives. The legislation is already in practice, but they still have to define the necessary details and for this reason the project will be executed next year. The alignment of every document to the new formats will facilitate the usage of metadata, because it will be much easier for machines to read performance reporting. Sambruk wants to be able to read and extract the performance reporting from every agency and then put that into a database and share it with everyone.

### *SS 12000*

This project was launched in the school sector by two managers that concluded that, they have a problem in the big IT ecosystem the Swedish school's sector have. The different systems cannot exchange information between themselves. For this reason, in Sambruk they decided to start a standardization process in the school sector, they started discussing about specifications on how these big systems within school area should optimally exchange information between them, then they set up a specification. The Swedish Standardization Board (SS) noticed it and decided to start the standardization process. Now in Sweden there is a formal and official standard called "SS 12000" which is formally accepted by the big supplier of the IT systems to the schools. This means that they are actually opening up the systems. This is a huge step and a good example of the collaboration in the public sector.

### *Nätverk digital signering*

Digital signing has become quite important after the pandemic and the increased number of people that work from home. About 30 municipalities collaborated in this area, looking for best practices and actually delivering some really good ideas. In this initiative a total collaboration between municipalities has happened.

### *EGIL*

EGIL is an application that allows the public sector to respect the GDPR in regard to students' information. The different municipalities worked together in order to find a solution about students' information, particularly on the sharing of this information to external parts. It is a small application, but it is quite important for personal data management and sharing.

### *Medborgarnas nav*

Medborgarnas nav is a big project, about the citizen's hub. The goal of this project is to put the citizen at the center allowing him to be on the driver seat, making him authorize the communication of their personal data to different public entities other than the one they communicated their data at the beginning. They believe it is a crucial project since there is a lot of legislation in this area, first of all the GDPR.

#### 4.5.3.3. SKR (Sveriges Kommuner och Regioner)

SKR (Sveriges Kommuner och Regioner) is a network of Swedish municipalities and regions that aims at contributing to the development of its members. It is worth of noticing that all municipalities and regions are member of SKR.

*“Vi fungerar som ett nätverk för kunskapsutbyte och samordning. I vår roll ingår att ge service och professionell rådgivning till tjänstepersoner och förtroendevalda i kommuner och regioner inom alla de frågor som kommuner och regioner är verksamma inom.”*

*[“We act as a network for knowledge exchange and coordination. Our role includes providing service and professional advice to civil servants and elected officials in municipalities and regions in all matters that municipalities and regions are active in.”]*

*(SKR - Sveriges Kommuner och Regioner website)*

Furthermore, SKR has the ambition of highlighting the important changes in the society and help determining the right direction, creating the greatest benefit possible for municipalities and regions.

SKR, in regard to collaboration between different public agencies, promotes Dela Digitalt which is a portal with the objective of creating a collaborative space for the public sector. Through Dela Digitalt every member can share experiences and work methods. All the past experiences are available in the platform to be consulted, in this way it is possible avoiding duplication of efforts: when an agency has a problem it can go in the platform, search through keywords, and find already built solutions.

## 4.6. Results discussion

After we analyzed the general characteristics, digital programs and interventions conducive to interoperability of the Danish, Swedish, Estonian and Dutch public sectors, we could gather and pinpoint the main lessons learnt and takeaways from the analysis of these cases. We will do it by grouping several common characteristics observed in the cases analysis in conceptual cluster, in order to provide guidance about how the quality of services and e-government can be increased and what contributes to create and increase interoperability in a country's public sector.

The cluster that will be analyzed are:

- **Digitalization approach:** it deals with considerations concerning the general approach, adopted by the government or the specific public organizations interviewed, throughout the digitalization process that led the country to reach such level of e-government and interoperability.
- **Collaboration:** here, remarks about the importance of collaboration, cooperation and involvement of all the stakeholders, are clustered. When the central government has to deal with such systemic processes it cannot do it all alone and therefore, has to cooperate with all the actors to deliver visible benefits to citizens and the society.
- **Technical interventions:** the common technical interventions, identified by the interviewees, that contribute to the achievement of interoperability are listed, from the need to develop a robust central digital government infrastructure and a distributed architecture for the fast retrieval of basic data by PAs, to the introduction of eID enabling unique identification for citizens and one-stop shops that provide single gateways to government information and e-services.
- **Legal interventions:** the cases analysis revealed the significance, along with technical interventions, of legal interventions needed and the regulatory commitment that a country has to demonstrate in order to optimally undertake digital projects with the purpose of enhancing public sector interoperability.
- **Incentives:** a crucial point is to be able to deploy digital and interoperability strategy, to make it actually successful, across the whole country public sector. To reach this goal, many incentives mechanisms are put in place by the most advanced PAs, which were able to incentivize all the public sector organizations and all government levels to align to the guidelines, strategies and goals set for the digitalization path.

- Financing structure: the financing strategy and structure have to be taken into account in order to reach a high level of public sector digitalization and interoperability, and to undertake digitalization interventions. Therefore, in the last cluster, reflections about the financing systems used are extracted. In particular, the considerations reported are concerning the origin of the funds used to finance the digitalization journeys and the behavior and strategies of the governments in regard to project financing.

#### 4.6.1. Digitalization approach

*“It is not possible to do everything together [...]. It is important to consider that development is decentralized so it is possible to do it in different PA in parallel.”*

*(Director of e-Government Technologies and Member of the Management Board,  
e-Governance Academy)*

The development of a functioning and efficient e-government is a long process, for example Estonia has spent almost 30 years to reach its actual advanced level. The establishment of an interoperable public digital infrastructure cannot be built overnight, particularly for Italy, that differently from Estonia, is not starting from scratch but instead has a functioning digital infrastructure, even though not fully interoperable.

*“That has been a gradual growing process and the strategy we are right now advising other governments is to start from low hanging fruit, see what the easiest services for you are to digitalize and the maximum impact for the human.”*

*(Digital transformation advisor, e-Estonia)*

The indication provided by the experts interviewed is to identify the services that would most benefit citizens and businesses and start working on them, allowing the systems involved in the service provision to interoperate in order to exchange data with each other. In this way once the service is provided to the citizens, they will use it and, in this way, contribute to the digitalization of the society.

Moreover, another variable that needs to be considered is the number of public services provided by local and central public authorities and the level of independence of local entities. For instance, in Estonia and the Netherlands the majority of public services are provided by federal PAs and the areas of interventions are set by law. While in Sweden municipalities and regions are more autonomous and in order to guide the entire country in the same direction a lot of commitment has to be put in collaboration efforts.

#### 4.6.2. Collaboration

The achievement of a smooth data and information exchange between the different public agencies, enabled by interoperability, requires collaboration.

*“Since 2001 we had strong collaboration, we made a common framework for architecture, started making standards and reference architecture and building common solution and have common implementation projects”*

*(Chief Consultant and Chief Architect for Federal Digital Architecture - FDA,  
Agency for Digital Government)*

*“All the parts within the public sector have their own agendas and their own decision base, meaning that if you are going to have a collaboration over the borders of the sector you have to find common pain points that actually can make deliver [digital services].”*

*(Executive officer, Sambruk)*

*“We have a large community of people from those domains, they get together in quarterly meetings where people share knowledge and country specific issues are being discussed and they talk about progress of projects. The community is a fundamental element in the NORA success.”*

*(Senior Advisor for Digital Services & Transformation, ICTU)*

Collaboration between different public agencies has been identified as fundamental for the actual realization of interoperability. In particular the engagement of all levels of the public sector in the project definition and update has proved beneficial both for the realization of the aforementioned project and the creation of a community.

*“Willingness of the departments to free their data to be used by others. This has been a gradual process, there was not a regulation that obliged different PA to share their data but awareness about how useful sharing data is, was built.”*

*(Senior expert on electronic democracy, e-Governance Academy)*

The process of involving all the PAs in the interoperability intervention is not simple, indeed it is one of the most difficult ones to achieve. For this reason, the comprehension by the different public entities of the actual benefit that the sharing of information can bring to citizens, business and to their everyday work is essential.

This aspect is strictly related to the organizational interoperability, since the different PAs to achieve it, are expected to harmonize their business purposes, responsibilities and prospects, and collaboration, aligning the different public agencies' expectations, facilitates this process.

*“What we do have in place is a very good collaboration between state, regions and municipalities.”*

*(Chief Consultant and Chief Architect for Federal Digital Architecture - FDA, Agency for Digital Government)*

Especially when the PA management is decentralized a good harmonization of the digitalization efforts is necessary, in order to avoid that different PA levels develop their digital government in autonomy without creating interoperability with other agencies.

#### 4.6.3. Technical interventions

Entering in a more technical and practical sphere, the analysis of the interviewed countries revealed some crucial and necessary steps, in terms of key digital interventions, that need to be undertaken in order to reach a good level of interoperability in the PA. In order to reach this purpose, the focus of each country has been to develop a consistent digital infrastructure that serves as backbone for the entire public sector, through the development of cross sectoral digital interventions.

The greatest and most successful example of infrastructural intervention is represented by the Estonian's X-Road. As described before X-Road is an advanced data exchange layer that connects all information systems and all public organizations in Estonia, enabling secure data exchange and service provision. By connecting the whole public sector and implementing a set of standard formats and features, the system ensures interoperability between information systems in the Estonian public sector.

Concerning other preconditions of interoperability, all the interviewed countries stress the importance and the necessity to develop a single electronic or digital identification. It can be used to access any type of government portal or service and allow the citizen to uniquely identify.

*“Then we have this approach where we develop this central infrastructure component that is the national e-ID, here in Denmark we have one e-ID, which is the same that you use across the public and private sector.”*

*(Team Lead Division for Analysis and Policies, Agency for Digital Government)*



*"All Estonians, no matter where they happen to live, have a state-issued digital identity."*

*(e-Estonia website)*

*"The government is striving for more autonomy for citizens and entrepreneurs. This means that as a government, we will ensure that citizens and entrepreneurs can arrange things with governments and institutions in one place that are linked to their person."*

*(Dutch Digital Government website)*

All countries have developed their own digital identity. For example, the first to be created was Estonian's e-Identity in 2002. Denmark, instead, developed over the years several generations of eID, in 2010 the NemID (second generation) and more recently, in 2022 the last generation MitID. The Netherlands, as well, have developed a digital identification system, the DigID.

Another point of contact in the process towards interoperability is represented by the work that has been done for basic data, in particular for facilitating their retrieval by the government agencies.

*"Basic data it's a great need in the society and different areas and everybody has to reach the data."*

*(Information architect, Swedish Agency for Digital Government - DIGG)*

*"Our main example of interoperability is regarding basic data and we are very mature in Denmark regarding basic data"*

*(Chief Consultant and Chief Architect for Federal Digital Architecture - FDA,  
Agency for Digital Government)*

The main projects undertaken consists, at the semantical level, in efforts to harmonize and standardize the data formats and using the same information model, and, at the technical level, in the introduction of infrastructural solutions that enable the smooth flow and distribution of the basic data. Both these two perspectives are necessary steps to ensure full interoperability of basic data between public organizations.

For example, Sweden started to move towards basic data interoperability by issuing the framework for basic data with the purpose of incentivizing all public organizations to use a single information model and the handle data in the same way. Instead, the Netherlands over the years developed a robust data infrastructure represented by their System of Basic Registers where data can be combined, requested and used for

government processes as needed. The same for Denmark that, in its system of registers, introduced the Data Distributor Node, a common distribution solution that enables to share data using a single channel and to retrieve data when needed rapidly and easily.

For the government it is also crucial to create a single point of contact with the citizen. In this context, the concept of one-stop shop revealed to be crucial, representing a unique online interface between the citizen and the government, where links and information for any type of public service and government agency are provided, reducing the administrative burden that the citizen has to bear when specific needs arise.

With this view Denmark developed Borger.dk (the National Citizen Portal) including also My Overview platform that allow the citizen to have a complete view on all the information that the public sector holds on them, as well as status on ongoing cases with public authorities, upcoming agreements and deadlines. Other examples with similar features are the Estonian Eesti.ee and the Dutch MijnOverheid, which are the gateways and single points for government information and e-services. Eesti.ee includes many e-services divided in categories such as family, work and labor relations, pensions, social services, allowances and many more. In Sweden, instead there are Verksamst.se, which provides a comprehensive single-point platform for only entrepreneurs and enterprises and Skatteverket which provides to everyone (i.e., private, businesses, associations) general information concerning Swedish services.

#### 4.6.4. Legal interventions

An important take away grasped by the interviewed countries, is the necessity to combine the digital interventions with legal measures in order to really support and make successful the digitalization projects. Therefore, also on interoperability matters, technology is fundamental to improve and make interoperability work, but legal efforts need to go hand in hand with the technical and infrastructural development.

The first country to realize this has been Estonia that, through the Public Information Act, in 2001, set the legal basis of their e-government structure. The point that it is worth of noticing is that the act prohibits to duplicate dataset of existing data, therefore, it prohibits to extract the needed data and keep them saved in another system. In this way the information remains always in the original point of collection. In addition to advantages in terms of data update and data quality, Estonia, through the legislation, was able to facilitate and incentivize the exchange and sharing of data, promoting the X-Road infrastructure and, thus, interoperability.

In order to furtherly strengthen interoperability, X-Road was additionally made mandatory for all public organizations.

The topic about ownership of data is another crucial area that has to be taken into account. Estonia, for example, moved in this context, by clarifying through a law that the ownership of personal data lies within the citizens and not with the holder of the information. In this way consents by the citizens are necessary for sharing and exchange their personal data. Again, this was done in line with the X-Road intervention.

A fast and easy communication between citizen and PA and, especially, between different public authorities is crucial for interoperability. As explained in the Denmark case, the Danish Government, for reaching that purpose, developed the National Digital Post and this is another case where the legal efforts accompanied the actual technological development. Indeed, Denmark, through a legislation, enables public authorities to send messages and documents with legal basis using Digital Post and therefore, made mandatory for citizens and businesses to be able to receive such correspondence by public authorities.

In the digitalization journeys that most countries are undertaking it is also crucial to control and verify that all digital projects and interventions developed by the several organizations, included those targeting interoperability, are lined up against the same goals, in order to maintain across the whole public sector homogenous and aligned structures. The Netherlands, for example, stressed the importance and centrality of their National Reference Architecture, the NORA, in their public sector. If on the one hand the NORA provides a platform for knowledge and experience exchange and for insights for digital projects, on the other hand it represents a consistent framework, including also all legislations that may be of architects' interest, constituted by binding agreements that each public agency in each domain has to follow in developing its digital and technological interventions on the overall infrastructure or on some specific services.

#### 4.6.5. Incentives

A point of continuity among all the interviewed experts was the importance given to practically implementing and spreading interoperability. If a government wants to undertake interoperability projects, a fundamental aspect to consider is to successfully deploy interoperability across all levels of the public sector and incentivize every level to undertake digital interventions, adopt solutions and practices, that promote interoperability.

In this context, the regulatory setting is a strong deterrent. As explained in the previous paragraph, through for example the Estonian and Dutch cases, the set of laws and legislations highly contributes to the success of any digital project, and it also represents a good incentive mechanism to have everyone aligned to the interoperability purpose and to encourage the implementation of projects that contribute to this goal.

Many countries adopt a cooperative approach giving a lot of value to collaboration among all public bodies. This means involving all the interested parties since the beginning of the decision-making process, when the strategies are decided, and the objectives are set. This approach is followed in Denmark, where since the beginning all the government actors collaborate together to develop a joint and agreed strategy and to push forward the digitalization agenda.

*“For the past 20 years in Denmark we have had joint public sector strategies that is all levels of government that together formulate a strategy and then collaboratively work on the digitalization of the public sector as a whole, in order to facilitate the interoperability”*

*(Team Lead Division for Analysis and Policies, Agency for Digital Government)*

Through this kind of approach, interoperability is naturally deployed throughout the whole public sector, and the incentive to follow guidelines and undertake interoperability projects, is intrinsic to this collaborative way to proceed, since government bodies are involved immediately in the process. A similar approach of collaboration is followed in Sweden. As extensively analyzed before, in that case, this approach is due to structural characteristic of the Sweden public sector, where there is a distance between government and political bodies with administration, which makes every public agency quite independent. Therefore, to ensure interoperability, alignment and collaboration between all the autonomous government entity is needed. The Swedish Agency for Digital Government developed the framework for digital collaboration exactly for this purpose, in order to incentivize all the public sector agencies, to collaborate and work for digitalization.

The allocation of funds for specific interventions is another incentive and aligning method for interoperability and digital projects that is used in Sweden. Particularly, this approach is applied for the development of the Swedish digital infrastructure ENA, which is composed by many building blocks. Thanks to this characteristic, its development can be easily monitored, and new funds can be set up and bind to the achievement of certain results and milestones. In this way the government bodies involved in the ENA development are always incentivized to undertake digital projects to expand the digital infrastructure.

#### 4.6.6. Financing structure

The implementation of a e-government development projects needs financing. The EU provided to its member state funds dedicated to the development of their digital agendas.

<i>Country</i>	<i>EU funds</i>	<i>State budget funds</i>
Denmark	Yes	Yes
Estonia	Yes	Yes
Netherlands	Yes	Yes
Sweden	Yes	Yes

Table 5: E-government development funding

The first notable output is that all the countries interviewed invested more than the amount of money provided by the EU, meaning that in order to realize a functioning e-government infrastructure, a State needs to invest extra budget funds.

Looking more in detail, Estonia started its digitalization process before being an EU member, so for the first 10 years the funds came from the state budget. After becoming an EU member Estonia established a structured financing frame, the EU funds are allocated for the long-term development of the digital government (e.g., procurement of new technologies, elimination of legacy systems) with the objective of upgrading the different capabilities. For what concerns every day running costs and systems upkeep state budget funds, which amount half of the entire digital governance budget, are used. Also, Sweden complements the EU funds with state budget funds, however it can happen that some specific projects are financed partially with private funds, with the public sector behaving similarly to a crowdfunding organization.

Even though at the high level the functioning seems similar for all the countries, each of them behaves in a different way in regard to project financing.

The Danish projects finance structure is organized as follows: the government pays 40%, the regions pay 20% and the municipalities pay 40%. The different projects are co-financed, so even though the Agency for digital Government run them, the responsibility is shared between the different levels of the public sector.

In Sweden a public activity, in order for be financed, needs to be inserted in one of the 27 budget public cost areas. When a public agency gets a mission from the state it will receive grants that may be normal grants if the mission is included in the scope of action of the agency or extra grants in the case in which it is outside of the scope. The agency will then have the task to collaborate and share the grant with the other public agencies involved in the project.



## 5 Methodology

Our master thesis consists in a literature review on the topics of proactive services and interoperability and in an empirical analysis of the best practices in the field of interoperability.

Particularly the literature review is structured in two paragraphs: the first one focused on proactive services, their characteristics, and the necessary preconditions to build them; the second one centered on the interoperability concept, on the ways to achieve and increase it with a focus on APIs. We decided to perform the second literature review on interoperability after having understood that it is at the base of the development of e-government and, as a consequence, to the design and implementation of proactive services.

Concerning the empirical analysis, we started it from an overview of Italian public sector concerning e-government and interoperability at the national level and we complemented this analysis with a survey sent to Italian local PAs, we analyzed the answers received in order to understand the Italian situation, at the municipal level, in regard to digital government. Additionally, we also performed a consistent number of interviews experts in the field of e-Governance and interoperability from EU countries, investigating their digital government experiences understanding the projects that they have undertaken throughout the years to reach their actual level of digital maturity.

### 5.1. Systematic literature review

The research at the base of the systematic literature review previously presented has been on proactive services in the public sector and on interoperability, one of the main pillars necessary to grant proactivity.

Concerning the first paragraph of the literature review the focus of our research, carried out through the SCOPUS database, is on proactive services in PAs. Through the defined query it has been possible to obtain 25 document that have been filtered, firstly through the abstract and secondly through the full text, to reach the final number of 9 documents aligned with the objective of the research.

The selected papers can be classified based on the main topics they focused on:

- Proactive services: 6 papers

- Service design for proactivity: 4 papers
- Moments of life: 3 papers
- One-stop shop and no-stop shop: 2 papers
- Reactivity proactivity spectrum: 3 papers

In Table 6 are listed the documents used to develop the literature review chapter on proactive services.

<i>Topics</i>	<i>Title</i>	<i>Author</i>	<i>Citations</i>
Service design for proactivity; Moments of life; Reactivity proactivity spectrum; Proactive services	<i>“Identifying design principles for proactive services through systematically understanding the reactivity-proactivity spectrum”</i>	<i>R. Erlenheim D. Draheim K. Taveter (2020)</i>	3
Moments of life; Proactive services	<i>“Designing Proactive Business Event Services: A Case Study of the Estonian Company Registration Portal”</i>	<i>H. Kõrge R. Erlenheim D. Draheim (2019)</i>	2
Service design for proactivity; Reactivity proactivity spectrum	<i>“How to Redesign Government Processes for Proactive Public Services?”</i>	<i>P. Kuhn M. Buchinger D. Balta (2021)</i>	1



Service design for proactivity; Proactive services	<i>"Proactive e-Governance: Flipping the service delivery model from pull to push in Taiwan"</i>	D. Linders C. Z. P. Liao C. M. Wang (2018)	41
Reactivity proactivity spectrum; Proactive services	<i>"Inclusion through proactive public services: findings from the Netherlands"</i>	S.F. Oude Luttighuis N. N. Bharosa F. F. Spoelstra (2021)	0
One-stop shop and no-stop shop	<i>"The long and winding road of digital public services-one next step: Proactivity"</i>	H. Scholta I. Lindgren (2019)	4
One-stop shop and no-stop shop	<i>"From one-stop shop to no-stop shop: An e-government stage model"</i>	H. Scholta W. Mertensb M. Kowalkiewicz J. Beckera (2019)	53

Moments of life; Proactive services	<i>“A conceptual framework for effective appropriation of proactive public e-services”</i>	R. Sirendi A. Mendoza M. Barrier K. Taveter L. Sterling (2018)	7
Service design for proactivity; Proactive services	<i>“Bringing service design thinking into the public sector to create proactive and user-friendly public services”</i>	R. Sirendi K. Taveter (2016)	14

Table 6: Literature review on proactive services

While we performed the literature review on proactive services, we understood that interoperability and data exchange are crucial prerequisites and foundation of proactive services. For this reason, in order to investigate more deeply these areas, we have performed a literature review on the interoperability concept as well. We have executed two queries, one about interoperability and one specific on APIs, at the end of the abstract and full text selection we obtained 19 papers.

Particularly the papers were divided by topic as shown below (Table 7):

- Interoperability definition: 11 papers
- Interoperability frameworks: 4 papers
- APIs: 5 papers

<i>Topics</i>	<i>Title</i>	<i>Author</i>	<i>Citations</i>
Interoperability definition	<i>“Approaching Interoperability for Identity Management Systems”</i>	<i>J. Backhouse R. Halperin (2009)</i>	12
APIs	<i>“Data sharing and interoperability: Fostering innovation and competition through APIs”</i>	<i>O. Borgogno G. Colangelo (2019)</i>	23
Interoperability definition	<i>“Benefits and requirements for interoperability in the electronic marketplace”</i>	<i>S. Y. Choi A. B. Whinston (2000)</i>	29
Interoperability definition	<i>“Web services and national spatial data infrastructure (NSDI)”</i>	<i>Ç. Cömert (2004)</i>	4

Interoperability definition	<i>“E-Government Interoperability: Architecture Model for Public Information Services of Sub-District Governments”</i>	<i>D. Er Riyanto P. Wisnu Wirawan K. Kurniawan (2018)</i>	0
APIs	<i>“Why APIs? Anticipated value, barriers, and opportunities for standards-based application programming interfaces in healthcare: perspectives of US thought leaders”</i>	<i>W. J. Gordon R. S. Rudin (2022)</i>	0
Interoperability definition	<i>“E-government grid system based on multi-agent for interoperability”</i>	<i>Y. G. Kook J. Lee J. S. Kim (2009)</i>	7
Interoperability definition; Interoperability frameworks	<i>“Governance of interoperability in intergovernmental services”</i>	<i>H. Kubicek (2008)</i>	4

Interoperability definition	<i>“Implementing interoperability infrastructures: Issues and challenges from the citizens’ base registry in Greece”</i>	<i>F. Lampathaki, N. Kroustalias, S. Koussouris, Y. Charalabidis J. Psarras (2010)</i>	5
Interoperability definition	<i>“Realizing the promise: Government information systems and the fourth generation of information technology”</i>	<i>D. Landsbergen Jr. G. Wolken Jr. (2001)</i>	223
Interoperability frameworks	<i>“Understanding Information: An Introduction”</i>	<i>J. Liebenau J. Backhouse (1990)</i>	128
Interoperability definition	<i>“Towards a Framework for Managing the Information Environment”</i>	<i>B. Miller M. A. Malloy E. Masek C. Wild (2001)</i>	28

Interoperability definition	<i>"Interoperability for Information Access: Technical Standards and Policy Considerations"</i>	W. E. Moen (2000)	17
Interoperability frameworks	<i>"Enhancing quality of service for eGovernment interoperability based on adaptive ontology"</i>	W. Ordiyasa L. E. Nugroho P. I. Santosa W. Kumorotomo (2016)	5
APIs	<i>"Microservice API implementation for e-Government service interoperability"</i>	N. Puspitasar E. Budiman Y. N. Sulaiman M. B. Firdaus (2021)	1
Interoperability frameworks	<i>"Understanding the roles of signs and norms in organisations"</i>	R. Stamper K. Liu M. Hafkamp Y. Ades (2000)	258

APIs	<i>“How data vocabulary standards enhance the exchange of information exposed through APIs: the case of public service descriptions”</i>	<i>E. Stani F. Barthélemy K. Raes M. Pittomvils M. A. Rodriguez (2020)</i>	0
APIs	<i>“APIs for EU governments: A landscape analysis on policy instruments, standards, strategies and best practices”</i>	<i>L. Vaccari M. Posada M. Boyd M. Santoro (2021)</i>	2
Interoperability definition	<i>“Self-jamming behavior: Joint interoperability, root causes, and thoughts on solutions”</i>	<i>S. R. Woodall (2000)</i>	4

Table 7: Literature review on interoperability

To complement our research in the scientific literature we have analyzed also the guidelines in regard to e-governance, proactive services and interoperability. At the international level we have explored:

- “E-government: analysis framework and methodology”, 2001, OECD
- “United Nations e-Government Survey 2008 From e-Government to Connected Governance”, 2008, UN

We have deepened also the guidelines given at the EU level:

- “Tallinn Declaration on eGovernment”, 2017, Council of the EU
- “New European Interoperability Framework”, 2017, European Commission
- “Digital Government Benchmark API study”, 2018, M. Williams European Commission

Lastly, we have also studied the Italian strategy, focusing on:

- “Piano Triennale per l’informatica nella Pubblica Amministrazione”, 2021, Agenzia per l’Italia Digitale and Dipartimento per la Trasformazione Digitale.
- “Piano nazionale di ripresa e resilienza”, 2021, Consiglio dei Ministri

At the end of the literature review we can state that proactive services are still a forefront topic that is under studied in the scientific literature and in the international and European guidelines. Indeed, just few countries have reached a consistent level of digital maturity and development as to include proactive services in their digital government. On the other end the interoperability concept is widely deepened by the scientific literature and is at the center of the international and Italian guidelines.

Although throughout our analysis we noticed that the scientific literature and EU guidelines in regard to interoperability contained in the “New European Interoperability Framework” and in the “Piano Triennale per l’Informatica nella Pubblica Amministrazione” does not specify properly the managerial aspect of interoperability, particularly concerning the persuasion of PA to adapt the new interoperability standards.

## 5.2. Empirical analysis

The empirical part of our thesis is composed of two sections: an analysis of the Italian situation in relation to e-Government and interoperability, through also a questionnaire submitted to municipalities, and a set of interviews with experts in the field of e-Government, interoperability and public sector information architectures to complement the literature review and investigate the actual implementation of interoperability framework to improve e-Government quality and efficiency.

### 5.2.1. Questionnaire analysis

The empirical research of our thesis is focused on interoperability, its development and its role in proactive service provision. We want to understand the actual Italian situation and the possible future steps to improve it. To properly define the Italian situation, we have analyzed the answers to the questionnaire that the Digital Agenda Observatory of Politecnico di Milano developed and submitted to the municipalities between August and October 2022, we have also consulted institutional websites to enrich our analysis. In the questionnaire, our focus has been on the questions related to interoperability, meaning the interventions that the municipalities have performed in order to integrated internally, connecting the different organizational units, and externally, with other entities.

The questionnaire was submitted to all the Italian municipalities and 952 of them answered. Every municipality had to indicate its population cluster (0-1000 residents; 1000-2500 residents; 2500-5000 residents; 5000-15000 residents; 15000-50000 residents;



50000+ residents) and this have allowed us to perform analyses based on the municipalities' size.

We have analyzed the answers to the following questions:

*Question 21*

[Cosa è stato fatto per diminuire gli adempimenti a carico di imprese e cittadini con riferimento ai servizi erogati dal Comune? (E' possibile selezionare più di una alternativa)]

What has been done to decrease the administrative burden on businesses and citizens with regard to services provided by the municipality?

*Answers:* [Non abbiamo fatto nulla] We didn't do anything; [Invio di promemoria in prossimità di scadenze legate ad adempimenti (ad esempio pagamento tasse, o rinnovo autorizzazioni/avvisi di pagamento automatici)] Sending reminders around deadlines related to obligations (e.g., tax payments, or renewal of authorizations/automatic payment notices); [Pre-compilazione automatica dei moduli] Automatic pre-filling of forms; [Eliminazione dell'adempimento grazie ai dati in possesso del Comune (es. iscrizione automatica del minore al 1° anno scuola primaria)] Elimination of action due to data held by the municipality (e.g., automatic enrollment of child in 1st grade elementary school); [Altro] More; [Non so] I don't know

*Question 22*

[Con riguardo ai servizi precedentemente indicati, sono elencati di seguito alcuni possibili ostacoli alla diminuzione degli adempimenti da parte del cittadino. Indichi per favore il grado di difficoltà incontrato, in una scala 1-5 (1 = ostacolo facilmente superabile; 5 = ostacolo insormontabile)]

With regard to the previously mentioned services, hereafter some possible obstacles to the decrease in citizen fulfillment are listed. Please indicate your degree of intensity of the criticalities you have run into, in a scale from 1 to 5 where 1 = no criticality and 5 = maximum criticality.

*Different obstacles:*

[Mancanza di personale] Lack of personnel; [Mancanza di competenze interne per gestire tali progetti] Lack of internal competences to manage such projects; [Scarsa disponibilità di risorse economiche / difficoltà di accesso ai fondi (ad es. bandi europei)] Low availability of economic resources/difficulty in accessing funds (e.g., European calls); [Difficoltà nel definire i propri bisogni nella fase di ingaggio del mercato] Difficulty in defining one's needs at the market engagement stage; [Difficoltà nella spesa (gestione degli appalti)] Difficulties in the purchase (contracts management); [Normativa o regolamentazione non adeguata] Inadequate legislation; [Difficoltà nell'impostare l'idea e/o il progetto]

(cosa e come farlo)] Difficulties in setting up the idea and/or project (what and how to do it); [Scarso interesse da parte dell'utenza (cittadini e imprese) a interagire con il Comune attraverso i canali digitali] Low interest of users (citizens and businesses) in interacting with the municipality through digital channels; [Scarso interesse da parte degli organi politici del Comune a sostenere i progetti di digitalizzazione] Lack of interest of the municipality's political bodies in supporting digitization projects; [Instabilità nella governance del Comune (es. per cambi frequenti della Giunta comunale, che impediscono di portare a termine i progetti avviati)] Instability in the governance of the municipality (e.g., due to frequent changes of the city council, preventing the conclusion of initiated projects); [Difficoltà di coordinamento dei diversi attori (pubblici e/o privati) coinvolti nei progetti] Difficulties in coordinating the different actors (public and/or private) involved in the projects; [Difficoltà nello sviluppare le soluzioni informatiche che servono all'ente] Difficulties in developing the IT solutions that the municipality needs; [Resistenze del personale del Comune impattato dai progetti di digitalizzazione] Resistance of municipalities employees impacted by digitization projects; [Resistenze da parte dei fornitori abituali dei software del Comune (ivi incluso il fenomeno del lock-in)] Resistance from the municipality's regular software vendors (including the phenomenon of lock-in); [Resistenze da parte di altri soggetti esterni al Comune impattati dai progetti di digitalizzazione] Resistance from other parties outside the municipality impacted by digitization projects; [Problemi di privacy / Gestione di dati particolarmente sensibili (es. videoanalisi)] Privacy issues / Handling of particularly sensitive data (e.g., video analysis)

*Answers:* 1; 2; 3; 4; 5

#### Question 23

[Avete integrato tra loro alcune delle banche dati dell'ente (ossia tra unità organizzative)?]

Have you integrated some of the institution databases (between different organizational units)?

*Answers:* [Si] Yes; [No] No

#### Question 24

[Relativamente a quali tipologie di dati avete realizzato l'integrazione tra unità organizzative dell'ente?]

In respect with which typologies of data have you integrated the different organizational units?

*Answers:* [Anagrafici (es. demografici)] Personal; [Attività produttive (es. SUAP, SUED)] Productive activities; [Culturali (es. musei, biblioteche)] Cultural;

[Geografici (es. idrografia, orografia)] Geographical; [Lavori Pubblici] Public works; [Mobilità (es. trasporto pubblico)] Mobility; [Patrimoniali (es. immobili)] Property; [Ricerche (es. risultati studi/indagini)] Research; [Risorse umane (es. dipendenti pubblici)] Human resources [Scolastici (es. studenti)] Scholastic; [Sicurezza (es. sanzioni)] Security; [Sociali (es. assistenziali)] Social; [Statistici] Statistical; [Territoriali (es. edilizia, rifiuti)]; Territorial; [Terzo settore (es. ONLUS)] Third sector; [Tributari (es. tasse, imposte)] Tax

#### Question 25

[Con riguardo all'integrazione dei dati tra unità organizzative dell'ente sono elencate di seguito alcune possibili criticità. Indichi per favore il grado di intensità delle criticità incontrate, in una scala 1-5 dove 1 = nessuna criticità e 5 = criticità massima]

In respect to data integration between organizational units, hereafter are listed some possible criticalities. Please indicate your degree of intensity of the criticalities you have run into, in a scale from 1 to 5 where 1 = no criticality and 5 = maximum criticality.

*Different criticalities:* [Difficoltà di estrazione dei dati] Difficulty to extract data; [Difficoltà a mantenere aggiornate le banche dati] Difficulty to keep up to date the databases; [Difficoltà di collaborazione tra le unità organizzative coinvolte] Difficulty of collaboration between the involved organizational units; [Scarsa affidabilità/qualità dei dati] Poor data quality; [Eccessivo sforzo necessario per la bonifica dei dati] Excessive effort necessary for data cleansing; [Mancanza di competenze interne] Lack of internal competences; [Resistenze interne da parte del personale] Internal personnel opposition; [Resistenze interne da parte delle figure apicali] Senior management opposition; [Alti costi progettuali] High project costs.

*Answers:* 1; 2; 3; 4; 5

#### Question 27

[Perché il Suo ente non ha effettuato l'integrazione dei dati tra unità organizzative? Indichi quanto considera rilevanti le seguenti motivazioni in una scala da 1 a 5 (1 = poco rilevante; 5 = molto rilevante)]

Why has your organization not integrated the different organizational units? Please indicate the relevance of the following motivations, in a scale from 1 to 5 where 1 = insignificant and 5 = very relevant.

*Different motivations:*

[Difficoltà di estrazione dei dati] Difficulty to extract data; [Difficoltà a mantenere aggiornate le banche dati] Difficulty to keep up to date the databases; [Difficoltà di collaborazione tra le unità organizzative coinvolte]

Difficulty of collaboration between the involved organizational units; [Scarsa affidabilità/qualità dei dati] Poor data quality; [Eccessivo sforzo necessario per la bonifica dei dati] Excessive effort necessary for data cleansing; [Mancanza di competenze interne] Lack of internal competences; [Resistenze interne da parte del personale] Internal personnel opposition; [Resistenze interne da parte delle figure apicali] Senior management opposition; [Alti costi progettuali] High project costs; [La mancanza di adeguate risorse economiche] Lack of proper economic resources; [La scarsa disponibilità di personale da dedicare al Progetto] Shortage of personnel to dedicate to the project; [La scarsa disponibilità di idonee soluzioni tecnologiche (es: infrastrutture)] Lack of adequate technical solutions; [La scarsa qualità e competenza dei fornitori di soluzioni] Poor quality and expertise of solution providers; [La difficoltà di interagire con altre aree organizzative del proprio ente] Difficulty of collaboration between the involved organizational units; [La difficoltà di interagire con altri Enti pubblici] Difficulty to collaborate with the entities involved; [La mancanza di interesse/sostegno degli organi politici] Lack of interest/support from political bodies; [La mancanza di interesse/sostegno della dirigenza del Comune] The lack of interest/support of the management of the Municipality; [La mancanza di un referente stabile in altri Enti Pubblici coinvolti] The lack of a stable contact in other public bodies involved; [La mancanza di interesse/sostegno del personale negli altri Enti coinvolti] Lack of staff interest/support in the other bodies involved.

*Answers:* 1; 2; 3; 4; 5

#### Question 28

[Il Suo ente ha realizzato integrazioni di banche dati con soggetti esterni?]

Has your institution integrated its databases with external parties?

*Answers:* [Si] Yes; [No] No

#### Question 29

[Relativamente a quali tipologie di dati avete realizzato l'integrazione tra unità organizzative dell'ente?]

In respect with which typologies of data have you integrated the different organizational units?

*Answers:* [Anagrafici (es. demografici)] Personal; [Attività produttive (es. SUAP, SUEDE)] Productive activities; [Culturali (es. musei, biblioteche)] Cultural; [Fiscali (es. IRPEF, IRAP, IVA)] Fiscal; [Geografici (es. idrografia, orografia)] Geographical; [Giudiziari (es. processi)] Judicial; [Infrastrutturali (es. reti, ponti, dighe)] Infrastructural; [Mobilità (es. trasporto pubblico)] Mobility;

[Patrimoniali (es. immobili)] Property; [Ricerche (es. risultati studi/indagini)] Research; [Risorse umane (es. dipendenti pubblici)] Human resources; [Sanitari (es. fascicolo sanitario)] Health; [Scolastici (es. studenti)] Scholastic; [Sicurezza (es. sanzioni)] Security; [Sociali (es. assistenziali)] Social; [Statistici] Statistical; [Territoriali (es. edilizia, rifiuti)] Territorial; [Terzo settore (es. ONLUS)] Third sector; [Tributari (es. tasse, imposte)] Tax.

### Question 30

[Con riguardo all'integrazione dei dati con soggetti esterni sono elencate di seguito alcune possibili criticità. Indichi per favore il grado di intensità delle criticità incontrate, in una scala 1-5 dove 1 = nessuna criticità e 5 = criticità massima]

In respect to data integration with external entities, hereafter are listed some possible criticalities. Please indicate your degree of intensity of the criticalities you have run into, in a scale from 1 to 5 where 1 = no criticality and 5 = maximum criticality.

*Different criticalities:* [Difficoltà di estrazione dei dati] Difficulty to extract data; [Difficoltà a mantenere aggiornate le banche dati] Difficulty to keep up to date the databases; [Difficoltà di collaborazione tra le unità organizzative coinvolte] Difficulty of collaboration between the involved organizational units; [Scarsa affidabilità/qualità dei dati] Poor data quality; [Eccessivo sforzo necessario per la bonifica dei dati] Excessive effort necessary for data cleansing; [Mancanza di competenze interne] Lack of internal competences; [Resistenze interne da parte del personale] Internal personnel opposition; [Resistenze interne da parte delle figure apicali] Senior management opposition; [Alti costi progettuali] High project costs.

*Answers:* 1; 2; 3; 4; 5

### Question 32

[Perché il Suo ente non ha effettuato l'integrazione dei dati tra unità organizzative? Indichi quanto considera rilevanti le seguenti motivazioni in una scala da 1 a 5 (1 = poco rilevante; 5 = molto rilevante)]

Why has your organization not integrated the different organizational units? Please indicate the relevance of the following motivations, in a scale from 1 to 5 where 1 = insignificant and 5 = very relevant.

*Different motivations:*

[Difficoltà di estrazione dei dati] Difficulty to extract data; [Difficoltà a mantenere aggiornate le banche dati] Difficulty to keep up to date the databases; [Difficoltà di collaborazione tra le unità organizzative coinvolte] Difficulty of collaboration between the involved organizational units; [Scarsa

affidabilità/qualità dei dati] Poor data quality; [Eccessivo sforzo necessario per la bonifica dei dati] Excessive effort necessary for data cleansing; [Eccessiva dimensione dei dati] Excessive size of data; [Mancanza di competenze interne] Lack of internal competences; [Resistenze interne da parte del personale] Internal personnel opposition; [Resistenze interne da parte delle figure apicali] Senior management opposition; [Alti costi progettuali] High project costs; [La mancanza di adeguate risorse economiche] Lack of proper economic resources; [La scarsa disponibilità di personale da dedicare al Progetto] Shortage of personnel to dedicate to the project; [La scarsa disponibilità di idonee soluzioni tecnologiche (es: infrastrutture)] Lack of adequate technical solutions; [La scarsa qualità e competenza dei fornitori di soluzioni] Poor quality and expertise of solution providers; [La difficoltà di interagire con altre aree organizzative del proprio ente] Difficulty of collaboration between the involved organizational units; [La difficoltà di interagire con altri Enti pubblici] Difficulty to collaborate with the entities involved; [La mancanza di interesse/sostegno degli organi politici] Lack of interest/support from political bodies; [La mancanza di interesse/sostegno della dirigenza del Comune] The lack of interest/support of the management of the Municipality; [La mancanza di un referente stabile in altri Enti Pubblici coinvolti] The lack of a stable contact in other public bodies involved; [La mancanza di interesse/sostegno del personale negli altri Enti coinvolti] Lack of staff interest/support in the other bodies involved.

*Answers:* 1; 2; 3; 4; 5

### Question 33

[Avete intenzione di attivare progetti d'integrazione dei dati nei prossimi 12 mesi?]

Do you intend to start integration projects in the next 12 months?

*Answers:* [Si] Yes; [No] No

## 5.2.2. Case studies analysis

Our research questions are focused on the practical interventions to increase the quality of e-governance. Particularly, we want to investigate the necessary steps to increase interoperability in the public sector through the implementation of an interoperability framework. To comply with this goal, we decided to develop four case studies on virtuous countries through interviews with experts that work in the field of e-governance and interoperability, and the additional exploration of institutional websites.

We have contacted 64 experts from governmental agencies and ministries of Denmark, Estonia, the Netherlands and Sweden, to participate to an interview on the topic of

interoperability in the public sector. We received an answer from 11 of them and managed to conduct the interviews.

The interviews were semi-structured, meaning that during the meeting we adjusted the order and the structure of the questions based on the conversation with the interviewees. The protocol was structured as follows:

<i>Role and organization</i>
1) What kind of organization is ... (organization name)? Is it a public organization, or a private organization? If it is private, what is the relationship with the government? Is it totally private or is it controlled by the state?
2) Tell us more about your role. What do you do? What are your tasks and goals?
<i>Interoperability</i>
1) What is the current level of (database) interoperability between PA databases in your country?
2) Which are the interventions that you made in the field of interoperability? Which "steps" did you follow?
3) How did you spread out (unfold, deploy) interoperability? Were guidelines provided to regional and local governments (by your organization or other), and was the adoption of interoperability standards incentivized through targeted programs?

<p>4) Did your organization directly finance interoperability projects of PAs? Did you give other type of support to local PAs for their interoperability interventions?</p>
<p>5) From which administration did you start? (School, public health, ...)</p>
<p>6) Which are the other administrations you coordinated with during this process?</p>
<p>7) What kind of funds did you use? Did you use budget funds or European funds? How much?</p>
<p>8) Did you plan a long-term program for interoperability, or did you proceed by punctual (siloed) projects?</p>
<p>9) Deepening more technical aspects of interoperability, did you migrate databases on the cloud (or in a single common database), or did you create interoperability by interconnecting the separate PAs' databases (through APIs)?</p>
<p>10) How about the managerial and organizational implications of the interoperability interventions? Did the PAs intervene also in changing internal processes, introducing new responsibilities for the new managed data or modified the procedure for delivering services to citizens?</p>

Table 8: Interview protocol



The interviews were conducted during October and November 2022 and lasted approximately 30-50 minutes each. To provide a context around the interviews we conducted hereafter are reported some information about the interviewees:

<i>Country</i>	<i>Organization</i>	<i>Role</i>	<i>Date</i>
Denmark	Agency for Digital Government	Chief Consultant and Chief Architect for Federal Digital Architecture (FDA)	06/10/2022
Denmark	Agency for Digital Government	Division for International Coordination	28/10/2022
Estonia	e-Governance Academy	Senior Expert on e-Democracy	05/10/2022
Estonia	e-Governance Academy	Director of e-Government Technologies and Member of the Management Board	11/10/2022
Estonia	e-Estonia	Digital Transformation Adviser	01/11/2022
Sweden	DelaDigitalt	SKR Responsible (Swedish Association of Local Authorities and Regions)	04/10/2022

Sweden	Swedish National Financial Management Authority	Central Government Accounting and Management: leader of the Data Lab.	06/10/2022
Sweden	Agency for Digital Government	Information Architect on Digital Development	14/10/2022
Sweden	Sambruk	Executive Officer	17/10/2022
Netherlands	ICTU	Senior Advisor Digital Services & Transformation	31/10/2022
Netherlands	ICTU	Strategic Advisor Digital Services & Transformation	31/10/2022

Table 9: Interviewees details

## 6 Conclusions and future developments

The research for our master thesis started with the deepening of the proactivity concept. We understood that the governmental use of proactive services has a huge impact on citizens' lives but at the same time, to be actuated, requires a lot of preliminary work. Particularly the availability of an interoperable infrastructure is mandatory, since in order to implement proactive services the flow of huge amounts of data are required. Thus, our research moved to the study of interoperability, the literature review allowed us to understand the interoperability concept and the different frameworks, available in the literature and published by national and international institutions. The framework analysis made us comprehend the different interoperability aspects such as legal, organizational, semantic and technical.

The literature gap involves the actual interoperability implementation, meaning the actions that a country has to perform in order to achieve a good level of legal, organizational, semantic and technical interoperability. Through the empirical analysis we performed, we aimed at filling this gap. The interviews with e-government experts allowed us to draft comprehensive case studies on four EU countries, namely Denmark, Estonia, the Netherlands and Sweden. The analysis of these countries' digital journeys and key interoperability interventions allowed us to gather the common characteristics of their paths and to cluster them in six intervention areas. The first one is the digitalization approach, countries in order to successfully develop their e-government have to start by digitalizing the services that most benefit citizens and businesses to facilitate the services' usage and their spreading in the society. The second one is collaboration, it is fundamental to create and nurture it between the different public entities, particularly all the experts stressed the necessity to engage all the administrations involved in an interoperability project since the beginning in order to create a community. The third one is technical interventions, here all the fundamental interventions regarding the infrastructure are stated: the development of a digital infrastructure, the introduction of a single digital identification, the availability of basic data, the harmonization and standardization of data formats and the creation of a single point of contact with the citizen. The fourth one is legal interventions, legal efforts need to go hand in hand with the infrastructural development to facilitate public agency adherence to the interventions, specifically regulation regarding data are fundamental. The fifth one is related to incentives that are crucial and facilitate the interoperability intervention implementation, they can be intrinsic, originating due to a sense of community, or extrinsic, originating from

monetary motivations. The sixth one is financing structure, all the countries interviewed complement the EU funds with budget ones, but they implement different financing strategies.

This research is subject, of course, to some limitations that suggest potential hints for future research. The contribution given through this study, is made possible, among others, by the experts' interviews. With this respect, a possible limitation of this work is the limited number of experts interviewed for each country. A possible development could be exactly the extension of the analysis on more candidates in order to be able to draw some more detailed conclusions regarding the steps and interventions that the countries with the most advanced public sector undertook. Additionally, the chosen countries for the analysis are all in the EU and this limits the scope of the analysis since very advanced public sectors like Taiwan's and New Zealand's are excluded. Connected to this, another limitation is the restricted institutional and cultural context in which we conducted this study. Despite their differences, the analyzed countries have similar characteristics such as limited extension or limited number of public bodies compared to other EU public sectors. Therefore, the low variety in the countries' choice and in their characteristics, could have led us to draw guidelines that works just in specific contexts. Diversity and variety of the countries to analyze should not be related only to the national, institutional or political characteristics, but also, to the stage of the digital journey the country is. The performed case studies were all of countries that started their digitalization and innovation process of the public sector many years ago, therefore they are quite advanced in the process. Including in the research countries with different experience in this sense would have enriched the guidelines and the intervention areas that we developed, better supporting other governments that has just start the process in overcoming the initial challenges.

The limitations of the study could suggest some potential future developments of the interoperability research. Surely, since this study was limited in size, it could be extended analyzing, as already stated, international countries with a strong e-government infrastructure and a consistent interoperability level. This enables to include more variety in terms of country characteristics, institutional, cultural, political context, challenges that the countries have to face, and interventions designed to succeed.

The intent of the study was to investigate how to practically implement interoperability and the guidelines and principles that frameworks, like the EIF, proposed and, therefore, in pursuing this goal, it was considered the broadest perspective of interoperability which include all its perspectives and layers. Future research could take the results we presented as a reference upon which building future analysis in order to develop new models specifically targeting a single perspective or layer of interoperability (i.e., technical, semantic organizational or legal) capable of giving more punctual results concerning a specific area of interventions.

Given the purpose of the research, in order to provide guidance to government and PAs, we investigated digitalization and interoperability in the public sector, without exploring digitalization, interoperability and data exchange in the private sector. In our opinion, best practices and successful cases from the private sector and private companies exist and some of them could be transferred and applied in the public sector, especially from the big tech companies with a large experience in data usage, collection, exchange as well as data-driven decisions. Exactly as a private business, that needs to innovate its strategy or products to bring something new to its customer, looks and takes hints from successful companies of other industries, also governments and PAs need to look at enterprises from corporate world to find guidance on the path and steps to take to enhance interoperability and the functioning of their public sectors.

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