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A multi-dimensional framework to evaluate the innovation potential of digital public services

A step towards building an Innovative Public Services Observatory in the EU

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Foreword

This report presents the results of a study conducted under the action 2018.01 "Innovative Public Services" (IPS) of the ISA² Programme[1] - Interoperability solutions for Public Administrations, businesses and citizens. The programme, coordinated by the Directorate General of Informatics (DIGIT) has, among others, the purpose to support the digital transformation of the EU public sector, facilitating the deployment and use of digital technologies, by proposing concrete interoperable solutions and identifying best practices to facilitate cross-border and cross-domain interoperability.

More specifically, the IPS action has the objective to assess the role that new and less new digital technologies can play in the transformation of Public Services and propose interoperable innovative solutions and support their piloting.

The aim of this study was to conduct a desk and field research on available evidence supporting European Public Administrations willing to embrace new digital technologies and deliver innovative public services according to the 4 layers of the European Interoperability Framework (EIF) and in alignment with the user centricity principles defined in the Tallinn Declaration in 2017, to ensure that adoption of new technologies do not lead to creation of new silos.

The main outcome of the study is an original multi-dimensional framework for evaluating digital readiness, interoperability, and user-centricity of innovative public services. The framework was conceptualised and tested in the context of the research funded by DIGIT, supervised in collaboration with the JRC and conducted by KPMG Italy.

The results of the research resonate well with the core principles of the ISA² Programme, which is in itself one of the instruments to support Digital Government Transformation in the EU, through stimulating cross-fertilisation among Member States, promoting exchange of practices and sharing of knowledge and digital solutions.

In this regard, it is worth noticing that the idea of the study originated when we met in June 2018 in Brussels at the "Future in the making" conference of the Future-Oriented Technology Analysis (FTA) series organised by JRC. Two years later, we can say that after that discussion we have completed the first step of the future that we planned.

The results of the work initiated with this study were instrumental to formalise a strengthened collaboration between DIGIT and JRC, as part of the IPS Action of the ISA[2] Programme now co-led also with CONNECT colleagues, and somehow 'upgraded' to become a tool to support the development of the future Digital Government policy.

In its communication "Shaping Europe's Digital Future[2], the Commission calls for a reinforced EU governments interoperability strategy and a strengthened EIF for the end of 2021. In this way, the orientation outlined in the Digital Europe Programme (DEP) have confirmed interoperability as a crucial aspect to be addressed, not only from a technical perspective, rather giving a more prominent role to the inherent governance dimensions of public sector innovation and to the public values generated by digital public services.

As the findings from this study show, not only organisational and legal aspects need to support the digital transformation, but they must be in its core as an essential part of the next EU Governments Interoperability Strategy, to guarantee adoption of innovative public services and societal impact.

[1] https://ec.europa.eu/isa2/isa2_en
[2] https://ec.europa.eu/digital-single-market/en/content/european-digital-strategy

In fact, based on the results of this research, even the most promising technologies still present several challenges, in terms of technological readiness, interoperability and user centricity. EU governments at all levels need to invest significantly to remove existing barriers, in order to provide seamless access to public services in line with citizens and businesses expectations.

The framework proposed was outlined to contribute as a first step to develop a practical instrument to monitor and assess the multiple dimensions of technological readiness and interoperability of innovative digital public services and respond to the user-centricity challenges faced when implementing Digital Government across the EU.

To this end, it paved the way to enhanced cooperation between DIGIT and JRC, which resulted in the establishment of an Administrative Arrangement to conduct a feasibility study to set up an EU Innovative Public Services Observatory (IPSO).

This exploratory research, implemented under the IPS Action of the ISA^2 Programme for the period 2020-2021, aims at assessing the potential for formulating an initiative at European level to support the innovation of public services with the help of emerging and disruptive technologies.

The framework, proposed in this report and tested against a number of concrete cases and promising pilots in EU Member States, should thus be considered a preparatory work to further develop the IPS Observatory and assess the innovation potential of digital services in terms of their comprehensive technological readiness, interoperability and user-centricity dimensions.

It is also complementary to other ways of measuring the progress of EU Member States towards the full digitalisation of public services, such as the yearly eGovernment Benchmark, which monitors and rates the maturity of online public services in terms of user centricity, transparency, and other key enablers.

Future research to be conducted within the context of the work stream of the IPS Action coordinated by JRC and DIGIT should thus focus, in collaboration with CONNECT and other relevant policy DGs, on further increasing the knowledge base that is being created and make sure that it could be easily used and constantly updated.

In this perspective, it is however pivotal to preserve the methodological rigour of the proposed framework, which should be the basis for developing technical and operational guidelines for Innovative Public Services in the EU and, in turn, contribute advance theory and practice of Digital Government Transformation and Public Sector Innovation.

In doing so, when we meet at the next FTA conference, we hope the IPS Observatory will be operational and digital by default, interoperable cross-border seamless innovative public services will be a closer reality and at all levels of governance across Europe.

Gianluca Misuraca and Georges Lobo

Acknowledgements

This report summarises the key actionable results of a Study conducted by KPMG Italy for the European Commission's DIGIT in collaboration with JRC in execution of a Framework Contract part of the ISA² Programme - Action 2018.01 "Innovative Public Services" (IPS).

The authors and editors of this report are grateful to the experts and colleagues who provided input to the Study deliverables, in particular Yannis Charalabidis, who supported us on the taxonomy and analysis of technologies and interoperability issues, Elio De Tullio, who focused on legal aspects of pilots assessment, Cristina Cosma, policy officer at DIGIT, and Andrea Perego, former Scientific Officer at JRC, for their feedback.

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Finally, we would like to express our special thanks to Natalia Aristimuño-Pérez, Head of the Interoperability Unit and Alessandro Annoni, former Head of the Digital Economy Unit, for their guidance in the setting up of the follow-up activities of this study, that we expect will lead to the establishment of the EU Innovative Public Services Observatory.

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Executive Summary

Nowhere like in the European Union is digital transformation playing a decisive role in the present and future evolution of our economy and society. 5 years before the outbreak of the Covid-19 pandemic, the intuition that connecting people, communities, businesses and governments by the use of Information and Communication Technologies (ICTs) would help create and reinforce a supranational sociocultural system and therefore strengthen the feeling of European identity was already evident in the European Commission priorities.

A digital single market for online transactions would constitute an invaluable opportunity for new and existing enterprises to grow and boost the generation of more numerous quality jobs. Citizens could and should be empowered in their capacity and skills to take full benefit of the Information Society, including by seamless access to news and social media on their mobile and smart devices, irrelevant of the country of residence. Government bodies at all levels (from local to regional and national) in all Member States were and are asked to digitalise existing public services and create new, natively online, facilities to increase their perceived quality, openness, diffusion and acceptance. In addition to interoperability and user centricity, a peculiar metric adopted since long in the EU eGovernment benchmark is "cross-border service delivery", which again clearly points at a future where location will no longer be determinant for the exercise of citizens' rights.

Indeed, in a well-functioning digitally transformed economy and society, public services at all levels need to be able to 'follow' their users' needs across administrative entities, policy sectors and country borders. More generally, digital transformation of the public sector is as important for renewing its relationship with economic and societal players as it is for the improvement of the efficiency and effectiveness of internal policy, governance and service delivery processes. However, recent research conducted at the JRC (Misuraca, Ed., 2019) shows that a big gap still exists between expectations and achievements. Not by chance, digitalisation remains a cornerstone of the new European Commission's 5-year strategy, which the Covid-19 global crisis has only added more reasons to. In this context, further support needs to be given to the widespread adoption and implementation of digital solutions in the local, regional and national Public Administration.

A typical approach followed by government bodies and agencies innovating their processes is built on the execution of pilot projects. These are small-scale experiments meant to reduce the costs and risks inherent to a diffused introduction of new technologies or other elements of transformation of the "machinery" of Public Administration, its functioning and input and output. By definition, pilot projects are more likely to be a failure, rather than a success. Whatever the outcomes, their "owners" – responsible persons of the execution and sometimes evaluation of pilot results – are expected to learn useful lessons from them, which will possibly be shared with a broader audience on due time and are supposed to be useful (and used) internally to support the decision of whether and how to follow up. Most of these pilot projects are financially supported by third party grants, such as from the EU research, innovation, or territorial cooperation programmes. Such circumstance does not only contribute to further reducing the costs (and to some extent the risks) of technology introduction, but also provides the best guarantee that pilot results will be shared widely on the occasion of the periodic and final reports to the funding agencies.

Unfortunately, and as the aforementioned JRC research also documented, the propensity of pilot owners to share results and lessons learned in a structured manner is quite limited and this adds noise to the evaluation of scalability potentials, not to mention the difficulty of defining reliable reuse or transfer pathways involving other public sector organisations than those in the original pilots. This lack of information is particularly

undesired in case of new and emerging technologies, such as blockchain or Artificial Intelligence, which naturally lend themselves to being trialled in very similar – yet never too much – pilot contexts, thus increasing the risk of "reinventing the wheel" – i.e. of duplication, if not proliferation, of limited size experiments.

To that end, the present study started with identifying 8 thematic clusters of relevant digital technologies, both mature and emerging, for the European public sector and examining their potentialities and constraints in terms of service delivery, governance and policy making by focusing on key interoperability and user centricity aspects. More specifically, scores were assigned to each technology cluster on the most significant interoperability issues and risks to argue about the presence of current or potential barriers preventing the full achievement of interoperability targets. Similarly, for each identified cluster of technologies, we also rated and commented the level of adherence to the 8 user centricity principles of the Tallinn Declaration.

Then, the Study team moved to create a broad collection of 150+ meaningful pilot projects from 24 European countries, covering all the 8 technology areas identified previously. As expected, many pilots pertained to EU funded initiatives, such as H2020 and territorial cooperation. The collection was intended to showcase the innovative public services that are currently being developed and/or tested across the EU harnessing the technologies previously identified. Around 80 pilots were selected for deeper analysis.

To carry out the assessment in a replicable fashion, we adopted a dynamically oriented and semi-quantitative approach, based on measuring the "*transition pathways*" that the pilots experienced across time (from t_0, before the pilot start, to t_1, at the pilot end), under 4 distinct "readiness" dimensions: technological, societal, organisational and legal, as well as to assess their attention to user-centricity principles and interoperability aspects. The original aspect of this exercise has been to highlight the crucial importance of all these aspects for the analysis of pilot results, contrary to the conventional wisdom giving differentiated weights – if not only a partial consideration – to those less directly related to the goal of technology trialling. In fact, it turned out that 31 innovative public service initiatives could be defined "successful", as they presented high and convergent scores (around 7-8 on a scale of 9) for all 4 readiness levels at the end of the testing phase. Additionally, those initiatives showed good interoperability levels (2-3 on a scale of 4) and satisfied the majority (5 out of 8) of user centricity principles.

Finally, the research team identified two promising pilots to be studied more in depth, namely IO App and Dublinked. These were further analysed in cooperation with project owners and preliminary advices for possible replication at EU level were outlined.

Globally, the multi-dimensional framework presented in this report proved to be a useful tool to evaluate the success or failure of public service digitalisation projects. Looking at their evolution over time, it was possible to conclude that the pilots showing low scores in the 4 readiness levels at the beginning of their activities and capable of reaching high scores at the end, were those most likely to produce the greatest impacts on government modernisation processes. Conversely, the absence of a strict correlation among the trends of improvement of these 4 dimensions quite often led to classify the pilot as a failure. This means that at the end of the experimentation, significant gaps were affecting either the technological, societal, organisational or legal aspects of the testing environment, in such a way that could not be neglected.

We can conclude that this framework is a good complement to other ways of measuring the progress of EU Member States towards the full digitalisation of public services, such as the yearly eGovernment Benchmark, which monitors and rates the maturity of online public services in terms of user centricity, transparency, and other key enablers. Further research activities should be undertaken to expand the size of the current knowledge base and enhance the use of the framework to predict the scaling up potential of newly started innovative projects, based on the experience gained by looking into the existing pilots with the aim of building an Innovative Public Services Observatory in the EU.

1 Introduction

Digitalisation is widely considered as a major driver of innovation, growth, modernisation and societal progress. It is a transversal phenomenon, affecting all areas of the economy and communitarian life, including, but not limited to, the public sector. Technically speaking, digitalisation is other than digitisation, although the two terms are often confused or used interchangeably. In fact, digitisation means the conversion of existing information formats from analogue to machine readable[3], a trend that has been with us since the late 20th century. Instead, digitalisation – quite often also referred to as digital transformation – is a more modern phenomenon, alluding to a change in the "way of thinking"[4], even before actually "going digital", i.e. starting to use digital technologies to innovate how products or services are designed, manufactured, delivered or consumed. No surprise then that the younger generations are usually pointed at as "digital natives"[5] and that digitalisation of the communication spaces of European citizens has been often mentioned as the embryo of a (still missing) single European public sphere, cutting across the differences in cultures, languages, legislations and social organisations between Member States.

As predicted in the **Europe 2020 strategy**, a digital single market for online transactions would constitute an invaluable opportunity for new and existing enterprises to grow and boost the generation of more numerous quality jobs. European citizens could and should be empowered in their capacity and skills to take full benefit of the information society, including by seamless access to news and social media on their mobile and smart devices, irrelevant of the country of residence. Government bodies at all levels (from local to regional and national) in all Member States were and are asked to digitalise existing public services and create new, natively online, facilities to increase their perceived quality, openness, diffusion and acceptance. In addition to interoperability and user centricity, a peculiar metric adopted since long in the **EU eGovernment benchmark**[6] is "cross-border service delivery", which again clearly points at a future where location will no longer be determinant for the exercise of European citizens' rights.

The **Tallinn Declaration on eGovernment,** signed in 2017, has been an important step in that direction: all Member States officially endorsed "the digital transformation of the Public Administration" as their "collective endeavour at national, regional and local levels" with the ultimate aim of putting "the end-users – citizens, businesses, public sector employees – truly at the centre of services." But there is more: digitalisation of public services ensures noteworthy savings of financial resources, giving new meanings to the well-known definitions of efficiency, effectiveness, and quality of government.

Another key element to take into consideration in the development and delivery of digital public services is interoperability. This is defined by the new **European Interoperability Framework (EIF)** as "the ability of Public Administrations, any entity acting on their behalf or EU institutions or bodies, to interact towards mutually beneficial goals, involving the sharing of information and knowledge between these organisations,

[3] See https://en.wikipedia.org/wiki/Digitization
[4] Marek Kowalkiewicz, The transformational difference between ditisation and digitalisation, Medium.com post, 27 October 2017. Retrieved online at: https://medium.com/qut-cde/digitise-or-digitalise-584c953e2d8
[5] Marc Prensky, Digital Natives, Digital Immigrants, article originally published in 2001. Retrieved online at: http://www.marcprensky.com/writing/Prensky - Digital Natives, Digital Immigrants - Part1.pdf
[6] https://op.europa.eu/en/publication-detail/-/publication/c896937b-f554-11e9-8c1f-01aa75ed71a1

through the business processes they support, by means of the exchange of data between their ICT systems."[7]

Indeed, in a well-functioning digitally transformed economy and society, public services at all levels need to be able to 'follow' their users' needs across administrative entities, policy sectors and country borders. More generally, digital transformation of the public sector is as important for renewing its relationship with economic and societal players as it is for the improvement of the efficiency and effectiveness of internal policy, governance and service delivery processes. However, recent research conducted at the JRC[8] shows that a big gap still exists between expectations and achievements.

Not by chance, digitalisation remains a cornerstone of the new European Commission's 5-year strategy, which the Covid-19 global crisis has only added more reasons to. Already in her first 100 days of mandate, President Ursula von der Leyen has given new momentum to **Shaping Europe's Digital Future**[9] through a pathbreaking **White Paper on Artificial Intelligence**[10] and a new **European strategy for data**[11], both aimed to build "A Europe fit for the digital Age", making digital transformation work for all citizens and businesses, while helping to achieve the target of a climate-neutral Europe by 2050.

In this evolving context, further support needs to be given to the widespread adoption and implementation of digital solutions in the local, regional and national Public Administration.

In fact, as shown in the **2020 Digital Economy and Society Index for e-Government (DESI)**[12]**,** based on 2019 data and assessing the status of the digital economy and society prior to the outbreak of the pandemic, both the quality and usage of government services are increasingly progressing: **today 67% of EU citizens use public services online.** However, differences between countries still persist: top performers such as Finland, Sweden, Netherlands and Malta are making the most of digitalisation whereas countries like Bulgaria and Greece seem to be trailing behind. The situation is even more challenging when it comes to availability and usability of cross-border services for businesses and the general public, since several barriers are still present, hampering the free mobility of data and people across Europe and the ultimately the full realisation of the Digital Single Market.

As stressed in the EIF, interoperability plays an important role in digital transformation, as it allows Public Administrations to digitally exchange data with unambiguous, shared meaning amongst themselves and with citizens and businesses. To further improve public service delivery and link similar services across Europe, digital solutions should be carefully designed considering four interoperability layers: legal, organisational, semantic and technical. These layers are meant to significantly affect digital public service delivery in the EU, from the preparation of the legislation to the organisation of Public

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[7] New European Interoperability Framework. Promoting seamless services and data flows for European public administrations. Retrieved online at https://ec.europa.eu/isa2/sites/isa/files/eif_brochure_final.pdf

[8] Barcevičius, E., Cibaitė, G., Codagnone, C., Gineikytė, V., Klimavičiūtė, L., Liva, G., Matulevič, L., Misuraca, G., Vanini, I., Editor: Misuraca, G., Exploring Digital Government transformation in the EU - Analysis of the state of the art and review of literature, EUR 29987 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-13299-8, doi:10.2760/17207, JRC118857.

[9] Shaping Europe's digital future, COM(2020) 67 final. Retrieved online at https://ec.europa.eu/info/sites/info/files/communication-shaping-europes-digital-future-feb2020_en_4.pdf

[10] White Paper on Artificial Intelligence - A European approach to excellence and trust, COM(2020) 65 final. Retrieved online at https://ec.europa.eu/info/sites/info/files/commission-white-paper-artificial-intelligence-feb2020_en.pdf

[11] A European strategy for data, COM(2020) 66 final. Retrieved online at https://ec.europa.eu/info/sites/info/files/communication-european-strategy-data-19feb2020_en.pdf

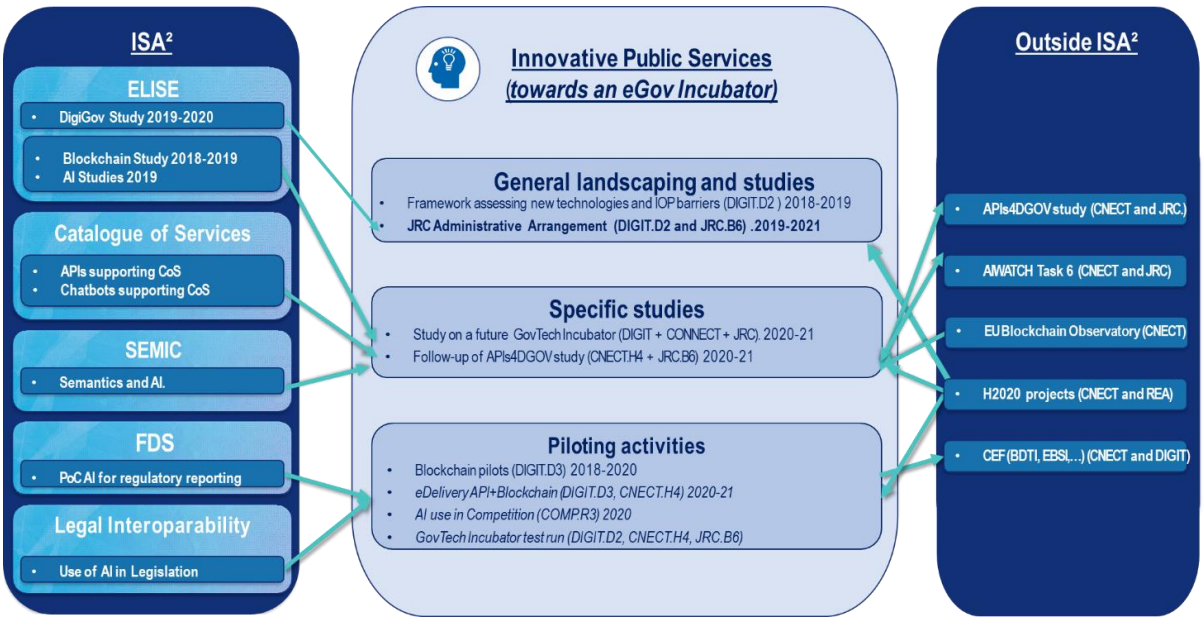
[12] https://ec.europa.eu/newsroom/dae/document.cfm?doc_id=67086

Administration processes and to the development of IT systems for the implementation of public services.

With the recommendations provided by the EIF, EU countries can follow a common and practical approach when they introduce a public service in order to make it accessible, not only within national borders, but also across countries, creating a favourable environment where Public Administrations can collaborate digitally.

Since 1999, the European Commission in accordance with the Member States has been stimulating in different ways the interchange of data between administrations. Among the key initiatives, it is worth to mention the eGovernment Action Plan 2016-2020, the eHealth Action Plan (2012-2020) and the Connecting Europe Facility (CEF). An important initiative supporting the EIF is the **ISA² Programme**[13] which is running since 2016. The Programme promotes the development of digital solutions to be made generally available for free to European Public Administrations, businesses and citizens in order for them to take benefit from interoperable, cross-border and cross-sector public services. The ISA² Programme includes several coordinated activities at EU level to develop the necessary instruments to boost interoperability such as: a revised European Interoperability Framework (EIF); a revised European Interoperability Strategy (EIS); the European Interoperability Reference Architecture (EIRA); and the European Interoperability Cartography (EIC). More recently, the **Digital Europe Programme (2021-2027**) has been launched, which includes among its objectives to promote the digital transformation of public services and their EU-wide interoperability.

The Study reported about in this publication was part of the Action 2018.01 - Innovative Public Services (IPS) of the ISA2 Programme, which includes several ongoing activities both inside and outside ISA2, as depicted in Figure 1.



Source: DIGIT

***Figure 1** - Overview of the IPS Action and related activities*

The IPS Study rests under the first group of activities ("General landscaping and studies") and had four specific objectives:

[13] https://ec.europa.eu/isa2/isa2_en

1. To identify key technologies - both mature and emerging in the public sector - and assess their potential for the design and implementation of innovative public services;
2. To evaluate the interoperability issues and user centricity aspects related to those technologies;
3. To collect evidence in terms of IPS pilots and the conditions for their success or failure;
4. To identify the most promising pilots, as successful examples of digital transformation of public services, to be shared and reused across Europe, also identifying the required activities for their further improvement.

The structure of this report follows the track of the desk and field research work carried out by the IPS Study team, which can be outlined as follows:

- **Chapter 2: Identification of relevant technologies**

  This section presents the eight thematic clusters gathering relevant technologies for the modernisation of European public services.

- **Chapter 3: Interoperability issues and user centricity aspects**

  This section presents the methods used to assess the identified eight technology areas according to their interoperability issues/risks and main user centricity challenges. It also overviews the results obtained from the application of the proposed methods to the technologies at hand.

- **Chapter 4: Readiness concepts and levels**

  This section describes the four readiness concepts and levels used to assess the IPS pilot projects under the technological, societal, organisational and legal aspects.

- **Chapter 5: Knowledge repository**

  This section overviews the MS Excel database conceived of and designed to make sure that the results of data collection could be easily used, shared and constantly updated, also by future studies, and could serve as a basis for the realisation of an Innovative Public Services Observatory in the EU, while preserving the methodological lessons learned in the form of technical and operational guidelines.

- **Chapter 6: Pilot analysis and evaluation**

  In this section the process followed for the analysis, the evaluation of each IPS pilot is described, and the main results are outlined. In particular, the criteria used to define a pilot as successful are highlighted.

- **Chapter 7: Pilot shortlisting**

  This section overviews the two pilots – Dublinked and IO App – shortlisted for further analysis in terms of readiness, interoperability and user centricity aspects.

- **Chapter 8: Final considerations and outlook**

  This section discusses the main findings of the Study and draws conclusions and recommendations for future work.

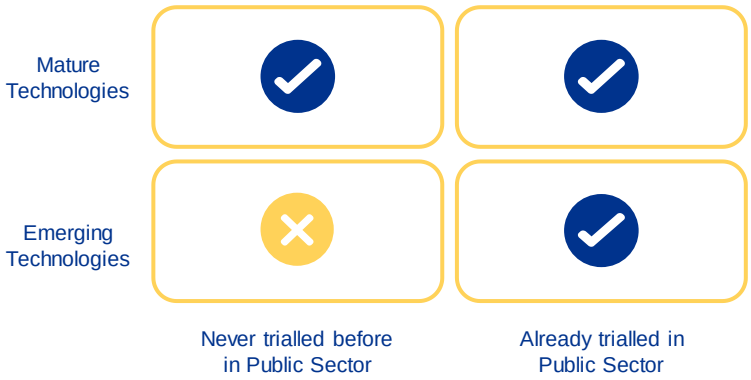
2 Identification of relevant technologies

The objective of the first Study activity was to identify the potentiality of emerging and mature technologies in the public sector as relevant for the design and implementation of digital public service provision.

To reach that objective, an extensive analysis was carried out of:

- **mature technologies** i.e. already existing in the state of the art, irrelevant to whether they had been trialled in the public sector before or not;
- **emerging technologies** under the condition that they had already been trialled in a public sector environment, so that their value could be inferred for the provision of innovative public services.

The following figure is a high-level categorisation of the technologies that have been in the scope of this analysis.



Source: authors' elaboration

***Figure 2** - Analysed technologies*

Basically, the idea was to answer the following business questions:

- BQ1: In the current landscape of technologies, which ones have been already applied to public service delivery?
- BQ2: Narrowing the focus on mature technologies, which are those potentially applicable to public service delivery?

The analysis started from an initial list of 12 technology areas. By **technology area** it was meant "*the extent of a determined technology enclosed within a specified boundary that can be subdivided into **categories** and **uses/applications***".

By **technology category** it was meant "*an exhaustive division of the technology area according to the proposed system of classification*". Finally, **uses and applications** consisted in the "*act of applying a technology to a particular purpose or use in real life*".

The 12 areas have been thoroughly discussed with the European Commission officials in charge of supervising the Study, leading to a reduction in the initial number to 8 and a better articulation of the internal components of each area, not only including categories, but also some (exemplary, non-exhaustive) related uses and applications.

The result of this endeavour, which is not intended to be a holistic taxonomy, is shown in Table 1.

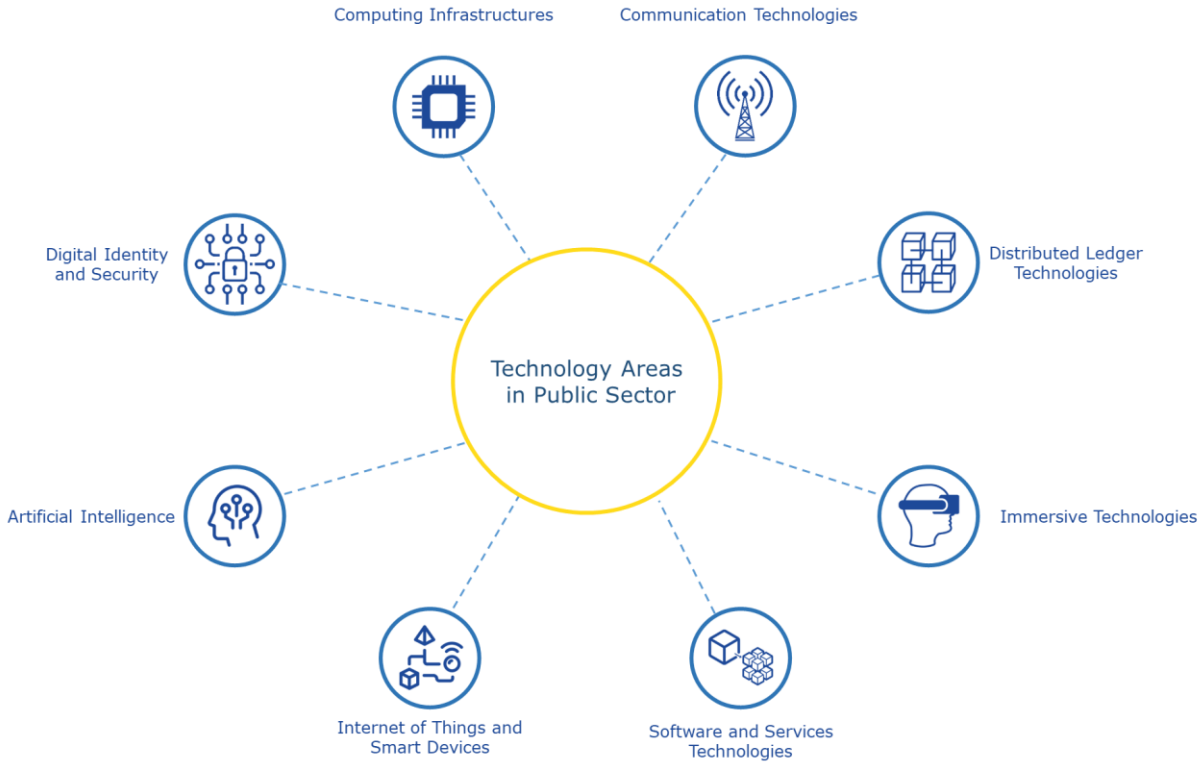
Technology Areas	Technology Categories	Technology Uses/Applications (exemplary, not exhaustive)
1. Artificial Intelligence	1.1 Robotic Process Automation	1.1 ERP System Reengineering; Smart Assistance
	1.2 Natural Language Processing, Text Mining, Computer Vision	1.2 Advanced Simulation; Autonomous Vehicles; Evidence based Decision Making; Intelligence Agents, Bots; Sentiment Analysis; Virtual Assistance
	1.3 Machine Learning, Deep Learning	1.3 Digital Twins; Evidence based Decision Making; Intelligent Agents, Bots
	1.4 Expert and Rule Based Systems	1.4 Operational Decisions in PA
	1.5 Cognitive Computing, Predictive Analytics	1.5 Big Data Analytics; E-Procurement; Government Efficiency
2. Communication Technologies	2.1 5G Networks and Handheld Devices	2.1 Big Data Streaming; HQ Multimedia (training UX); Real-time Data Processing
	2.2 Software Defined Networks	2.2 Programmable Networks; Network Visualisation
3. Computing Infrastructures	3.1 High Performance Computing	3.1 Advanced Simulations and Visualisation
	3.2 Cloud Computing	3.2 Backup; Big Data Processing; Disaster Recovery; File Storage; Real-time Data Processing; Test and Development
	3.3 Edge Computing	3.3 Autonomous Vehicles; Financial Sector; Healthcare; Industrial Manufacturing; Smart Cities
4. Distributed Ledger Technologies	4.1 Blockchain	4.1 Cryptocurrencies and Token; Distributed Governmental Registries; Distributed Multi-user Applications; e-Voting (certification); Intellectual Property Rights; Personal Information Recording and Security (i.e. BSc, MSc, certifications, personal health information
	4.2 Other Distributed Ledger Technologies	4.2 e-Procurement; ID Identification; Smart Contracts
5. Digital Identity and Security	5.1 Firewall and Protocols	5.1 Business Security; Environmental Security; Human Resources Security; Protocol Security; Secure Exchanges and Transactions

Technology Areas	Technology Categories	Technology Uses/Applications (exemplary, not exhaustive)
	5.2 Antivirus and Vulnerability Scanners	5.2 Backup Files Disclosure; File Disclosure; File Inclusion; Language based Security; Machine Learning and Artificial Intelligence Security; Vulnerability Discover
	5.3 Biometric Screening	5.3 Biometric Analysis and Monitoring; Border Control; ID Identification; Public Safety; Video Surveillance
	5.4 Cloud-oriented Cybersecurity	5.4 Privacy by Design
	5.5 Advanced User Analytics	5.5 Fraud Prevention; Vulnerabilities Detection
	5.6 Mobile ID	5.6 Advanced, Proactive Public Services; User / Citizen Identification
	5.7 Digital Identity Frameworks	5.7 Authentication and Trust Frameworks (eIDAS); Digital Signature; e-Voting; Financial and Commercial Transactions Security; Gaming & Gambling; Security Framework for Internet of Things and Blockchain
6. Immersive Technologies	6.1 Augmented Reality	6.1 Employee and User Training; Next Generation User Experience; Gamification; Rich Experience Intelligent Agents
	6.2 Virtual Reality	6.2 Employee and User Training; Next Generation User Experience; Gamification; Rich Experience Intelligent Agents
7. Internet of Things and Smart Devices	7.1 Mobile Devices, Wearables and Sensors	7.1 Drones and Autonomous Vehicles; Electronic Appliances; Robots; Speaker Systems
	7.2 Internet of Things Platforms	7.2 Analytics; Data Management; Devices Connection; Smart Cities; Smart Homes; Smart Personal Living
8. Software and Service Technologies	8.1 APIs, Web Services, Microservices including Registries and Marketplace	8.1 Software Integration; System Integration
	8.2 Enterprise Service Bus Technologies and Government Service Utilities	8.2 Linked Data Collection, Processing and Diffusion; Open Data Collection, Processing and Diffusion; Next Generation Public Service Provision Models; Proactive Service Provision

Table 1 *- Technology Areas, Categories and Uses/Applications (authors' elaboration)*

In line with this representation, the following figure (Source: authors' elaboration

Figure 3) shows the technology areas selected as relevant, with respect to the purpose of the project.



Source: authors' elaboration

***Figure 3** - Technology areas supporting public service delivery*

3 Interoperability issues and user centricity aspects

Once the thematic clustering was finalised of relevant digital technologies, both mature and emerging, for the European public sector, the next activity was aimed at examining their potentialities and constraints in terms of service delivery, governance and policymaking by focusing on key interoperability and user centricity aspects.

Basically, the idea was to answer the following business question:

- BQ3: What is the current or prospective impact of those technologies on the design and implementation of digital public service provision (assessed in particular with regards to interoperability and user centricity principles)?

This section briefly overviews the methods used to assess the identified eight technology areas according to their interoperability issues/risks and major user centricity challenges and the results obtained from the exercise.

3.1 Interoperability assessment method

The adopted method focused on the 4 layers of the EIF Interoperability Model[14] that are relevant to the process of establishing interoperable European public services.

The EIF promotes electronic communication among European Public Administrations and stresses the importance to address interoperability issues according to a holistic approach, based on 12 principles, and keeping into account the four layers presented in the following Table.

Interoperability Layers	Description
Legal Interoperability	It represents how the provision of a European public service works within its own national legal framework. Legal interoperability is about ensuring that organisations operating under different legal frameworks, policies and strategies are able to work together and reuse innovative public solutions.
Organisational Interoperability	It refers to the way in which Public Administrations align their business processes, responsibilities and expectations to achieve commonly agreed and mutually beneficial goals.
Semantic Interoperability	It ensures that the precise format and meaning of exchanged data and information is preserved and understood throughout exchanges between Public Administrations, in other words "what is sent, is what is understood" and it is analysed by the semantic and syntactic aspects.

[14] https://ec.europa.eu/isa2/sites/isa/files/eif_brochure_final.pdf

Technical Interoperability	It covers the applications and infrastructures linking systems and services. Aspects of technical interoperability include interface specifications, interconnection services, data integration services, data presentation and exchange, and secure communication protocols.

***Table 2** – 4 interoperability layers description*

The rating of interoperability was done using a 4-level scale, each of them denoting the level of caution and effort that should be exercised in ensuring interoperability along time, among European Union Member States:

- 1 – **Critical**: Important considerations have to be taken in mind for each of the technologies / areas included in the domain.
- 2 – **High**: A significant part of the existing documentation and regulation on the topic should be updated, to ensure interoperability.
- 3 – **Medium**: Some caution should be exercised, and specific references should be made / guidelines should be given in the relevant documentation (e.g. EIF, EIRA, etc.).
- 4 – **Low**: No significant interoperability issues. A general mention of technologies in the relevant interoperability documentation is enough.

3.2 User centricity assessment method

The 12 principles of the EIF Interoperability Model underline another relevant aspect to consider for the process of modernisation of European public services: the user centricity principle. User centricity is not a stand-alone EIF Principle (#6) but is closely related to two of them (#7 to #9) also concerning general user needs and expectations.

Furthermore, user centricity is identified as a key aspect in the Tallinn Declaration on eGovernment signed in 2017 by 32 Member States. Accordingly, user centricity means putting the end-users (citizens, businesses, public sector employees) truly at the centre of services through the spread of digitalisation across all policy areas.

The eight user centricity principles as acknowledged by the Tallinn Declaration are presented below in Table 3.

User Centricity Principles	***Description***
Digital Interaction	Technology gives to citizens and businesses the option to digitally interact with administrations.

Accessibility, security, availability and usability	Technology makes digital public services more accessible (including findable) and secure and can be used by all in a non-discriminatory manner, with appropriate assistance available upon need; Technology makes it so that the principles of universal design are applied to the setting up of the services and that the websites are simple to read and easy to understand; technology makes it so that the authenticity of digital public services is secured and can be recognised in a clear and consistent manner.
Reduction of the administrative burden	Technology supports Public Administrations' efforts to reduce the administrative burden on citizens and businesses, namely by optimizing and/or creating digital processes and services where relevant and possible, and by offering personalised and pro-active services; technology facilitates citizens and businesses not to be asked to provide the same information to public services more than once, in due respect of data protection rules and regulations.
Digital delivery of public services	Technology procures that public services can as much as possible and appropriate, especially upon request of the user, be fully handled online, including the provision of any evidence required to obtain a right or fulfil obligations; technology ensures that the status of service delivery can be checked online where relevant.
Citizen engagement	Technology empowers citizens and businesses to voice their views, allowing policy makers to collect new ideas, involving citizens more in the creation of public services and ultimately providing better digital public services.
Incentives for digital service use	Technology helps remove barriers to use digital public services effectively, including by extending and promoting the benefits of, for example, higher confidence, speed, effectivity and reduced costs to individuals who are able to use them.
Protection of personal data and privacy	Technology allows the handling of personal data in compliance with the GDPR and privacy requirements in the EU and at national levels, when applicable through informing citizens about the use and storage of their personal data and allowing citizens to access and ask for the correction and deletion of personal data, where appropriate.

Redress and complaint Mechanisms	This technology procures that redress mechanisms are available online and that citizens and businesses have access to complaint procedures online, while also in other available channel(s) of their choice.

Table 3 *– 8 user centricity principles description*

Similarly, to interoperability challenges, for each of the eight technology areas identified in the previous activity their user centricity status was rated, taking on a EU wide perspective. To that end, a 4-level scale was introduced, based on the following convention[15]:

1 – **Not At All**: No evidence that this specific dimension (aka principle) of user centricity is active or meaningful in the technology at hand.

2 – **To Some Extent**: Some evidence exists that such dimension (principle) is present, but there are clear and evident limits – which can be of technological or even non-technological nature – preventing a more intense or extensive occurrence of that character in the supported or facilitated public services.

3 – **To a Great Extent**: Significant evidence shows that this dimension (principle) of user centricity is active, though not reaching its full potential, as far as the associated public services are concerned.

4 – **Quite Likely So**: We can safely state that the corresponding dimension is fully operational and effective in the direction of promoting user centricity in the public services enabled by that technology area.

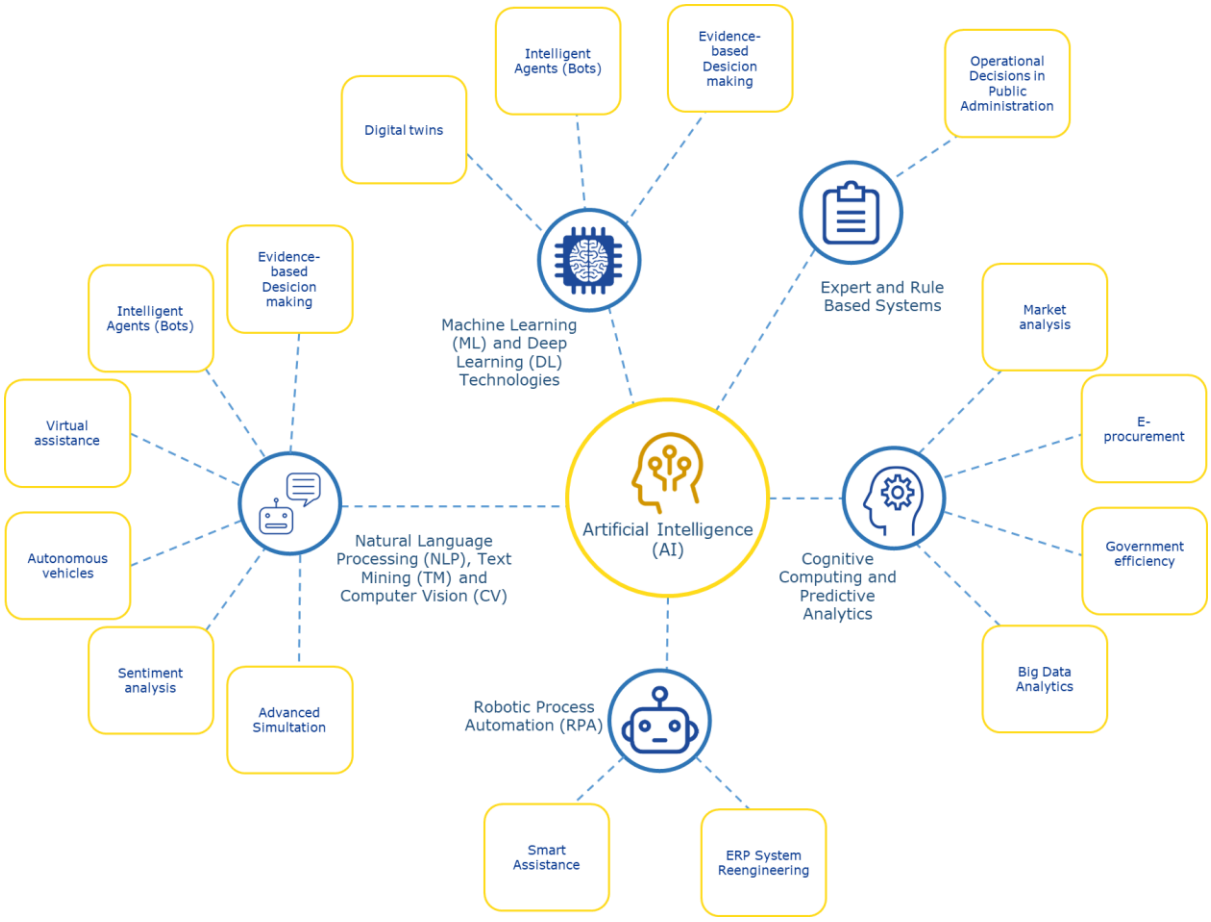
3.3 Technology assessment results

In the following subsections, we provide a detailed report of the implementation of the above methods to assess the capacity of the 8 chosen thematic clusters to be interoperable and user centric.

3.3.1 Artificial Intelligence

Artificial Intelligence (AI) applies advanced analysis and logic-based techniques to interpret events, support and automate decisions, and take actions. AI is the simulation of human intelligence processes by machines, especially computer systems. These processes may include learning (acquisition of information and rules to understand those input), reasoning (using algorithms to reach approximate or definite conclusions) and self-correction (adjust the behaviour according to conclusions). AI can be seen as an umbrella term encompassing **Machine Learning** (ML) and **Deep Learning** (DL), **Natural Language Processing** (NLP), **Text Mining** (TM) and **Computer Vision** (CV), **Cognitive Computing and Predictive Analytics**, **Expert and Rule Based Systems**, to interpret events, provide support, automate decisions and take action.

[15] In case of complex dimensions, i.e. a principle composed of a number of sub-principles, the assessment score is calculated as linear average and rounded where appropriate.



Source: authors' elaboration

Figure 4 *- Artificial Intelligence Area, Categories and Uses/Applications*

Artificial Intelligence (AI) is spreading fast and the impact on the public service delivery is approaching. Consequently, huge implications will be propagated towards the existing and foreseen interoperability documentation and guidance. Moreover, an increasing number of government agencies are considering adopting AI in the decision-making process. Thanks to AI, all governments can perform more efficiently, improving outcomes and keeping costs down.

Source: authors' elaboration

Figure 5 reports about the interoperability and user centricity assessment of Artificial Intelligence. The explanation of the evaluation is provided below.

ARTIFICIAL INTELLIGENCE Interoperability Assessment			
Legal interoperability	Organisational interoperability	Semantic interoperability	Technical interoperability
1	1	2	2

User-Centricity Assessment							
Digital interaction	Accessibility, security, availability and usability	Reduction of the administrative burden	Digital delivery of public services	Citizen Engagement	Incentives for digital service use	Protection of personal data and privacy	Redress and complaint Mechanisms
3	3	3	2	1	3	4	1,5

Source: authors' elaboration

Figure 5 *- Artificial Intelligence Interoperability and User centricity assessment*

Regarding interoperability, the main aspects to consider are both legal and organisational, pertaining to the alignment of processes but also ethical considerations and governing frameworks across the Member States.

The alignment of Member States' **legal frameworks**, ensuring that European citizens will feel "at home" in any Member States after the utilisation of Artificial Intelligence, will be a very hard task. This includes both innovation in operations (how AI will be used in the back and front office, in the long run or in real time) as well as ethical considerations (what the thresholds or limits will be), at each Member State. EC and Member States should continue to focus their efforts on the realisation of a coordinated Action Plan for AI to provide recommendations on policy and investment and to set guidelines on the ethical development of AI. This aspect is also identified in the latest EC report on AI in which it is clearly emphasised the need for a balanced regulatory framework, since many European Countries are developing national strategies to embrace AI.[16]

Moreover, **organisational interoperability** poses major challenges in the application of Artificial Intelligence within the public sector. It is unclear what will be the pan-European processes that will govern the new possibilities that Artificial Intelligence offers, such as instant decision making or deep-learning enabled, big data-based forecasting or budgeting.

For what concerns **semantic interoperability**, AI is not expected to bring extremely demanding new needs. However, fully automated service delivery, as envisaged by Artificial Intelligence applications in the public sphere, will generate more pressure for full coverage of existing semantic interoperability issues. In other words, we need to solve all the codification and semantic standardisation issues to work in an acceptable way.

Technical Interoperability is foreseen to be an important, but less critical, issue for Artificial Intelligence. Most important needs will come from the aspect of integrating AI infrastructures and dedicated systems within the overall reference architecture for Public Administrations, as well as from the ever-emerging new paradigms of utilizing AI in

[16] https://publications.jrc.ec.europa.eu/repository/bitstream/JRC113826/ai-flagship-report-online.pdf

service provision. The emergence of technical standards for AI is apparent in ISO and IEEE, in recent months. However, this is expected to be a dynamically evolving phenomenon: as more capabilities and applications will be discovered, the need for technical coordination and interoperability is bound to rise in the upcoming years.

To date, technology and semantic standardisation needs will be below the critical level, as the overall AI sphere is still rapidly expanding, and issues of AI platform interoperability or semantic codification of elements are not yet the main showstopper. Nevertheless, as AI will be penetrating every form of service provision, new needs for interoperability guidance will emerge day-by-day.

Regarding user centricity, Artificial Intelligence has the clear potential to provide citizens and businesses with the opportunity to digitally interact with Public Administrations. It holds a largely untapped potential to make digital services more accessible and secure and that can be used by everyone in a non-discriminatory way, at the same time guaranteeing a high level of data protection.

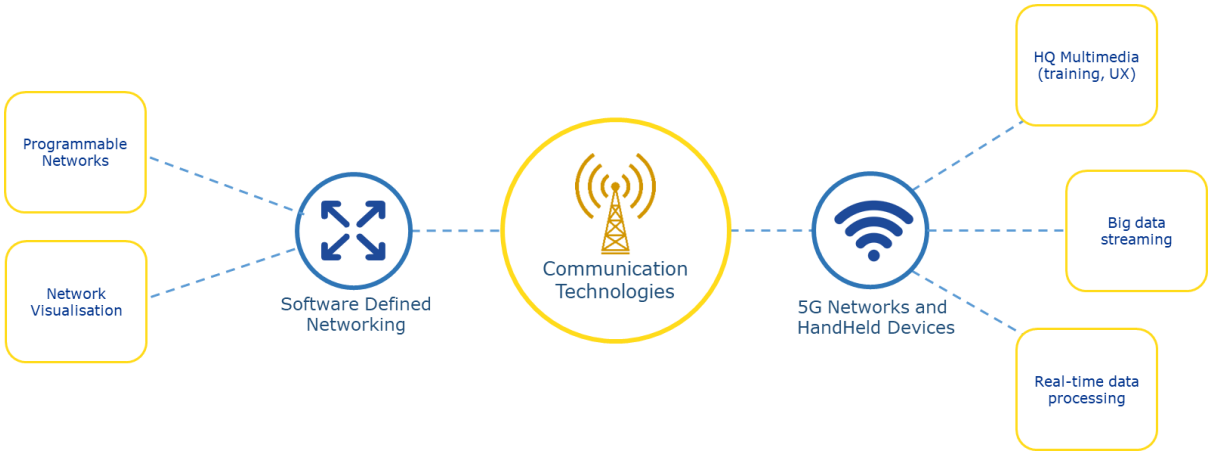
Moreover, with most of its implementations – including e.g. *Machine Learning* and *Predictive Analytics* – AI can greatly contribute to support Public Administrations efforts to restructure existing digital processes and services and/or create new ones where relevant and possible, to reduce the administrative burden on citizens and businesses. Even though Artificial Intelligence engages citizens less than other technologies used in the public sector, there are important incentives for its usage, and this is seen as a starting point to breakdown the public service barriers.

AI is probably the technology area that will mostly affect the operations of Public Administrations, businesses and citizens, in the years to come. There are several interoperability issues to be solved, specifically in legal and organisational fields, but the potential of this technology area is relevant. Governments can exploit the power of AI with the purpose to innovate or redefine policies and services to make administrative tasks as a process-driven algorithm, in order to boost efficiency and meet citizen's needs.

3.3.2 Communication Technologies

Communication Technologies refer to all equipment and programs that are used to process and communicate information. The main Categories identified within Communication Technologies are **5G Networks and Handheld Devices** and **Software Defined Network**. The first one represents a wireless technology that allows individuals to connect handheld devices (smartphone, tablet, PDAs) to a broadband internet connection wirelessly through a mobile phone network. **5G Networks** aim is to increase data communication speeds by up to 3 times compared to its predecessors.

Software Defined Networks (SDN) **is an approach to network management** that enables dynamic, flexible and programmatically efficient network configuration in order to improve current network performance. This is a new architecture that is intended to be the backbone of the 5G Infrastructure. SDN is currently much more mature than 5G and is successfully implemented for managing large datacentres and is redefining the architecture to bolster the development of the 5G ecosystem, which is still to come and will play a pivotal role in the creation of multiple network hierarchies.



Source: authors' elaboration

***Figure 6** - Communication Technologies Area, Categories and Uses/Applications*

With the introduction of 5G networks and relevant infrastructures and their large-scale deployment in the years to come, communication technologies will pave the ground for important challenges in the interoperability arena. Moreover, the novelty of 5G networks will support the promise to make digital public services more accessible and secure.

In Source: authors' elaboration

Figure 7, the interoperability and user centricity assessment of Communication Technologies is summarised. The explanation of the evaluation is provided below.

COMMUNICATION TECHNOLOGIES							
Interoperability Assessment							
Legal interoperability		Organisational interoperability		Semantic interoperability		Technical interoperability	
3		4		4		3	
User-Centricity Assessment							
Digital interaction	Accessibility, security, availability and usability	Reduction of the administrative burden	Digital delivery of public services	Citizen Engagement	Incentives for digital service use	Protection of personal data and privacy	Redress and complaint Mechanisms
3,5	3,5	3,5	3,5	3,5	3	4	2

Source: authors' elaboration

***Figure 7** - Communication Technologies Interoperability and User centricity assessment*

The analysis carried out suggests that significant efforts should be made to improve legal and technical interoperability. This relates to new services that will be made available, new devices that should be embodied in the relevant technical standardisation by Member States and possible types of services that the new infrastructure may allow.

Alignment of Member State legislation will be needed, in the areas of data roaming and cross-country exchange of information via ultra-high-speed networks, following on the existing robust regulatory framework at EU level. However, since 5G may enable completely new capabilities and services for citizens and businesses, most of the

countries will have to adapt or enhance their legislation in order to cover their alignment "by design".

Regarding **organisational interoperability**, few needs are foreseen: the governance structures are well in place in the area of Mobile Communication and regulation of Mobile Communication is well established through BEREC[17].

Semantic interoperability aspects are deemed of somewhat lower importance. Possible issues relate to the development of controlled vocabularies and code lists for various types and subtypes of communication infrastructures, in use within the various service profiles and relevant directories in Member States.

Technical interoperability issues might be important in the upcoming years, as a new generation of networks, devices, service types and final services towards citizens and businesses will evolve. Interoperability must be ensured among these new elements and layers, keeping in mind also the "mobile-first" principle for digital public services. However, the effort will not be tremendous as the current technical standardisation level at mobile (3GPP) and IoT (protocols) is deemed robust and inclusive. 5G will certainly become an enabler that will provide interoperability in the IoT connectivity paradigm.

Looking at **user centricity**, communication technologies will likely support the promise to make digital public services more accessible and secure. They can be used by everyone, in a non-discriminatory manner. Moreover, this technology area can facilitate the application of the principles of universal design to the setting up of the services, ensuring that the websites are simpler to read and easier to understand. In addition, they can contribute to making so that the authenticity of digital public services is secured and recognised in a clear and consistent manner.

Communication Technologies can contribute to support Public Administrations' efforts to restructure existing digital processes and services and have a great influence on the empowerment of citizens and businesses, reaching remote areas even where broadband is not economically viable. In general, a broader diffusion of such technologies can help to create the conditions in the public sector for setting up redress mechanisms and complaint procedures that citizens and businesses can have access to. Beyond the mobile use, 5G might revolutionise IoT networks that are largely used in the context of smart cities, maximizing the scores of several principles such as digital interaction, accessibility or citizen engagement.

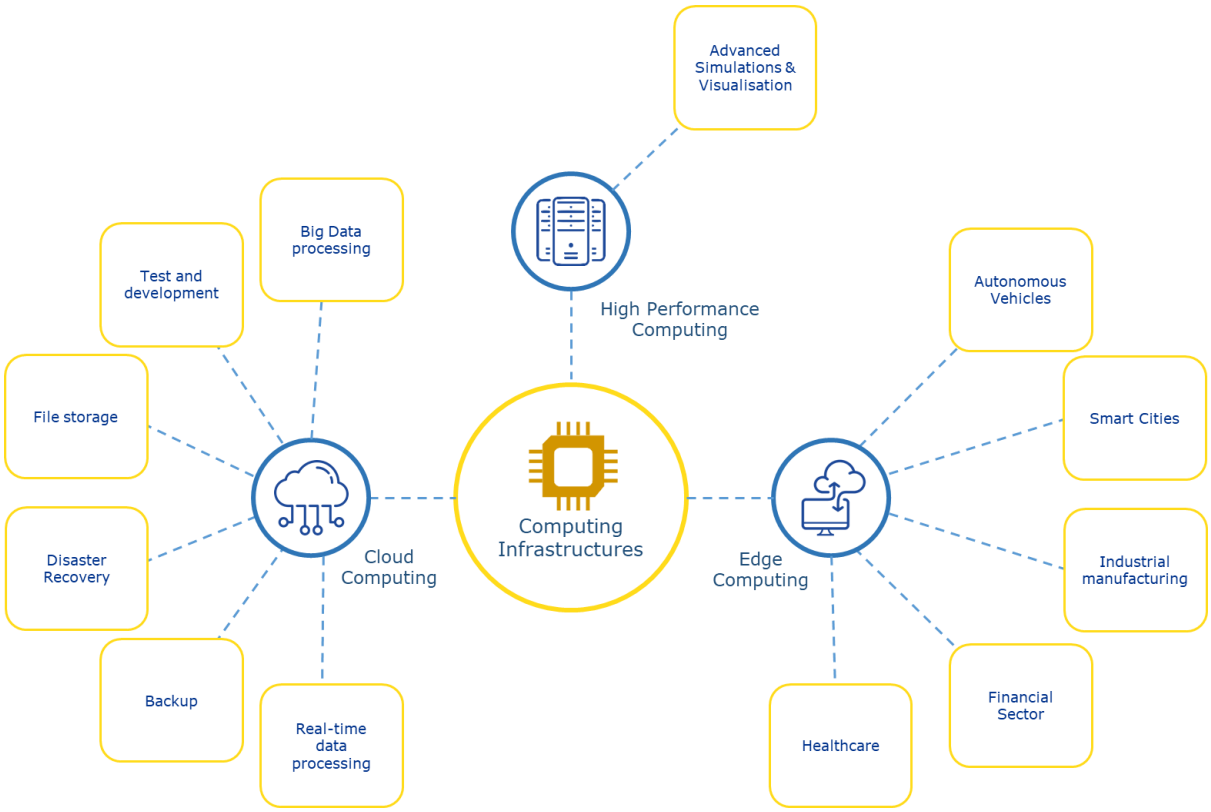
In the European context, Communication Technologies must be considered the basis for important challenges in the interoperability and user centricity fields. 5G networks as well as Software Defined Network architectures will enable, within the near future, to increasingly reach remote areas and will revolutionise IoT networks and the consequent diffusion of Smart Cities.

Regarding the interoperability layers, this technology area does not present particular issues. A specific regulating agency (BEREC) was established in order to ensure "*high quality application of the European regulatory framework for electronic communications markets*". Moreover, technical interoperability is solid thanks to the 3GPP group and to the existent protocols enabling communication between all types of devices. To ensure the full deployment of communication technologies and their future developments, consistent and coordinated efforts need to be made at a European level.

[17] Body of European Regulators for Electronic Communications: regulating agency of the telecommunication market in the European Union, composed by EC and all National Regulators.

3.3.3 Computing Infrastructures

Computing Infrastructures represent a collection of servers, networks, physical and cloud data centres and related equipment to provide a specified level of aggregate computing capacity. It provides the hardware and software that other systems and services are built on. The main categories identified are **High-Performance Computing, Cloud Computing and Edge Computing.**



Source: authors' elaboration

Figure 8 *- Computing Infrastructures Area, Categories and Uses/Applications*

The technology area of Computing Infrastructures forms the fundamental layer of the technology stack and is not foreseen to pose extreme challenges in interoperability, as most of the issues are to be dealt with in higher layers (e.g. services, applications, devices, etc.). Moreover, it is a technology area that is built with a formal and explicit attention to the user centricity principles, therefore it could considerably help governments to put users at the heart of public services.

Source: authors' elaboration

Figure 9 reports the interoperability and user centricity assessment of Computing Infrastructures. The explanation of the evaluation is provided below.

COMPUTING INFRASTRUCTURES							
Interoperability Assessment							
Legal interoperability		Organisational interoperability		Semantic interoperability		Technical interoperability	
2		3		2		2	
User-Centricity Assessment							
Digital interaction	Accessibility, security, availability and usability	Reduction of the administrative burden	Digital delivery of public services	Citizen Engagement	Incentives for digital service use	Protection of personal data and privacy	Redress and complaint Mechanisms
3	3	3	3	3	2,5	3,5	3

Source: authors' elaboration

***Figure 9** - Computing Infrastructures Interoperability and User centricity assessment*

Even if Computing infrastructures does not present notable issues, important aspects of Cloud Interoperability need to be dealt with, primary at a legal and technical level and then at organisational and semantic levels.

Regarding **legal interoperability**, a high level of interoperability guidelines is needed for the following years. These guidelines should regulate cloud interoperability at an infrastructure and platform level, give instruction for aligning the legislation on data storage and processing over the cloud and give directions on how to tackle ethical issues when using HPC infrastructures for big data processing (relating also to Artificial Intelligence).

Concerning **organisational interoperability**, medium level of interoperability guidelines is needed. Main issues include processes and process alignment for embedding cloud and/or HPC infrastructures in digital public services and internal procedures of the Member State public sector organisations. However, the procurement and selection processes for computing infrastructures by the public sector will be needing continuous adaptation, as more and more facilities will be moving towards the cloud.

Semantic interoperability aspects are deemed of medium importance. Possible issues relate to development of controlled vocabularies and code lists for various types and subtypes of computing infrastructures, in a way that they will facilitate their categorisation and (automated) comparison for selection.

Technical interoperability issues are still important, concerning HPC and cloud infrastructures, especially embracing the new edge and fog paradigms. New guidelines and items of standardisation will be needed for Member States to ensure interoperable infrastructures at a technical level. The various possible types of Cloud Infrastructures should also affect the Enterprise Interoperability Architecture and relevant guidelines. Cloud interoperability, the ability for a public sector organisation to move freely within and among cloud infrastructure providers is critical.

Regarding **user centricity**, this technology area could be considered as natively built with a formal and explicit attention to the principles listed in the Tallinn Declaration. In fact, Computing Infrastructure Technologies are ready to support Public Administrations efforts to reorganise and enhance existing digital processes that are more suitable to

citizens by offering accessible, easier, convenient and more secure digital services to users. Moreover, where relevant, this technology also offers new services and application, empowering citizen engagement. Looking at the protection of personal data, with the diffusion of Privacy by Design principles and the growing awareness of the importance of data protection, it would be impossible to conceive a Computing Infrastructure not allowing the handling of personal data in compliance with the GDPR and privacy requirements in the EU. However, as most of the Cloud providers are US based, it becomes difficult to ensure full protection of personal data and privacy, despite the GDPR.

Overall, Computing Infrastructures can support European governments to create more coherent, user-centric and digital public services for citizens and seamless efficient public sectors across Europe. In fact, as seen from the assessment, this technology does not pose critical challenges for both interoperability and user centricity aspects.

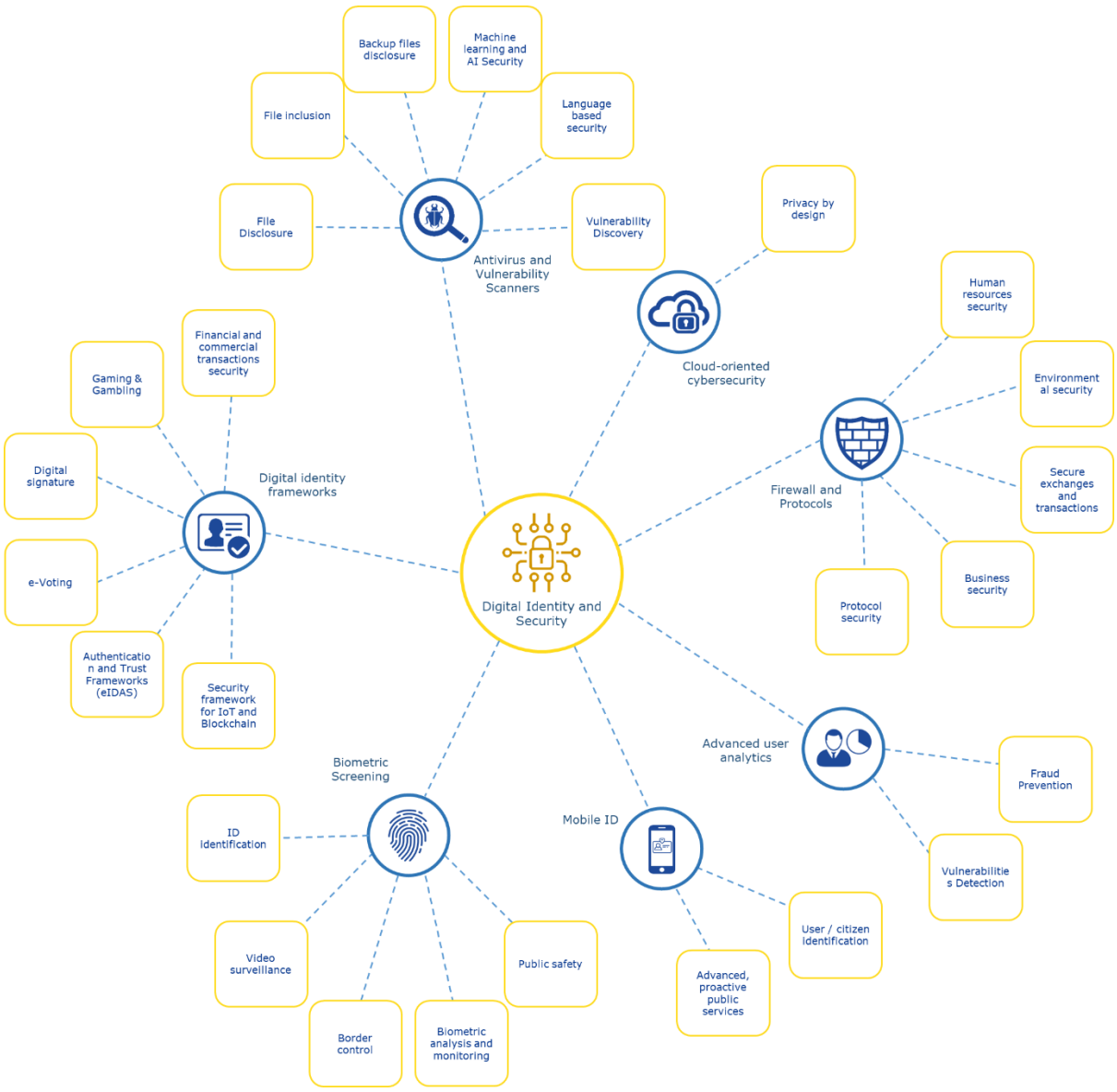
However, in the long run, specific efforts should be made to tackle legislative and technical challenges. Even if Computing Infrastructure Technologies encourage citizens and businesses to digitally interact with Public Administrations, the overall take up remain low.

The introduction of the Cloud in Public Administrations is enabling the attainment of higher quality services increasing PAs transparency and security.

3.3.4 Digital Identity and Security

Digital Identity and Security technologies englobe both ICT security and physical security guaranteed through technological tools. This area comprises a set of products, services, organisation rules and individual behaviours that protect the ICT system of an entity. The categories embedded in Digital Identity and Security are **Firewall and Protocols**, **Antivirus and Vulnerability scanners**, **Advanced user analytics**, **Biometric Screening**, **Cloud-Oriented Cybersecurity**, **Mobile ID** and ultimately **Digital Identity Frameworks**.

Digital Identity and Cyber-Security infrastructures are horizontal elements in the digital public service infrastructures of any country. Consequently, any progress in such technologies and their new applications usually affects the whole stack of digital public service provision of administrations. To date, Member States are focusing their efforts on delivering easy-to-use and secure online public services that satisfy citizens' needs.



Source: authors' elaboration

***Figure 10** - Digital Identity and Security Area, Categories and Uses/Applications*

In Source: authors' elaboration

Figure 11 the interoperability and user centricity assessment of Digital Identity and Security are reported. The explanation of the evaluation is reported below.

DIGITAL IDENTITY AND SECURITY			
Interoperability Assessment			
Legal interoperability	Organisational interoperability	Semantic interoperability	Technical interoperability
1	2	2	2

User-Centricity Assessment							
Digital interaction	Accessibility, security, availability and usability	Reduction of the administrative burden	Digital delivery of public services	Citizen Engagement	Incentives for digital service use	Protection of personal data and privacy	Redress and complaint Mechanisms
3,5	3,5	3	3	2	3	4	2

Source: authors' elaboration

Figure 11 *- Digital Identity and Security Interoperability and User centricity assessment*

Legal interoperability issues emerging from developments in Digital Identity and Security technologies are foreseen as critical. Developments beyond the eIDAS specification in Member States, which might include IoT-based identity protocols or biometrics, are bound to create interoperability standardisation challenges, by means of the needed alignment of Member State legislation to allow for interoperable operations of such new developments in all Member States. In parallel, envisaged infrastructure and data security developments in the post-GDPR era are also bound to create primarily legal interoperability challenges for the alignment of Member States' legislation both from an operational (how the new services will operate) and ethical points of view. Therefore, specific efforts must be devoted for guidelines enabling the alignment of Member States legal frameworks in new uses of devices and biometrics for digital identity, as well as for the new security analytics and cloud cyber-security.

New challenges in **organisational interoperability** will emerge from Digital Identity and Security technologies, pertaining to the embodiment of new technologies (biometrics, mobile ID, security analytics) and regulations (eIDAS, GDPR) in the public service generic models and archetypes.

Since e-ID is the common denominator in almost all digital public services, new documentation of **semantic** components around identity and security (such as types of ID's, types of data to be gathered, codifications of security-related data) will be needed. The creation of core components for digital identities for persons, devices (IoT), personas (immersive technologies), bots and agents (AI) will also be required.

With the development of new identity and security mechanisms, without considering the introduction of a multiplicity of IoT devices, AI agents and autonomous systems, the **technical standardisation** for e-identity and cyber-security needs significant updates.

For what concern user centricity, the importance to ensure data protection and to put end-users at the heart of public services has been stressed in the Tallinn Declaration.

As Computing Infrastructures, also this family of technologies can be seen as a key enabler – if not a prerequisite – of the introduction of any new digital public service or application. In that regard, the support for citizens and businesses willing to digitally interact with Public Administrations is fully evident. Indeed, there are some categories –

such as biometric screening – that have only recently emerged and thus cannot be associated with a broad documentation of cases in the European public sector yet.

Generally, Digital Identity and Security technologies are likely to significantly increase the uptake of eID by citizens, increase accessibility and participation and conduct secure, online and cross-border transactions with public and private sector entities. The eIDAS Regulation (EU No 910/2014) has encouraged the widespread and seamless use of secure eID at a European level.

This technology area does not pose extreme challenges in **user centricity**, except in the involvement of citizens in the creation of digital public services and in the procurement of redress mechanisms. Digital Identity and Security Technologies could significantly contribute to support digital interaction among citizens and businesses willing to interact with Public Administrations. However, since some technology categories have recently emerged, more research is needed to assess how these technologies foster digital interaction and how they can be used in a non-discriminatory manner.

This technology area presents interoperability challenges, above all with respect to legal aspects. In fact, European countries have varied security mechanisms for identification and authentication, which are based on different philosophies and lack cross-border recognition and validation.

Specific effort has to be invested in order to create homogeneous guidelines that enable the alignment of Member States' legal frameworks in new uses of devices and biometrics for digital identity, as well as for the new security analytics and cloud cyber-security.

Digital Identity and Security technologies are fundamental to put end-users truly at the centre of public service delivery, by improving security of services offered to the citizens and businesses and assuring personal data protection.

3.3.5 Distributed Ledger Technologies

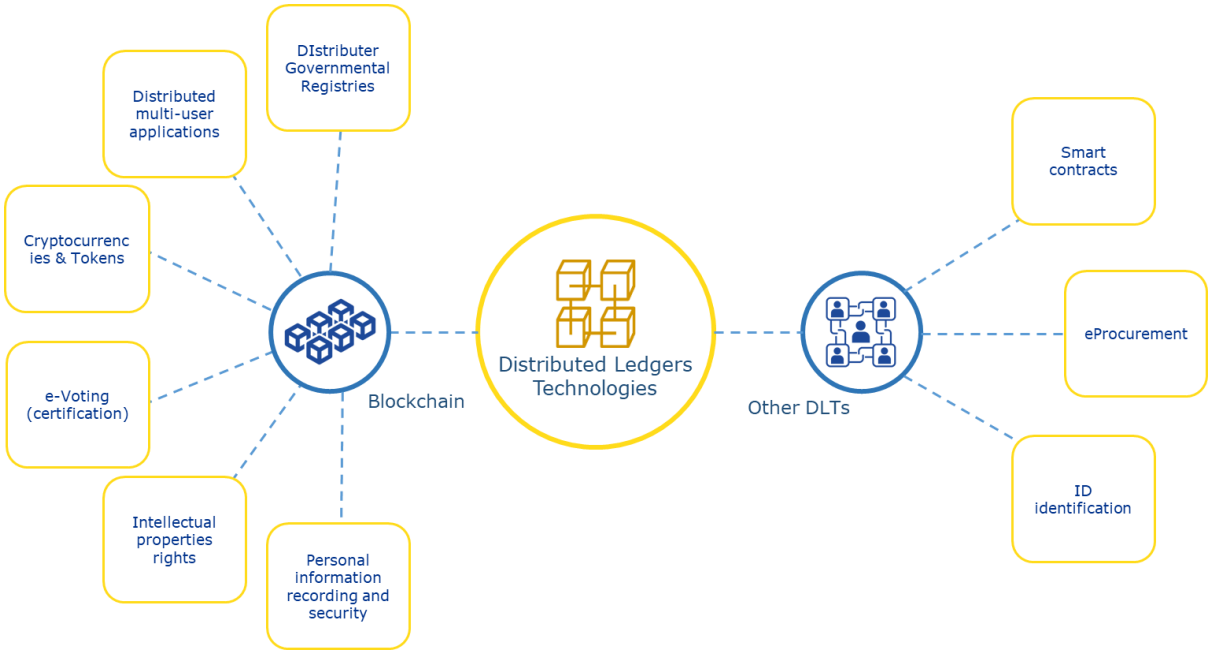
Distributed Ledger Technologies have been magnified by the success of Bitcoin and the explosion of potential use cases, becoming mainstream in research and policy agendas. This trend has created high expectations regarding the transformative role of blockchain for both the industry and the public sector. However, ongoing project has proven to bring incremental changes rather than fundamental ones to the operational capacities of governments.

A Distributed Ledger Technology (DLT) is a digital system for recording the transaction of assets in which the transactions and their details are recorded in multiple places at the same time. Distributed ledger technologies have therefore the potential to speed transactions because they remove the need for a central authority or middleman. Moreover, they have the potential to reduce costs of transactions and are more secure because each node of the network holds records, thereby creating a system that is more difficult to manipulate or successfully attack. Distributer Ledger Technologies embrace two main categories: **Blockchain** and **other DLTs**.

Distributed Ledger Technologies concern Distributed Databases or Distributed Registers that can be updated, managed, controlled and coordinated not only centrally, but in a distributed way, by all players. The prerequisites for Distributed Ledger Technology are in the creation of large networks consisting of a series of participants and each participant is called upon to manage a node in this network. Each node is authorised to update the Distributed Ledger independently of the others but under the consensual control of the other nodes. Similarly, updates or records are no longer managed, as

traditionally happened, under the strict control of a central authority, but are instead created and uploaded by each node independently. In this way, each participant is able to process and control every transaction, but at the same time every single transaction, even if managed independently, must be verified and approved by the majority of the participants of the network. Here lies the concept behind Distributed Ledger Technology or the concept of consensus. The autonomy of each node is subject to reaching a consensus on the operations that are carried out and only with this consent they are then authorised and activated. The various types of DLT are distinguished primarily in the way in which the consensus applies to the actions of writing on the Register.

Blockchain is a category of DLTs and one of several consensus management applications used to apply Distributed Ledger Technology. Blockchain organises data into blocks, which are chained together, and information cannot be cancelled out. This technology has been successfully implemented in the world of cryptocurrencies and has the potential of rewriting the notions of transaction. Moreover, Blockchain has and could been used to manage identity (birth certificates, marriage licenses, passport and death records); personal records (health, insurance and financial); land title registry; voting; copyrights, risks and fraud, etc.



Source: authors' elaboration

Figure 12 - Distributed Ledger Technologies Area, Categories and Uses/Applications

Currently, Distributed Ledger Technologies and primarily Blockchain are "right in the middle" of a techno-commercial turmoil, with great possibility to affect all European Union Member States and beyond, in the years to come. Given the very limited, if any, information on how governments and public sector administrations are to embrace this new phenomenon, and include it within their National Interoperability Frameworks, Base Service Registries or Service Portals, new guidelines are needed for achieving interoperability in infrastructures, organisational issues, and final services.

Even if Distributed Ledger Technologies are still considered "newcomers" in the European context, and thus their advantages related to their usage are not demonstrated, they can be expected to potentially support Public Administration by reducing administrative barriers and by fostering digital interaction with citizens and businesses.

In Source: authors' elaboration

Figure 13, the interoperability and user centricity assessment of Distributed Ledger Technologies is summarised. The explanation of the evaluation is provided below.

DISTRIBUTED LEDGERS TECHNOLOGIES							
Interoperability Assessment							
Legal interoperability		Organisational interoperability		Semantic interoperability		Technical interoperability	
1		1		3		1	
User-Centricity Assessment							
Digital interaction	Accessibility, security, availability and usability	Reduction of the administrative burden	Digital delivery of public services	Citizen Engagement	Incentives for digital service use	Protection of personal data and privacy	Redress and complaint Mechanisms
2	2,5	2,5	2	1	3	4	1

Source: authors' elaboration

***Figure 13** - Distributed Ledger Technologies Interoperability and User centricity assessment*

The estimates suggest that the most crucial issues revolve around legal, organisational and technical interoperability issues, the semantic issues being slightly easier to deal with. As a new legislation will evolve in the upcoming years in Member States and currently documentation on the use of DLT's in the public sector lacks, new guidelines should be developed and put into effort. Alignment of Member States **legal frameworks** concerning DLTs should be seen both from an administration and a business/citizen point of view, as blockchain will be radically disrupting the status quo (trusted authorities, data protection, etc.). The specific issue of GDPR that contradicts the inalterability of the Blockchain to be forgotten is already being assessed by the latest European Parliament study on "**Blockchain and the General Data Protection Regulation**"[18].

With respect to **organisational interoperability**, the application of DLTs within the organisational processes may fundamentally impact the way services are provided, moving from the traditional trusted-server-based model to openly accessible, distributed infrastructures. As a result, the model of service provision will have to be revisited, from an organisational (but also technical) point of view, implying that organisational interoperability looks still complex to realise. These changes will then propagate within service types, providing alternate means and processes for fulfilling numerous new services towards administrations, businesses and citizens.

Although the DLTs phenomenon is still evolving, **semantic interoperability** challenges might be the mildest of the 4 aspects.

Moreover, the DLTs and blockchain disruption will also pose critical challenges in the **technical interoperability** layer: the distributed ledger will alter the established ways that services are provided, through base registries, trusted API's and Web Services, centrally maintained Governmental Portals, etc. A new, broader interoperability enabling reference architecture will be needed, allowing for distributed ledger applications and

[18] https://www.europarl.europa.eu/RegData/etudes/STUD/2019/634445/EPRS_STU(2019)634445_EN.pdf

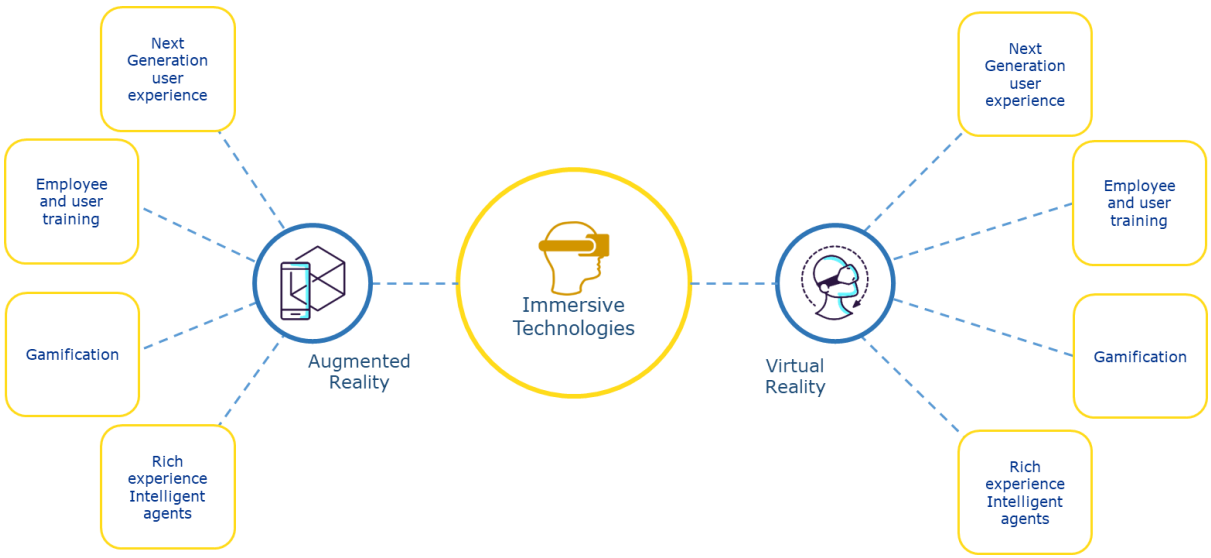
services, or even hybrid approaches where the new technological elements co-exist with the more traditional ones, following on initial pattern as depicted in the recent EC/JRC study on "**Blockchain for digital government**".[19]

Undoubtedly, for what concerns **user centricity**, Distributed Ledger Technologies can enhance citizens' data protection and privacy assurance and the effective use of digital public services. On the other hand, this technology area has a limited influence on the empowerment of citizens and businesses and on the definition of redress mechanisms and complaint procedures.

As a whole, Distributed Ledger Technologies provide above all transparency and inalterability of transactions since any changes made in a blockchain are viewable by all parties of the system and once processed they cannot be removed or tampered with. In addition to this, DLT have the potential to reduce costs of transactions and are more secure because each node of the network holds records, thereby creating a system more difficult to manipulate or successfully attack. Moreover, there is the potential to speed transactions because the need for a central authority or middleman is removed. In the near future, the main interoperability challenges will involve the legal, organisational and technical fields. Regarding user centricity, the main challenges will be related to the capacity to involve citizens in the creation of public services and ultimately provide better digital public services. On the other hand, the main issue of Distributed Ledger Technologies regards its limited influence on the empowerment of citizens and businesses to express their opinion and on the creation of conditions in the public sector for setting up redress mechanisms and complaint procedures, which businesses and citizens have online access to, by means of various channels.

3.3.6 Immersive Technologies

Immersive Technologies are defined as the technology that digitally simulates the real world by creating a sense of immersion. Immersive Technology could be divided in two Categories: **Augmented Reality** and **Virtual Reality**.



Source: authors' elaboration

***Figure 14** – Immersive Technologies Area, Categories and Uses/Applications*

[19] https://joinup.ec.europa.eu/sites/default/files/document/2019-04/JRC115049%20blockchain%20for%20digital%20government.pdf

Virtual and augmented reality might have significant applications in new service design and deployment over the years to come, especially in the areas of training, gamification, and user experience. In fact, this technology area provides an environment where virtual objects are enriched by real vision, sound, and touch, allowing a sense of immersion for users in the physical world. Immersive Technologies hold a large untapped potential and could improve the delivering of new services and applications, promoting at the same time digital interaction between citizens/businesses and Public Administrations.

Figure 15 reports the interoperability and user centricity assessment of Immersive Technologies. The explanation of the evaluation is explained below.

IMMERSIVE TECHNOLOGIES							
Interoperability Assessment							
Legal interoperability		Organisational interoperability		Semantic interoperability		Technical interoperability	
4		3		4		3	
User-Centricity Assessment							
Digital interaction	Accessibility, security, availability and usability	Reduction of the administrative burden	Digital delivery of public services	Citizen Engagement	Incentives for digital service use	Protection of personal data and privacy	Redress and complaint Mechanisms
2,5	3	2	2	1	3	3,5	1

Source: authors' elaboration

***Figure 15** - Immersive Technologies Interoperability and User centricity assessment*

Based on the current status and interconnectivity of such applications with the rest of the public sector infrastructures, their resulting need for interoperability documentation and standardisation is currently foreseen as below average.

Immersive Technologies present very limited needs for **legal interoperability** elements. There could be possibilities in aligning legal aspects with/of the area of ethics and proper usage of technologies.

Regarding **organisational interoperability**, specific effort should be made for coordinated guidance, on how immersive technologies may be integrated with the existing service provision models, using new capabilities of 5G networks, IoT or Artificial Intelligence applications.

Semantic interoperability does not pose relevant challenges, only in the areas of categorisation and codification of different immersive technology types and applications.

Technical interoperability does not present significant issues. Specifically, medium efforts are needed for interoperability-related documentation, mainly in the areas of types and formats of new, rich media applications and the ways they can be interconnected with the backbone of digital service provision.

Regarding **user centricity**, Immersive Technologies constitute a new and innovative way to promote an effective, purpose oriented, digital interaction between citizens and businesses, on the one hand, and Public Administrations on the other. Indeed, this potential needs to be further explored and substantiated with evidence, going beyond

the experimentation level and documenting a transformative impact on public service delivery.

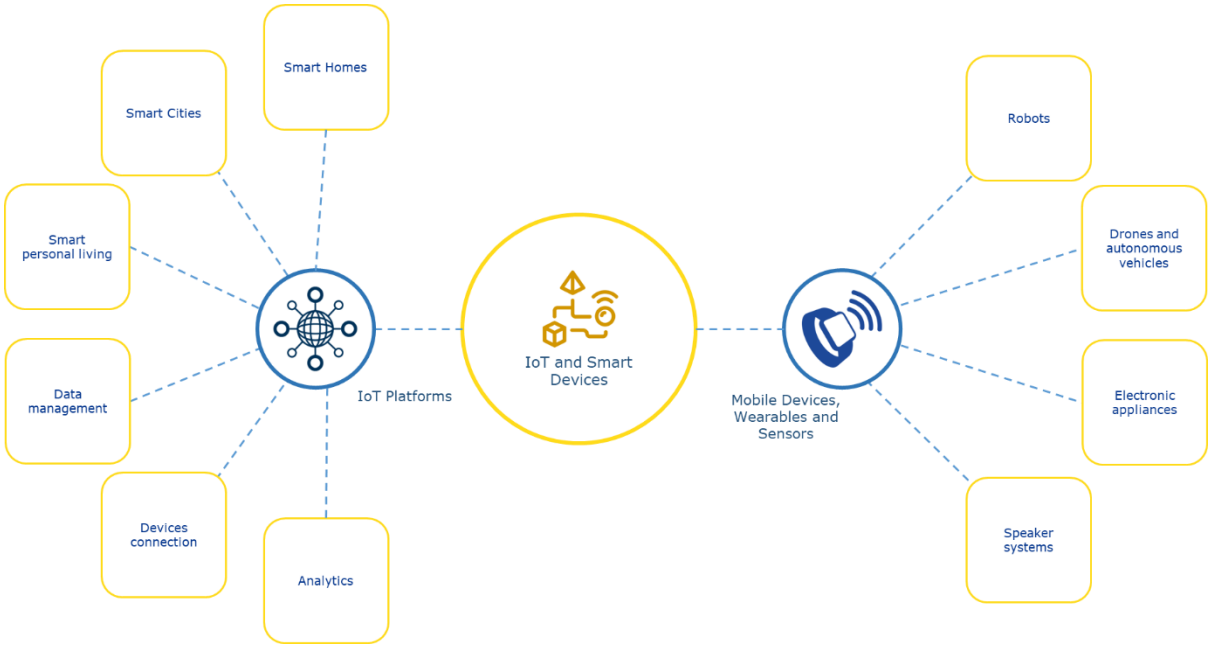
Immersive Technologies can significantly improve user experience since technologies, such as Virtual Reality and Augmented Reality, are able to create a user-centric world, immersing users in the physical world while interacting seamlessly with machines. However, the potential that lies behind this technology area is greater than explored so far/in the analysis; consequently, it is hard to affirm whether this technology area has a remarkable influence on the empowerment of citizens and businesses to voice their view and on setting up redress mechanisms.

In conclusion, immersive technologies do not present relevant issues concerning interoperability. However, there is a need for coordinated guidance on how these technologies could be introduced in the public service provision process (specifically regarding organisational interoperability and technical interoperability). Research, documentations and prototypes must be done to fully understand the potential that lies behind this technology area. On one hand, European Member States lack concrete examples and for the moment it is only possible to speculate a possible role of Immersive Technologies. On the other hand, the great impact and influence that these technologies can have in enriching user experience, accessibility, trust and convenience are recognised.

3.3.7 Internet of Things and Smart Devices

Internet of Things has been defined as a set of physical objects embedded with sensors or actuators and connected to a network. An IoT platform enables the development, deployment and management of solutions that connect to and capture data from IoT endpoints.

IoT and Smart Devices could be classified in two Categories: the first one composed by **Mobile Devices Wearables** and **Sensors**; the second includes all **IoT Platforms** (IoT data platforms, IoT connectivity platforms, IoT cloud end to end platforms).



Source: authors' elaboration

Figure 16 *- Internet of Things and Smart Devices Area, Categories and Uses/Applications*

The technology area of Internet of Things is foreseen to display major needs for coverage by interoperability-related standardisation and guidelines in the years to come. Nowadays, IoT and Smart Devices are contributing to an effective removal of usage barriers of digital public services. In fact, this technology area can be considered a building block for a new definition of digital public service applications.

In Source: authors' elaboration

Figure 17, the interoperability and user centricity assessment of Internet of Things and Smart Devices are reported. The explanation of the evaluation is provided below.

INTERNET OF THINGS AND SMART DEVICES							
Interoperability Assessment							
Legal interoperability		Organisational interoperability		Semantic interoperability		Technical interoperability	
2		3		2		2	
User-Centricity Assessment							
Digital interaction	Accessibility, security, availability and usability	Reduction of the administrative burden	Digital delivery of public services	Citizen Engagement	Incentives for digital service use	Protection of personal data and privacy	Redress and complaint Mechanisms
3,5	3	3	3,5	3,5	3,5	4	1,5

Source: authors' elaboration

***Figure 17** - Internet of Things and Smart Devices Interoperability and User centricity assessment*

Regarding interoperability, the envisaged multiplicity of new devices that need to find their ways in the digital public service models and relevant standardisation will create significant challenges at a technical and organisational interoperability aspect.

Legal interoperability aspects of Internet of Things are considered very important, as new legislation will emerge for regulating the use of devices, the channelling and storage of sensor-created (big) data, and the overall ethical and operational issues in the new smart cities and smart services of the future.

For what concern **organisational aspects**, significant effort should be devoted, for updating interoperability guidelines, process descriptions and service provision models that will integrate the new Internet of Things devices, both at the citizen and enterprise, as well as the Public Administration sides.

Moreover, new **semantic** elements and structures will be needed, for the identification, description (at data and metadata level) and overall operation of millions of new devices that will have a role in the digital service provision. Also, the vast amount of data that will be generated will create new needs for metadata specifications, code lists and controlled vocabularies for their linking and publishing.

Technical interoperability is probably the most important aspect of interoperability concerning IoT and Smart Devices, as a vast variety of hardware and embedded software components will need to be made interoperable, at API and web services level with the existing and emerging digital public service infrastructure. Technical interoperability lies at different levels in IoT (connectivity, platform, data, identification,

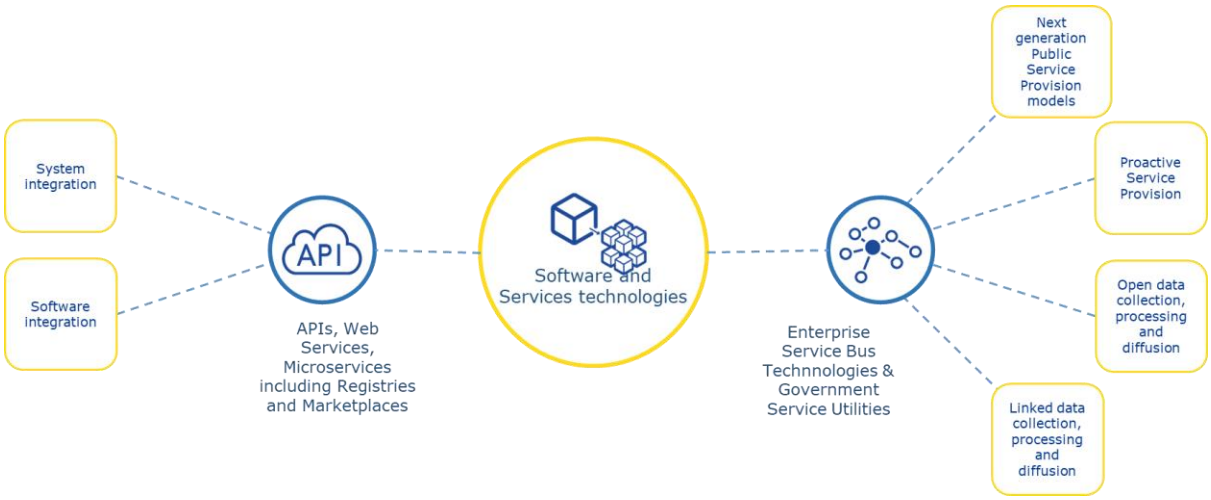
etc). There are plenty of solutions and standards posing a threat to interoperability. In addition, new approaches to reference architectures for Smart Cities might need to be broadly adopted as guidelines at EU level.

There are no relevant issues concerning **user centricity**. The only field that needs to be improved concerns the set-up of redress mechanisms and complaint procedures that citizens and businesses can have access to online. The capacity of this technology area to allow citizens and businesses to access complaint procedures online requires careful coordination at the European Level. In addition, a full level of maturity has not yet been reached given the heterogeneity of technological components, many of which – such as wearables – are not well established in the European public sector.

As a whole, the IoT and Smart Devices technology area presents some issues concerning interoperability. Specifically, the interoperability layer that requires more improvements is the technical layer because there are plenty of solutions and standards at different level of IoT, posing challenges to interoperability. Looking at user centricity, this family of technologies, developed only 15 years ago, can now be considered as a building block for a new definition of digital public service applications, which takes considerable distance from the old-fashioned definition of government. In that regard, IoT and Smart Devices can be intrinsically supportive of citizens and businesses willing to digitally interact with Public Administrations.

3.3.8 Software and Service Technologies

Software and Service Technologies englobes everything concerning software. An evident example of Software and Service Technologies is Software as a Service (SaaS) which is owned, delivered and managed remotely by one or more providers. Within this technology area, two macro-Categories are included: **APIs, Web Services and Micro-services** including Registries and Marketplaces on the one hand; **Enterprise Service Bus Technologies and Government Service Utilities** on the other hand.



Source: authors' elaboration

***Figure 18** - Software and Service Technologies Area, Categories and Uses/Applications*

Software and Service technologies have traditionally been the most "well represented" technology area within the existing documentation for interoperability at a pan-European level. However, the emerging new paradigms in the areas of service design, new APIs and micro services, together with the ever-maturing infrastructures for service

orchestration (aca Enterprise Service Buses), are setting the tone for important challenges and needs from an interoperability point of view.

In the European context, Software and Service Technologies can be considered as a common enabler for a wide variety of applications, supporting citizens and businesses to digitally interact with Public Administrations.

Source: authors' elaboration

Figure 19 summarises the interoperability and user centricity assessment of Software and Service Technologies. The explanation of the evaluation is provided below in the relative subparagraphs.

SOFTWARE AND SERVICE TECHNOLOGIES							
Interoperability Assessment							
Legal interoperability		Organisational interoperability		Semantic interoperability		Technical interoperability	
3		1		1		2	
User-Centricity Assessment							
Digital interaction	Accessibility, security, availability and usability	Reduction of the administrative burden	Digital delivery of public services	Citizen Engagement	Incentives for digital service use	Protection of personal data and privacy	Redress and complaint Mechanisms
3,5	3,5	3,5	3,5	3	3	4	3

Source: authors' elaboration

***Figure 19** - Software and Service Technologies Interoperability and User centricity assessment*

Regarding interoperability, organisational and semantic issues will be the most critical for the years to come.

For what concern **legal interoperability**, this layer is not considered the major issue with respect to the development of standards and guidelines for the next years. Work should continue, from the current status of EIF 3.0, for making legal interoperability more applied than more designed for Service Level Agreements (SLA's) for the automated provision of digital public services through open API's in an area that will require some attention, especially considering new ways of providing G2G and G2B services.

A critical aspect is **organisational interoperability**, as new service paradigms should be developed, allowing also for new infrastructures and topologies to be integrated (e.g. with respect to possible Blockchain applications that will need to be interoperable with the existing software and service infrastructures).

Very important **semantic issues** continue to be a challenge, concerning service categorisation, EU-wide service catalogues and repositories, converging service typologies for all member states and the needed semantic components (controlled vocabularies and core components) for a vast number of entities.

Technical interoperability is still a major issue, but also a well-tackled one over the last 10 years. Significant effort has to be provided both towards enhancing the documentation of existing service models and reference architectures, as well as for

allowing new paradigms and disruptive technological solutions to come into play, in the next years.

Regarding **user centricity,** Software and Service Technologies are supportive for the application of the principles of universal design in several services and for the "never ask twice" principle. It helps to avoid that citizens and businesses are requested more than once for the same information, reducing loss in time.

Software Services Technologies can be considered as a common enabler for a wide variety of applications, supporting citizens and businesses willing to digitally interact with Public Administrations. While the global maturity level is high, the top may not have been reached in the European public sector yet, due to the quite high variety of components that are included.

In general, Software and Service Technologies are largely aligned with the broad aim to make digital public services more accessible, personalised and secure. Besides, this technology has a great potential influence on the empowerment of citizens and businesses to voice their views.

From the analysis carried out on this technology area and considering the current European context, organisational and semantic aspects, such as service categorisation and service standardisation need to be improved, in order to guarantee interoperability of Software and Service Technologies across Member States. The main challenge is to develop new paradigms and allow the integration of new infrastructures and service typologies. From a technological point of view, technical aspects are still a major issue, but also a well-tackled one over the last 10 years.

3.4 Final considerations on the assessment of technologies

The main results of the previous exercise are summarised in Table 4 below, in order to better outline which technologies score lower, in terms of interoperability and user centricity and which layers seem to be the most critical.

TECHNOLOGY AREA	LEGAL INTEROPERABILITY	ORGANISATIONAL INTEROPERABILITY	SEMANTIC INTEROPERABILITY	TECHNICAL INTEROPERABILITY	AVERAGE
Artificial Intelligence	1	1	2	2	1,5
Communication Technologies	3	4	4	3	3,5
Computing Infrastructures	2	3	2	2	2,3
Distributed Ledgers Technologies	1	1	3	1	1,5
Digital Identity and Security	1	2	2	2	1,8
Immersive Technologies	4	3	4	3	3,5
Internet of Things (IoT) and Smart Devices	2	3	2	2	2,3
Software and Service Technologies	3	1	1	2	1,8
AVERAGE	2,1	2,3	2,5	2,1	

Source: authors' elaboration

***Table 4** - Synopsis of Interoperability per technology area*

As shown in Source: authors' elaboration

Table 4, we can observe that **Artificial Intelligence, Distributed Ledger Technologies, Digital Identity and Security, and Software and Service Technologies** exhibit the lowest scores in terms of Interoperability.

As previously outlined in subsection 3.3.5, **Distributed Ledger Technologies** show significant limitations in being interoperable on a legal, organisational and technical level; challenges are respectively linked 1) to GDPR right to be forgotten and the

inalterability of the Blockchain; 2) to the impact of the model of service provision - from the traditional trusted-server-based model to openly accessible, distributed infrastructures - that need to be revisited both from an organisational and technical point of view.

Digital Identity and Security shows critical results in legal interoperability. Currently this technology area is at the centre of an ongoing discussion about how to effectively achieve strong and flexible authentication while successfully addressing privacy and security concerns[20]. Moreover, even if protocols were developed through standard processes and released openly, technical barriers are still high; standards can lead to improved interoperability only if users, providers, and consumers start to adopt them.

Similarly, legal challenges raised by **Artificial Intelligence** refer to tensions between protecting rights of individuals, personal data and fostering innovation with openness and transparency. In addition, it has relevant limitations with regard to organisational interoperability since it is still unclear what will be the pan-European services, or sub-processes that will make use of the new possibilities of AI.

Finally, **Software and Service Technologies** show critical scores in both organisational and semantic interoperability, since in the years to come, new service paradigms will be developed requiring new infrastructures to be integrated and EU wide vocabularies and repositories will need to converge for all Member States.

As a whole, **legal and technical interoperability** pose the greatest challenges along the eight identified technology areas. In fact, a solid legal and ethical framework at EU level is fundamental to ensure the development and the adoption of innovative technologies. In addition, technical interoperability is crucial to ensure seamless information exchange and free movement of data; however, unless semantic is fully standardised across Europe, this layer poses challenges. Technical interoperability could be enhanced through a greater reliance upon open standards making the environment of public/private entities and citizens more interoperable. In addition, organisational interoperability also presents relevant issues when dealing with commonly agreed and mutually beneficial standards for roles and processes alignment in the digital public services delivery. Regarding semantic interoperability, it is possible to observe that this layer is likely to represent a lower challenge for the eight technology areas even if improvements are required. For instance, in the case of electronic invoicing, many standards and syntaxes are still in use; economic operators wishing to carry out cross-border procurement activities are often required to comply with a new standard and/or codification system each time they access a new market. Therefore, a common European standard for the semantic data model of the core elements is needed to increase citizen uptake for any digital services delivered.

TECHNOLOGY AREA	Digital Interaction	Accessibility, security, availability and usability	Reduction of the administrative burden	Digital delivery of public services	Citizen engagement	Incentives for digital service use	Protection of personal data and privacy	Redress and complaint Mechanisms	Average
Artificial Intelligence	3	3	3	2	1	3	4	1,5	2,6
Communication Technologies	3,5	3,5	3,5	3,5	3,5	3	4	2	3,3
Computing Infrastructures	3	3	3	3	3	2,5	3,5	3	3,0
Distributed Ledgers Technologies	2	2,5	2,5	2	1	3	4	1	2,3
Digital Identity and Security	3,5	3,5	3	3	2	3	4	2	3,0
Immersive Technologies	2,5	3	2	2	1	3	3,5	1	2,3
Internet of Things (IoT) and Smart Devices	3,5	3	3	3,5	3,5	3,5	4	1,5	3,2
Software and Services Technologies	3,5	3,5	3,5	3,5	3	3	4	3	3,4
Average	3,1	3,1	2,9	2,8	2,3	3,0	3,9	1,9	

Source: authors' elaboration

[20] https://cyber.harvard.edu/interop/pdfs/interop-digital-id.pdf

Table 5 *- Synopsis of User centricity challenges per technology area*

Another significant aspect to consider to fully exploit the technologies' potentials and to allow the reuse of common IT solutions is user centricity. Moreover, the design of user-centric digital Public Administrations is growingly seen as one of the key ingredients of good governance.

Source: authors' elaboration

Table 5 shows how the analysis of the different technology areas highlights positive trends that help to enrich user experience, accessibility and convenience and to ensure data protection and trust. However, citizen engagement and redress and complaint mechanisms are still low for almost all the technologies.

According to the results and findings, it is possible to observe that among the eight technology areas, Artificial Intelligence, Distributed Ledger Technologies and Immersive Technologies score the lowest in terms of user centricity whereas Software and Service Technologies, Communication Technologies and Internet of Things and Smart devices register the highest score. The reason why some technologies are under performing is explained by the fact that there is still a lot of untapped potential to harness in order to make digital services more user oriented.

In conclusion, as previously mentioned, EU governments at all levels still need to invest significantly in the exploitation of emerging and mature technologies, in order to provide seamless digital public services. They must adopt a proactive attitude to better tackle these challenges and, while introducing a digital public service, all the four interoperability layers have to be equally addressed and particular attention should also be dedicated to the eight user centricity principles.

4 Readiness concepts and levels

This section provides a detailed overview of the approach followed in the Study, to analyse the innovative pilot initiatives that harness digital technologies to improve public service delivery. In a nutshell, the approach is based on the joint consideration of 4 distinct "readiness" dimensions: technological, societal, organisational and legal. These are presented in the next four subsections, forming the axes of a composite Maturity Model, which will be used to dynamically assess the evolution of pilot projects across time, as explained in the last subsection. There, the approach is shown "in action", with the help of an appropriate visual representation.

4.1 Technology Readiness Level

The Technology Readiness Level (TRL) is a method for estimating the maturity of a certain technology. Being based on readiness (i.e. closeness) to the market, it has the big advantage of being technology neutral. In fact, while originally invented at NASA headquarters in 1974 and consistently used within the aerospace industry until codified in the ISO 16290:2013 standard, it has become widespread in all technology sectors.

The Technology Readiness Level (TRL) scale has been widely adopted at EU, national and regional levels in the current (2014-2020) programming period as a decision-making tool when financing Research, Development and Innovation investments with public grants. Since 2014, the Technology Readiness Level (TRL) scale has become part of the EU Horizon 2020 Work Programmes and in many countries and regions of Europe has been widely adopted in the context of ERDF (European Regional Development Fund) supported Research, Development and Innovation investments. TRLs are based on a scale from 1 to 9, where 9 represents the most mature technology.

The nine possible instances of TRL are reported in the Table below.

MATURITY LEVEL	DESCRIPTION
TRL1	Basic principles observed
TRL2	Technology concept formulated
TRL3	Experimental proof of concept
TRL4	Technology validated in lab
TRL5	Technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies)
TRL6	Technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies)
TRL7	System prototype demonstration in operational environment
TRL8	System complete and qualified
TRL9	Actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies, or in space)

Source: authors' elaboration

***Table 6** - TRL scale used in Horizon 2020 and ERDF*

In terms of readiness, TRLs 1-3 pertain to the initial stages of any Research and Development project, while TRLs 4-6 belong to the validation and demonstration phases, which can be done, first, in a closed laboratory, then in real or almost real world conditions. TRL 7 is the final stage of prototyping, while TRLs 8-9 constitute the usual pre-market and market launch conditions.

However, this criterion has been subject to criticism, and one of the strongest objections has been related to the non-linear, cyclical and iterative shape of technology development processes, the TRL scale is mostly used as a Research and Innovation Policy tool. The aim is to support decision making when financing Research, Development and Innovation investments with public grants – rather than an ontological description of how technologies are developed and rolled out in the respective usage contexts. In this sense, it brings an invaluable help to clarify and specify the differential impact of the public grant on some, though maybe not all, of the sub processes leading to a certain progress along the TRL scale.

4.2 Societal Readiness Level

The SRL is an approach originally proposed by Innovation Fund Denmark[21] and revised in this Study to assess the level of societal adaptation of a certain technology, product, process, or intervention. The rationale is that any innovation – be it technical or social – must be integrated in the societal environment. Thus, the higher the SRL, the higher is such integration or the lower will be the need to set up ad hoc measures to promote "a realistic transition towards societal adaptation".[22]

The SRL is analysed through the readiness of the society to adopt the solution. The approach is technology neutral and, very importantly, there is no overlap with the TRL, which makes the two maturity models both valid and rigorous interpretative lenses. According to its proposers, also the SRL has nine possible stages, which are reported in **Table 7** (with slight changes from the original list)[23].

MATURITY LEVEL	DESCRIPTION
SRL1	Identification of the generic societal need and associated readiness aspects
SRL2	Formulation of proposed solution concept and potential impacts; appraisal of societal readiness issues; identification of relevant stakeholders for the development of the solution
SRL3	Initial sharing of the proposed solution with relevant stakeholders (e.g. through visual mock-ups): a limited group of the society knows the solution or similar initiatives
SRL4	Solution validated through pilot testing in controlled environments to substantiate proposed impacts and societal readiness: a limited group of the society tests the solution or similar initiatives
SRL5	Solution validated through pilot testing in real or realistic environments and by relevant stakeholders: the society knows the solution or similar initiatives but is not aware of their benefits

[21] https://innovationsfonden.dk/sites/default/files/2019-03/societal_readiness_levels_-_srl.pdf
[22] ibidem
[23] Information about the society awareness and familiarity with the solution were formulated.

SRL6	Solution demonstrated in real world environments and in co-operation with relevant stakeholders to gain feedback on potential impacts: the society knows the solution or similar initiatives and awareness of their benefits increases
SRL7	Refinement of the solution and, if needed, retesting in real world environments with relevant stakeholders: the society is completely aware of the solution's benefits, a part of the society starts to adopt similar solutions
SRL8	Targeted solution, as well as a plan for societal adaptation, complete and qualified; society is ready to adopt the solution and have used similar solutions on the market
SRL9	Actual solution proven in relevant societal environments after launch on the market; the society is using the solution available on the market

Table 7 *- SRL scale (adapted from Innovation Fund Denmark)*

As shown in Table 7, the connection between TRL and SRL is very closed and direct if we think of the target "solution" as a technological one. However, the approach is broader than that, as it encompasses new solutions that may not be technical – wholly or in part.

In the above, our reading of SRLs 1- 2 is that they reflect the growing awareness of a research Team about the existence of a societal readiness issue. In turn, SRLs 3-6 are concerned with the more and more extended inclusion of societal stakeholders (such as prospective users or other similar groups) in the testing, validation and demonstration of the Research and Development output. SRL 7 well matches TRL 7 in its being referred to the final stage of prototyping, while SRLs 8-9 belong to the pre-market and market launch phase of the target "solution" – a phase that may also be related to a non-commercial situation, as can evidently be the case for a newly developed digital public service.

4.3 Organisational Readiness Level

While the TRL and SRL scales (particularly the former) are already established in both literature and practice, the ORL is a fully original approach invented here for the purposes of this Study. By analogy to SRL, ORL must be seen as a maturity model related to the organisational impact of a certain technology, product, process, or intervention. Following Eleanor D. Glor[24], the term "impact" is defined to include both the results of an innovation (outcomes) and its broader effects inside the perimeter of the organisation implementing it. Key impact areas span from professional roles, competencies and skills to organisational functions, processes and physical infrastructures. Here, we are more interested in defining the preparedness level of an organisation to receiving it, instead of analysing the consequences of that innovation in terms of (for e.g.) improved organisational performance. The assumption here is that any innovation – be it technical or social – requires being embedded in the organisational environment to become permanently adopted. For reasons of symmetry, we propose nine possible instances for the ORL, which are presented below.

[24] https://pdfs.semanticscholar.org/8a6f/553006eda9aed6a4ea1b077374c37d5dcf98.pdf

MATURITY LEVEL	DESCRIPTION
ORL1	Identification of the organisational need (infrastructures, capabilities, skills) and associated organisational readiness aspects
ORL2	Formulation of proposed solution concept and potential impacts; appraisal of organisational readiness issues; identification of relevant roles, processes, functions and structures for the solution
ORL3	Comprehensive description of proposed solution's impacts within the organisation in terms of roles, competences and skills, physical infrastructures required
ORL4	Solution validated through simulation of major induced changes to substantiate proposed impacts and organisational readiness: the organisation which is developing the solution starts to acquire roles, competences and skills, physical infrastructures required
ORL5	Proposed solution validated through pilot testing in real or realistic organisational environments: the organisation which is developing the solution achieves roles, competences and skills, physical infrastructures required
ORL6	Solution demonstrated in real world environments and in co-operation with relevant stakeholders to gain feedback in order to improve roles, processes, functions and infrastructures required
ORL7	Refinement of the roles, processes, functions and infrastructures required and retesting of the solution in relevant organisational environments
ORL8	Targeted solution, as well as a plan for organisational embedment, complete and qualified: roles, processes, functions and infrastructures are available
ORL9	Actual solution proven in relevant organisational environments: roles, processes, functions and infrastructures are correctly used for the solution on the market

Table 8 *- ORL scale (our elaboration)*

ORLs 1-2 match SRLs 1-2 in reflecting the growing awareness of a research Team about the existence of an organisational readiness issue. In turn, ORLs 3-6 are concerned with the more and more extended consideration of roles, processes, functions and structures in the testing, validation and demonstration of the targeted output. ORL 7 matches both SRL 7 and TRL 7 in its being referred to the final stage of prototyping, while ORLs 8-9 belong to the pre-market and market launch phase.

4.4 Legal Readiness Level

Like ORL, also LRL is an original approach invented for the purposes of this study. Conceptually, it is even less rooted than ORL in academic literature or practice. However, the analogy with SRL and ORL is developed enough to allow the formulation of a maturity model that looks at the legal and regulatory implications of innovations in terms

of compliance, but also transformative power. In fact, while no new technology, product, process, or intervention could survive if proven to go against the existing set of binding rules that govern the selected domain, the opposite is also true (to a large extent). A legal system evolves over time, as a result of breakthrough innovations, bringing to the surface, the need of limiting the range of possibilities or configuring new spaces of legitimate action. The nine possible instances for LRL are presented below in Table 9.

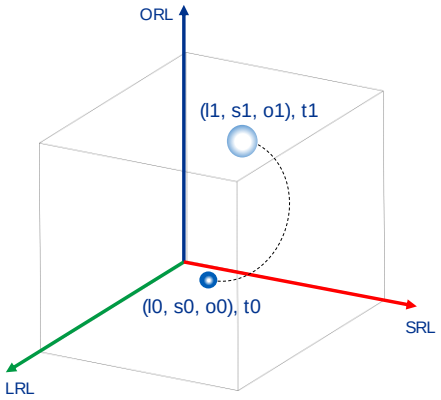
MATURITY LEVEL	DESCRIPTION
LRL1	Generic considerations of legal and ethical compliance aspects are observed but nothing has yet been done for the development of the solution
LRL2	Formulation of the need to enhance the legal normative, laws, rules and guidelines and solution concept; appraisal of legal and ethical compliance issues
LRL3	Abstract description of the proposed solution's legal and ethical compliance
LRL4	Solution's legal and ethical compliance prospects validated against any required or recommended changes in the legal and/or regulatory system
LRL5	Definition of the proposed solution's legal and ethical compliance status after pilot testing in real or realistic organisational environments
LRL6	Detailed description of the required or recommended changes in relevant laws, regulations or organisational rules to ensure full compliance with the proposed solution
LRL7	Refinement of the solution within the existing legal and ethical system and, if needed, proposals for required or recommended changes to some aspects of it
LRL8	Targeted solution, as well as a legal and ethical compliance audit, complete, qualified and ready to be launched on the market
LRL9	Actual solution proven legally and ethically compliant after launch on the market

Table 9 *- LRL scale (our elaboration)*

4.5 Application to pilot evaluation

The application of our 4-axis maturity model to pilot evaluation is exemplified below in Figure 20. There, "t" stands for technology readiness, "l" for legal, "s" for societal, and "o" for organisational. The figure shows an idealistic example of a trial run between t_0 and t_1 in a certain location, where both technology and organisational readiness progressed considerably, while legal and societal readiness observed a slower increase across time. Note that the TRL improvement is represented by the size of the small ball inside the cube, which becomes bigger between t_0 and t_1, while the LRL, SRL and ORL changes are all measured along the respective axis as shown.

The global change occurred in the four dimensions above reflects what we will call the "transition pathway" of the pilot.



Source: authors' elaboration

Figure 20 *- Framework in action and transition pathway*

The Readiness Levels, briefly exposed in this section, are very relevant in the context of the European public sector. Ideally, public services must be built on proven technologies (hence with high TRLs). However, it is also particularly important that they are used and accepted by the targeted audience (hence the need of a high SRL) and that business processes in the Public Administration are ready or flexible to implement the technology (hence the concern for a high ORL). Finally, although the private sector may quite often challenge existing laws when proposing new products and services (if not operate at the margin), any governmental service is tied to operate strictly within the boundaries of the law (hence the importance of a high LRL).

5 Knowledge repository

Taken together, the methods presented in section 3 for the assessment of interoperability and user centricity and the 4-axis readiness concept and model outlined in section 4 constitute an original multi-dimensional framework to evaluate the success and scalability or reuse potentials of pilot projects aimed to experimentally deploy innovative public services at the national, regional or local levels.

As mentioned in the introduction, the framework was hosted in an interactive database as knowledge repository, making it possible to filter data according to the pilot catchment area, its readiness levels, its reference country, its starting or ending testing phase, and allow the desired data to be displayed. Generally speaking, the database was conceived of and designed to make sure that it could be easily used and constantly updated, also by future studies, while preserving the methodological lessons learned in the form of technical and operational guidelines and be the foundation of the possible development of an Innovative Public Services Observatory to be developed by JRC and DIGIT as a follow-up of this preparatory study.

5.1 Metadata

Within the database, gathered information for pilot analysis can be accommodated in **36 columns**. Some of these are to be filled in with qualitative information whereas others with quantitative data, such as the scores assigned to observed dimensions (namely TRL, LRL, SRL, ORL and interoperability. User centricity principles are flagged when relevant to a pilot).

The table below lists the metadata of the **16** qualitative columns.

Column Name	Description
Name of the project	Shows the short name of the project.
Accepted/Rejected for the analysis	Indicates if the case study has been considered for the project analysis. A pilot is "Accepted" for the analysis if it satisfies 5 specific requirements: (1) First and foremost it has to be applicable in the Public Administration; then, (2) it has to be a European project or an extra EU best practice; (3) it must use one of the 8 identified technologies; furthermore, (3) the project needs to be closed or ready to be launched; finally, (5) information and documentation need to be available to proceed with the pilot evaluation. If at least one of the criteria of the high-level analysis is missed, the pilot is "rejected" for the analysis.
Description of the project	Reports in depth what the project was about, including identification of the technology vendor if available, the public service involved, the benefits and issues etc.
Goals of the project	Explains briefly the goal(s) of the pilot.
Technology Area	The extent of a determined technology enclosed within a specified boundary that can be subdivided into categories and uses/applications.
Technology	Individual exhaustive division of the technology area according to the

Category	proposed system of classification.
Government broad objective (COFOG)	The Classification of the Functions of Government (COFOG) is a classification defined by the United Nations Statistics Division, designed to be a standard to indicate the government divisions of different countries.
Sub-items (COFOG)	Represents the single Activity Domain covered by the pilot.
Target groups	Group / entity the pilot / project is developed for.
Reference country	Country where the pilot is implemented. Most of times the country corresponds to the coordinator of the project.
Catchment area	Determines the wide view of the project, considering the people caught during the pilot or development of the programme.
Turned into PS	It indicates if the pilot and the project has turned or not into a public service.
Starting period	Year when the pilot/project started.
Ending period	Year when the pilot/project finished.
Project source	The link of the project website.
List of sources used for the contract	URL of sources used for the contract.

Table 10 *- Metadata of the qualitative columns in the database*

As can be noted, the catalogue of cases assigns them to the respective public sector domain following the COFOG, the Classification of the Functions of Government defined by the United Nations Statistics Division, to facilitate the classification of digital public services in thematic areas[25].

The table below lists the metadata of the **20** quantitative columns. More specifically:

- 8 columns refer to the 4 readiness criteria (TRL, SRL, LRL and ORL) with the respective levels recorded both at the beginning of the pilot phase (t_0) and at the end of it (t_1) to monitor the evolution of the project across time;
- 8 columns are related the 8 user centricity principles mentioned in the Tallinn declaration, to be flagged if/when relevant for the pilot at hand;
- 4 columns point at the technical, semantic, organisational and legal interoperability layers, each to be attributed a score depending on observed status, as explained in section 3 above.

[25] https://unstats.un.org/unsd/classifications/Family/Detail/4

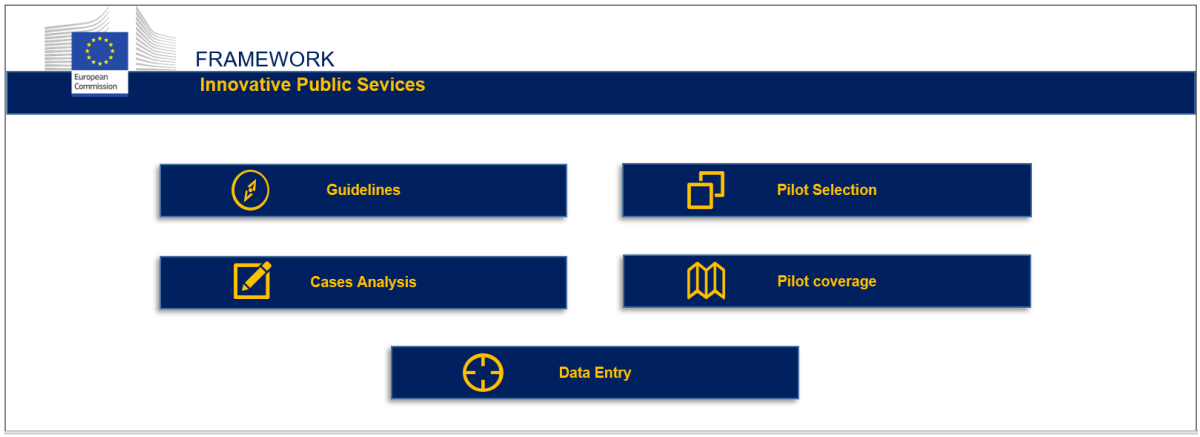
Column Name	Description
READINESS ANALYSIS	Section where the results of the readiness analysis are collected. It uses a 1-9 scale and shows the initial and final status of the pilot in terms of maturity with respect to technical, organisational, societal and legal aspects in the country where the project has been carried out.
TRL Level before	The Technological Readiness Level when the project started.
TRL Level after	The Technological Readiness Level at the end of the pilot.
SRL Level before	The Social Readiness Level when the project started.
SRL Level after	The Social Readiness Level at the end of the pilot.
ORL Level before	The Organisational Readiness Level when the project started.
ORL Level after	The Organisational Readiness Level at the end of the pilot.
LRL Level before	The Legal Readiness Level when the project started.
LRL Level after	The Legal Readiness Level at the end of the pilot.
INTEROPERABILITY ANALYSIS	Section where the results of the interoperability analysis are collected. It uses a 1-4 scale and indicates if the case study undercovers the interoperability solutions for Public Administrations, businesses and citizens, according to the 4 layers of the EIF Interoperability Model.
Legal Interoperability	The Legal Interoperability score of the pilot based on a 1-4 level scale (looking at legal framework, policies etc.)
Semantic Interoperability	The Semantic Interoperability score of the pilot based on a 1-4 level scale (looking at syntactic and semantics aspect such as format etc.)
Organisational Interoperability	The Organisational Interoperability score of the pilot based on a 1-4 level scale (looking at business, processes, roles etc.)
Technical Interoperability	The Technical Interoperability score of the pilot based on a 1-4 level scale (looking at interface, specifications, interconnection services etc.)
USER CENTRICITY ANALYSIS	Section where the results of the user centricity analysis are collected. It measures the level of user centricity on the 8 well-defined user centricity principles. According to the Tallinn Declaration, user centricity means putting the end-users (citizens, businesses, public sector employees) truly at the centre of services through the spread of digitisation across all policy areas. User centricity principles have been tagged when relevant with the objective and aim of the pilot.

Digital Interaction	Digital Interaction principle identified and flagged when relevant to a pilot.
Accessibility, security, availability and usability	Accessibility, security, availability and usability principle identified and flagged when relevant to a pilot.
Reduction of the administrative burden	Reduction of the administrative burden principle identified and flagged when relevant to a pilot.
Digital delivery of public services	Digital delivery of public services principle identified and flagged when relevant to a pilot.
Citizen engagement	Citizen engagement identified and flagged when relevant to a pilot.
Incentives for digital service use	Incentives for digital service use identified and flagged when relevant to a pilot.
Protection of personal data and privacy	Protection of personal data and privacy identified and flagged when relevant to a pilot.
Redress and complaint Mechanisms	Redress and complaint Mechanisms identified and flagged when relevant to a pilot.

Table 11 *- Metadata of the quantitative columns in the database*

5.2 Structure

The database has been realised with the use of MS Excel. As mentioned, it was meant to be as interactive and user-friendly as possible. 5 distinct sections (guidelines, pilot selection, cases analysis, pilot coverage, data entry) were created to ensure an intuitive and simple navigation for users, as shown in **Figure 21** – Database structure overview 1.



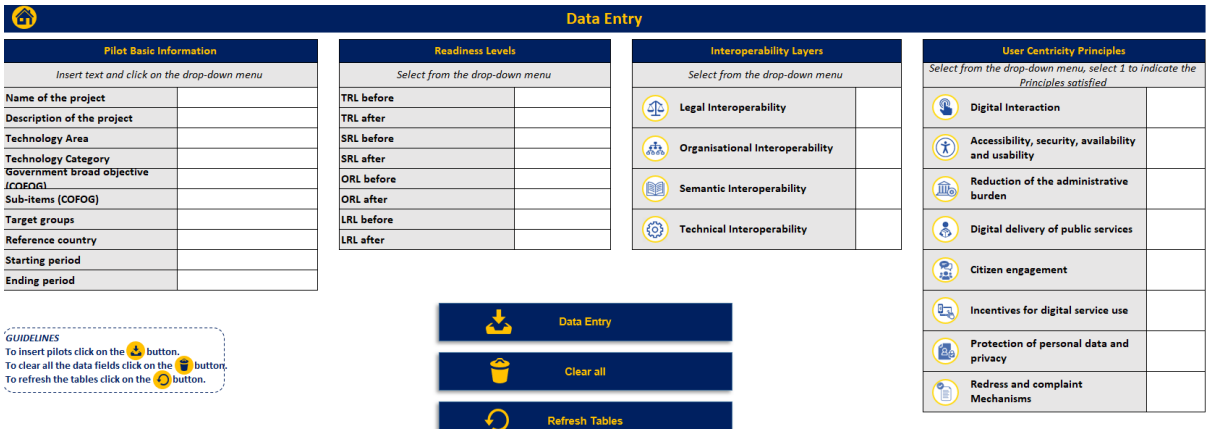
Source: authors' elaboration

Figure 21 *– Database structure overview*

Within the "**Guidelines**" section, a general guidance on how to use the framework ("user manual" on the use of the worksheet), and an overview of what the other sections

contain is provided. Moreover, it is possible to consult the dictionary of the data columns inserted for the pilot analysis as well as the scoring classification assigned for the parameters used for the assessment of pilots.

In the "**Data entry**" section**,** users can insert the information available on the pilot at hand. 4 sections can be filled with data input: 1) **pilot basic information** such as the name of the project, the country, and the technologies used; 2) the **readiness levels** i.e. a score assigned to each dimension both before and after the pilot's execution; 3) the **interoperability layers** with a score entered for each of them; and 4) **user centricity principles** inviting to select those that the pilot seems to satisfy.



Source: authors' elaboration

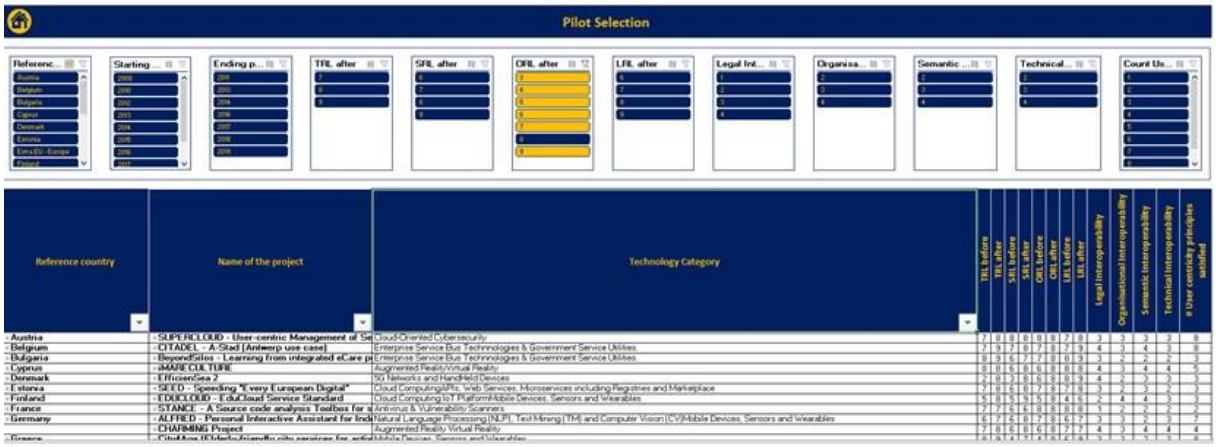
Figure 22 *- Data entry interface*

The "**Case analysis**" section shows all the available information on a certain pilot project. The section maps and records all the information and allows the user to elaborate that information and edit the related analyses.

In the "**Pilot Selection**" sheet, users can filter data about any pilot stored in the database, according to the value or qualitative data they want to select. The slicers include, e.g.: the reference country of the pilots, its starting or ending period, its readiness criteria before and after, its interoperability level, and the number of user centricity principles satisfied, as shown in **Figure 23** and **Figure 24**

Source: authors' elaboration

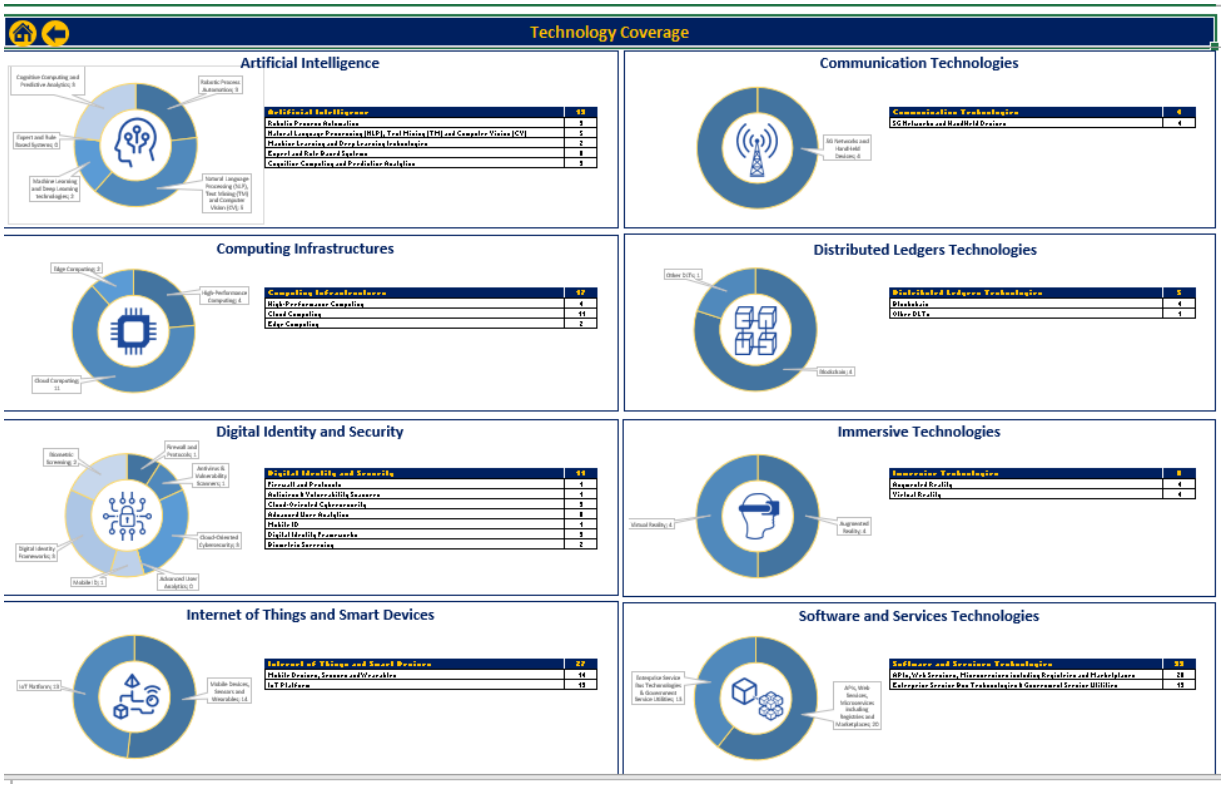
Figure 23 *- Data filter according to project ending in 2017*



Source: authors' elaboration

Figure 24 *- Data filter according to ORL "after" or in "t1" equal to 8*

In the "**Pilot coverage**" section, the system allows to synthetize and visualise inputted data for easier understanding. For instance, it can provide a representation of the technology categories and countries covered by the projects collected, as depicted below in **Figure 25** and **Figure 26**.



Source: authors' elaboration

Figure 25 *- Technology coverage by collected pilots*

Country Coverage

Country	Count
Austria	2
Belgium	6
Bulgaria	2
Croatia	0
Cyprus	2
Czechia	2
Denmark	1
Estonia	1
Finland	1
France	4
Germany	6
Greece	6

Country	Count
Hungary	1
Ireland	2
Italy	8
Latvia	1
Lithuania	2
Luxembourg	0
Malta	1
Netherlands	4
Poland	0
Portugal	0
Romania	0

Country	Count
Slovakia	0
Slovenia	0
Spain	14
Sweden	0
United Kingdom	11
Extra EU - Asia	0
Extra EU - Africa	0
Extra EU - North Americ	1
Extra EU - Europe	3
Extra EU - Oceania	0
Extra EU - South Americ	0

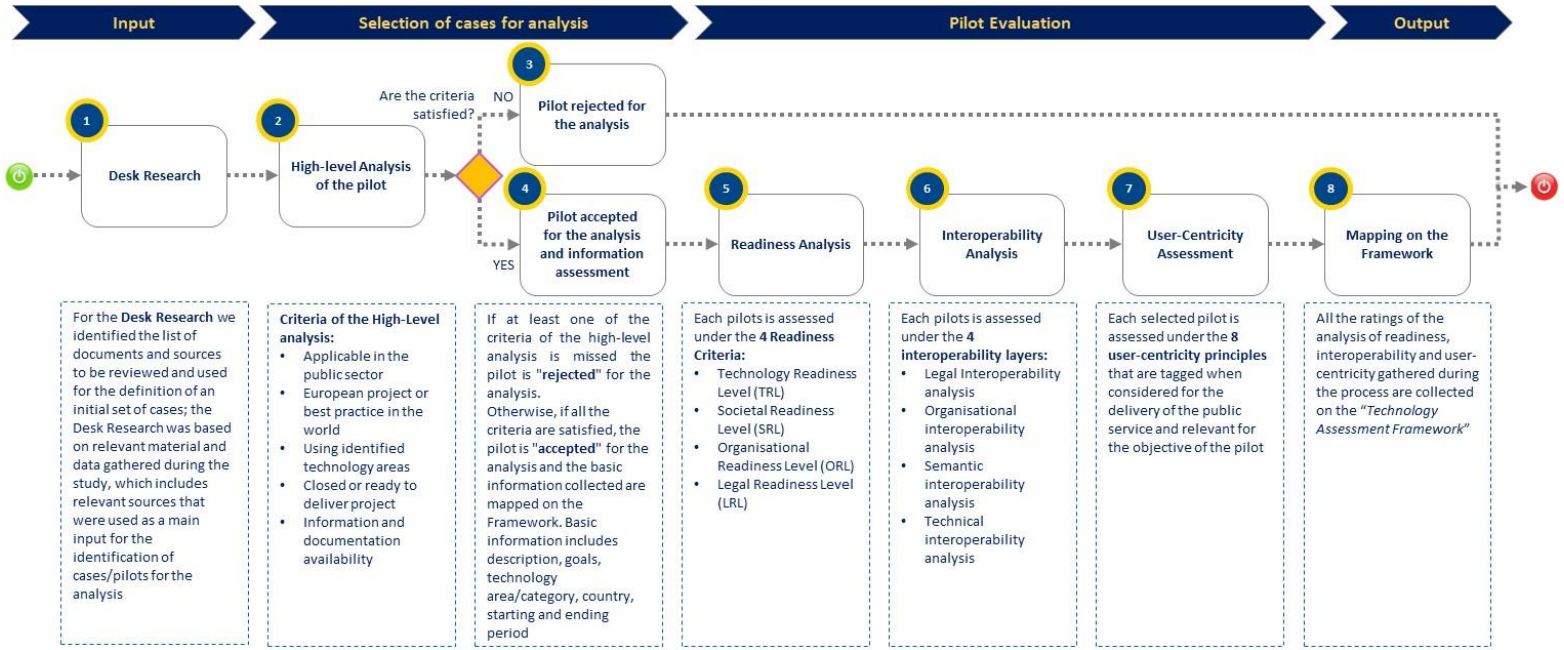
Source: authors' elaboration

Figure 26 *- EU and extra EU country coverage by collected pilots*

6 Pilot analysis and evaluation

Based on the multi-dimensional framework and database described in the previous sections, the process of analysis and evaluation of each pilot project considered relevant for the Study is composed by 8 sequential stages that are represented below in Source: authors' elaboration

Figure 27.



Source: authors' elaboration

Figure 27 *- Process of pilot analysis and evaluation*

In the following paragraphs, those eight stages are explained in detail:

- **Desk Research:** during this phase, relevant documentation was gathered and used as evidence base for the identification of cases. The main sources included European Commission's strategic documents and official communications, studies and reports from International Organisations and private/global consulting firms including KPMG, academic papers from leading researchers and universities, and project collections such as the Interreg and CORDIS databases.
- **High-level analysis of sources:** during this phase, five specific conditions were to be verified upfront for the pilot to be retained. 1) First, it had to be applicable to the public sector; then (2) it should be either a European project or an extra-EU good practice example; afterwards (3) one of the 8 identified technology areas had to be represented; furthermore, (4) it was checked if the project was closed or near to be finalised. This is because it was crucial to observe the evolution of the pilot from an initial (t_0) to a final point (t_1). Finally, (5) enough information and documentation had to be available to proceed to a more in-depth analysis.
- **Pilot rejected from the analysis**: based on the outcome of the previous stage, all the pilots that did not meet one or more of the previous five conditions were not retained in the case study database.
- **Pilot accepted for the analysis and basic information assessment**: if all the 5 criteria/conditions were satisfied, the pilot was considered "accepted" for the analysis and some basic information was collected and stored into the database; this included the description and goal of the project, the technology area and related category, the government's broad objective, the target group, reference country, catchment area and finally the pilot's starting and ending time.
- **Readiness analysis**: at the two points of time (t_0 the pilot's start and t_1 the pilot's end) each was scored under the 4 criteria of technical, societal, organisational and legal readiness, based on a scale of values from 1 to 9, where 1 represents the lowest and 9 the highest possible level.
- **Interoperability analysis**: each pilot was also scored under the 4 interoperability layers (legal, organisational, semantic and technical), based on a scale of values from 1 to 4, where 1 denotes the highest level of effort that should be exercised in ensuring interoperability, whereas 4 implies that no particular issues should be taken in mind.
- **User centricity assessment**: finally, the pilot was tagged according to which of the eight user centricity principles are represented in it.
- **Mapping on the framework**: All the ratings deriving from readiness, interoperability and user centricity analyses were collected and inserted in the database to be mapped on the framework.

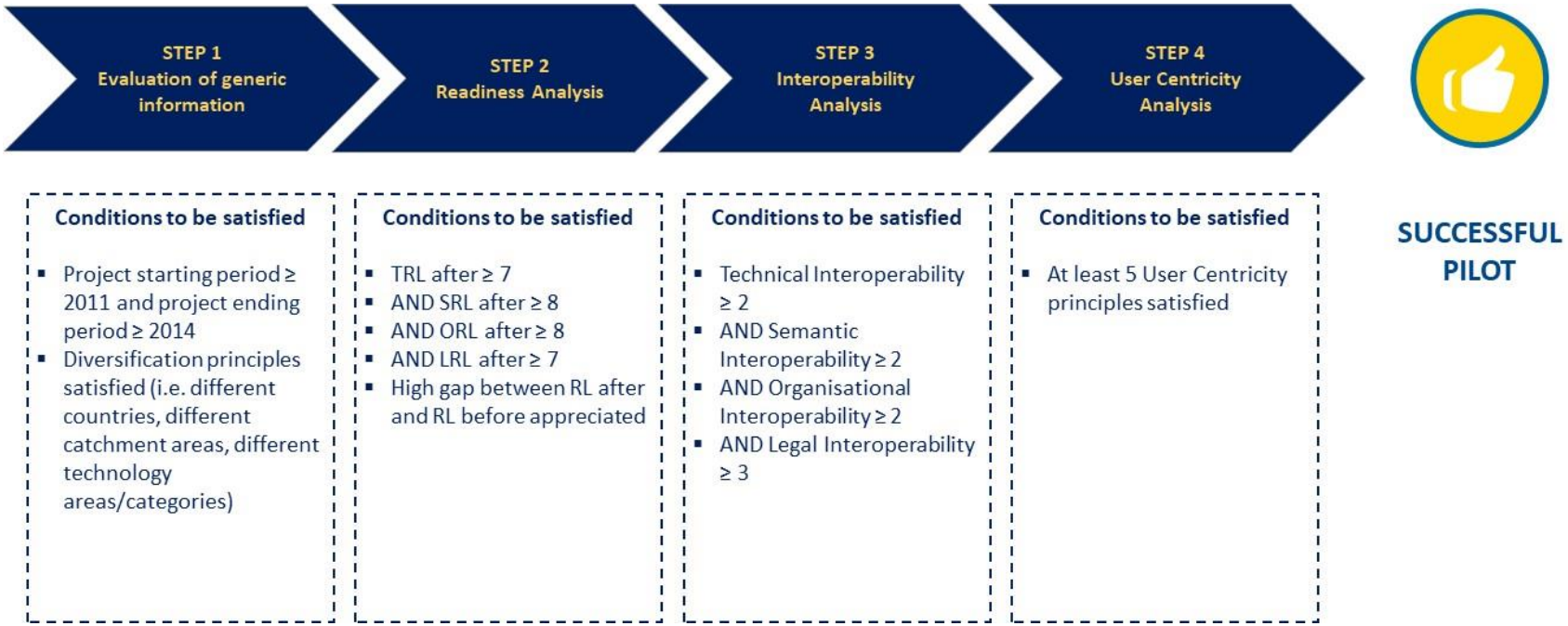
Generally speaking, utmost attention was paid to the identification of pilot projects that could be easily shared and reused all over the EU, including also some extra-EU stories that could be considered as "good practice examples" in order to allow a clearer and broader view of the current scenario. As mentioned, the Study team focused the analysis on both "closed and delivered" and "near to be delivered" projects, which may have been a source of bias towards more mature and consolidated technologies. The assessment included both low and large-scale pilots and covered most European countries, technology areas and categories. More specifically, **150 pilots** from 24 European countries were pre- selected, covering all the eight technology areas previously identified. From them, **80 pilots** were "accepted" for deeper analysis. They are visualised in the map below.

Source: authors' elaboration

Figure 28 *- Representation of successful pilots across technology areas and European countries*

Within the **80 "accepted" pilots**, the in-depth analysis allowed to identify the successful and unsuccessful cases. Generally speaking, a pilot was considered successful when it showed a homogenous growth of all four Readiness Levels, each of them nearing the top score in t_1 (7-8 or higher), demonstrated good interoperability levels (2-3 or higher) and fulfilled a majority (5 or more) of user centricity principles. Based on such evidence, **31 "successful" pilots** were identified as exemplary and supportive of the digital transformation of public services, with solutions that can be shared and reused across Europe (see Figure 30).

The chart below (Figure 29) shows the detailed conditions to be satisfied by the successful pilots.



Source: authors' elaboration

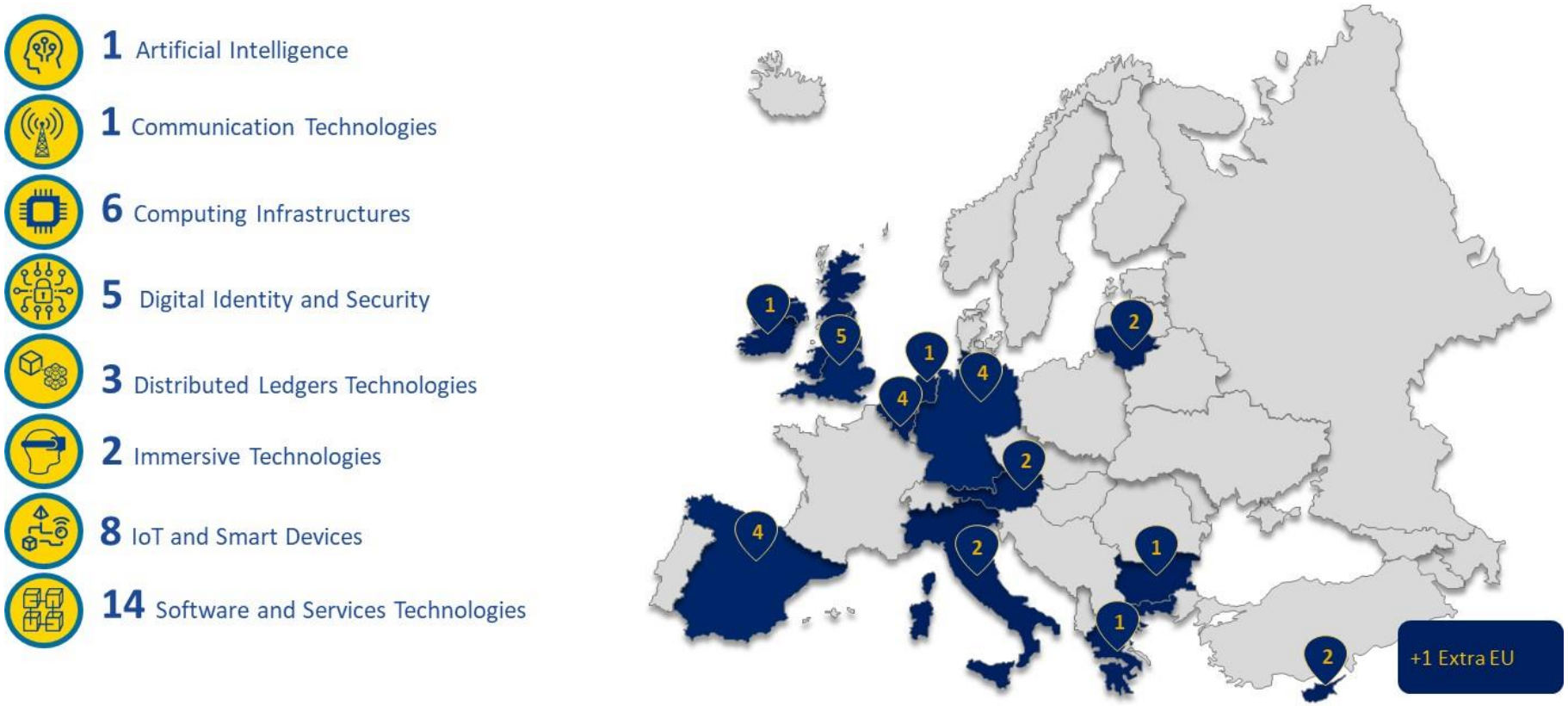
Figure 29 *- Criteria satisfied by successful pilots for future implementation*

The sequence of evaluation tasks entails 4 consecutive steps: 1) Evaluation of generic information, 2) Readiness analysis, 3) interoperability analysis and 4) User centricity analysis.

First, it must be ensured that the launch of the pilot occurred after the year 2011 and end after 2014, to prevent it from being considered "outmoded" or even "obsolete" (**STEP 1**). Second, successful pilots must show a TRL and LRL "after"[26] higher than or equal to 7, and an ORL and SRL that increase simultaneously across time, bringing the score higher or equal to 8 (**STEP 2**). Otherwise, one might think that the pilot has had some malfunction in terms of legal, organisational or societal readiness.

[26] "after": at the end of the pilot testing phase

STEP 3 focuses on the four interoperability layers. Successful pilots must score equal to or above 2 for the technical, semantic and organisational layer, and equal to or above 3 for the legal one. Below that threshold, specific efforts should address interoperability challenges to allow an easy and effective sharing and reuse of the pilot solution. Finally, on the user centricity assessment (**STEP 4**), if the pilot satisfies at least 5 of the 8 principles, it can be considered an inspiring example for a possible replica or adoption (scaling out) in the European public sector context.



Source: authors' elaboration

Figure 30 *- Coverage and technologies used in the successful pilots*

7 Pilot shortlisting

Using the approach presented in the previous section and after consulting with external experts and international researchers in the field of public sector's digital transformation, the 31 successful projects were not only identified and extracted from the database, but also confirmed in their capacity to be transferred or reused at a larger scale. As Figure 30 shows, these projects are representative of diverse technology applications and are located in 12 EU and 1 extra EU countries. Two of them, in agreement with the European Commission, were selected for a more in-depth analysis in terms of readiness, interoperability and user centricity aspects:

- **Dublinked** – the Open Data store for the Dublin Region, the aim of which is to publish quality open data, foster a culture of knowledge sharing and spur innovation by speeding up the advancement of services based on publicly available data.
- **IO App** (literally "I App") – a project of the Italian Digital Transformation Team, the goal of which is to increase the readiness of citizens and businesses to interact digitally with the Public Administration and make it easier for them to digitally manage their personal data, held by public authorities.

For both of them, the team collected additional information also thanks to the collaboration of the Project Owners, which allowed to significantly deepen the analysis, identify possible threats and future opportunities and give more value to the results obtained.

The detailed results of the evaluation of the two shortlisted case studies are presented in the next subsections.

7.1 Dublinked

Dublinked: The Open Data Store for the Dublin Region

Pilot overview

Dublinked is an example of **quality open data** that is globally positioning the Dublin Region as a leader. Currently it is part of **Smart Dublin** an initiative aimed at using smart technologies, engage researchers, developers and citizens to solve challenges and improve city life.

Within Dublinked **Open Data Portal,** 4 Dublin Local Authorities (**Dublin City Council, South Dublin, Fingal and Dún Laoghaire Rathdown)** can share data about the region and anyone can load, use and reuse data to spur innovation and economic development.

Dublin City Council (DCC), one of the 4 Local Authorities, took the lead of the initiative and coordinated the whole work group composed by the 3 **Local Authorities**, **Maynooth University (MU)** and **IBM**. The partnership between

entities from the **private** and **public sector** has been pivotal for Dublinked success, thanks to the combination of different skills and background. **MU's** participation as a neutral independent party revealed to be crucial since it contributed to solve most of the issues and challenges faced in the start-up process. Besides, **IBM** was important to ignite the initiative thanks to its data understanding such as the identification of most 'valuable' types of data to collect and release. More recent support is provided by **Derilinx**, a local Irish SME.

Dublinked's aim is to make **data about public provisions** available to a wider audience (e.g. water, transport and infrastructures, government and participation, population and communities, art and culture, environment and energy, planning, public health and safety), to enable cross-sectoral collaboration and promote new data-driven businesses and innovation around the Dublin city region.

Moreover, thanks to the potential of Open Data, Dublinked has enabled to contribute in improving transparency and efficiency of Government and created potential for business innovation and improvements in policy, to date.

This pilot distinguishes itself from other open data initiatives by proactively supporting the creation of new communities of innovators and promotes the release of complex (yet potentially more valuable) types of datasets based on data streams and live feeds. In fact, within Dublinked, anyone can download, use, reuse and create something new from available data. The main objectives and benefits are to:

- Make the city of Dublin a **global promoter of quality**, **transparent and standardised open data**, as well as to foster a culture of knowledge sharing and civic engagement;
- **Improve economic development** by speeding up the advancement of services based on data and enabling test bedding of new services;
- **Exploit and utilise public data** to generate new revenue streams and address regional challenges;
- **Create a pool of high-value data** for research purposes and to give Dublin-based companies a significant advantage in this rapidly growing area.

Like EC, Dublinked uses the **Creative Commons Attribution (CC-BY) licence**. This license lets others distribute, remix, tweak, and build upon data, even commercially, as long as users credit the original publisher for the original creation.

Currently, Dublinked portal, being a pioneer in the field of open data portal at a regional level, is harvested to the **Irish National Open Data Portal data.gov.ie**, that promote the publication of datasets, in line with agreed standards, facilitating accessibility, re-use and interoperability.

Before the launch of Dublinked, many cities launched open data initiatives such as online platforms where urban data was made available and was freely accessible. A key challenge in these cases was to turn raw data (such as planning application data, transport movements, water flows) into useful applications that improve efficiency, quality and transparency of urban services.

In order to win this challenge, Dublinked logical architecture combines an **Open Data platform** with a **network of innovative solutions** based on data

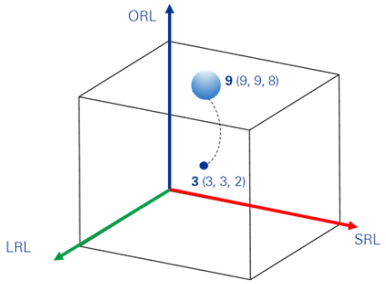
visualisations, app for smartphones, data downloads, data requests received by users and the release of open data. The collaboration with citizens, universities and lead firms in this field helped to ignite the initiative, showing the relevance of the data and the opportunity for the city.

Technology Area	Technology Category
Software and Service Technologies Computing Infrastructure Internet of Things and Smart Devices	APIs, Web Services, Microservices including Registries and Marketplaces Cloud Computing IoT Platforms

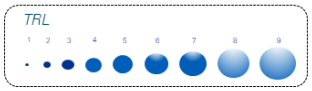
Country	Period	Catchment area
Ireland	1st phase: 2011 - 2016 2nd phase: 2016 - ongoing	Regional

Pilot Analysis

Readiness of the pilot



	Before	After
TRL	3	9
SRL	3	9
ORL	3	9
LRL	2	8



User centricity principles satisfied

Digital interaction	Accessibility, security, availability and usability	Reduction of the administrative burden	Digital Delivery of public services	Citizen engagement	Incentives for digital service use	Protection of personal data and privacy	Redress and complaint Mechanisms
Focus on interoperability							
Legal interoperability		*Organisational interoperability*		*Semantic interoperability*		*Technical interoperability*	
3		3		3		3	

Benefits & Impacts

In the following paragraphs, the main benefits and impacts related to **user centricity** and **interoperability** analysis are reported.

Regarding **user centricity**, a central feature of Dublinked is user involvement, in fact users have always been put at the centre of Dublinked's implementation and design, to speed up the processes, improve the overall performance of initiative and promote new co-operation networks around open data.

Looking at the analysis **on the eight user centricity principles**, Dublinked satisfies nearly all of them apart from redress and complaint mechanisms.

Regarding **interoperability,** Dublinked is a regional data sharing initiative that has made unreleased public operational data available online for others to research and reuse, thus integrating **interoperability's aspects right from the beginning of its realisation**. The project has been strongly influenced by the **European Interoperability Framework** in particular with regard to organisational, semantic and technical interoperability aspects.

- **Legal Interoperability**: Dublinked is fully compliant with **European Privacy legislation (GDPR), PSI and Inspire European directive**. Dublinked has introduced some relevant advancements regarding Legal Interoperability aspects that allowed operation in a cross-country level, for instance Smart Dublin is currently responsible for coordinating a common approach to data collection and publication. Moreover, the Dublinked team also participated on the **Irish Open Data Advisory Group**, which agrees on a National approach to the transposition of the EU Open Data Directive, including the identification of high-value datasets, and the focus on the publication of real-time / dynamic datasets.
- **Organisational Interoperability**: Dublinked is composed by **4 Municipalities** and each of them have different approaches and architectures for extracting, managing and using data. In fact, **South Dublin County**

Council uses **ArcGIS** and a harvester is used to extract data to the Dublinked platform. An **FME** is used to extract data from **Dun Laoghaire Rathdown Council**. This implies that the organisational interoperability of Dublinked has still not reached its peak of performance requiring therefore some improvement. In particular, the standardisation of source systems and sources processes would help to increase organisational interoperability. However, some efforts have been made to introduce advancements in organisational interoperability and promote collaboration between the 4 Municipalities: the Smart Dublin team meet regularly to set out common goals and review existing programmes and work together to coordinate common projects (i.e. the **SBIR** (Small Business Innovation Research) initiative supports innovative projects that will impact all 4 Local Authorities).

- **Semantic Interoperability:** any data associated to an Open Data License is considered Open Data by default. However, the data format is crucial for the exchange of data and can have significant implications for the usability of the data. Within Ireland Open Data Initiative, the idea is to publish data in the most open way possible and at a minimum 3 Star such as CSV, JSON or XML. According to the **5-star deployment scheme for Open Data** which measures the openness of the formats**,** most datasets published on Dublinked are scored **3 Stars out of 5** on the openness scale, and most come in multiple formats. The Dublinked portal is DCAT-compliant, meaning that all its metadata is available in a standardised, semantic format. The team is currently reviewing the recently launched DCAT v2, for its adoption into Dublinked. In particular, the inclusion of Web Service metadata is of interest. Regarding advancement about improving semantic interoperability, Dublinked had been part of the Open Data Advisory Group for the definition of the Open Data Technical Framework national project to identify common vocabularies and help standardise datasets (metadata, description tags, schema, field names etc.) to be used in the publication of Irish datasets.

- **Technical Interoperability:** no critical intervention is needed. Dublinked uses open specifications, welcoming the publication of the **Open Data Licenses** (Creative Commons, also used by the National Open Data Platform data.gov.ie) and complies to the **INSPIRE Directive** which includes key technical interoperability arrangements. However, some efforts need to be done, since the 4 municipalities have different approaches and architectures for managing data. Geospatial data is harvested from an ArcGIS system in South Dublin County Council to the Dublinked platform, while FME ETL processes are put in place to extract data from Dun Laoghaire-Rathdown County Council. Infrastructure and processes have been put in place to improve organisational interoperability, which are continually being built on. For example, a Dublinked AWS infrastructure is now available to all 4 Local Authorities to publish real-time, dynamic or large datasets. Moreover to ensure successful data integration with other players' sources (linked data) and ensure a smooth exchange between all the interesting parties, the idea would be to reach the maximum rating according to the 5 star-deployment scheme and ensure a uniform approach for all the players that feed the platform.

Main impacts and benefits:

Dublinked has enabled the realisation of an open, machine readable platform fed by a diverse range of municipal datasets deriving from 4 local authorities, which could be used by research and developer communities and wherein several apps and initiatives developed out of data. Moreover, Dublinked has allowed the creation of new communities of innovators around open data in Dublin and Ireland and increased the coordination between public authorities, and increased awareness about the value of open data in society. Moreover, the datasets were previously stored on enterprise-based servers, but now they are increasingly stored on the cloud meaning they can reconfigure and react quickly.

Risks & Challenges

The main risks and possible threats Dublinked could face in future, are reported below:

- Absence of revenue streams;
- Cyber-security, datasets may be hacked into, or shut down. If services or programs are dependent on the data (e.g. through apps) they would be let down;
- Open data platform might provide a 'back door' into network or local authority systems;
- Changing priorities and personnel in Local Authorities which can increase or decrease value placed and resources given to open data.

The main challenges Dublinked could transform into opportunities:

- Invest in an effective software to prevent cyber-attacks;
- Invest resources to create a sustainable revenue model stream;
- Accelerate the pace in order to contribute in recasting the EU PSI Directive which promotes 'open data by default' and data sharing by private companies;
- Harness the underlying potential of IoT devices, APIs, real time insights, to scale services quickly;
- Provide data available instantly to provide quicker response times;
- Harness the potential of Linked data.

Table 12 *– Summary of Dublinked Analysis*

7.2 IO App

IO, the project to develop the public services app - Italian Digital Transformation Team

Pilot overview

The IO App is an **open source project** and is considered an important pillar of the Italian government's vision of **digital citizenship**. Currently, it is also **part of Co-VAL best practices**.

Within the IO App, the **Digital Transformation Team in collaboration with AgID** which objective is the implementation of the **article 64 bis of the Italian Digital Administration Code**[27], is developing, since 2017, the "**IO App**" in order to provide the main functions necessary for the interaction between PA and citizens. Thanks to the integration with other enabling platform like **SPID, PagoPA, ANPR** and the reliance **on the new API interoperability model** and **on the various tools and guidelines of the Designers Italia and Developers Italia communities.**

The new interoperability model represents a cornerstone of the **3-year IT Plan** designed to guarantee the **functioning of the entire Information System of the Public Administrations**.

The aim of IO App is to create **a unique interface** to public services to provide personalised and tailored services to each citizen wherein:

- they can receive **all the messages** of the Public Administration on their smartphone, manage them in an archive; always be updated on deadlines and manage alerts in an "integrated" mode;
- **receive and store documents, receipts, certificates** directly on their smartphone and share them with a public office in a few clicks;
- make digital payments to the Public Administrations through PagoPA channel, saving the preferred payment methods (credit cards and soon debit cards, PayPal, etc.);
- **pay any paper notice** issued in the PagoPA circuit by simply framing a QR code; elect their digital home directly from the app.

To access the app, citizens need to create a **SPID account** to ensure that whoever uses the app is an individual who has the right to access that data. Biometric screening to unlock the app is also foreseen.

The revolutionary aspect of this app is that the user will not have to register actively for the services and will be directly reached by the services that know the tax code.

Regarding the other side of the platform, namely Public Administrations, IO provides

[27] Art.64 CAD (Codice dell'Amministrazione Digitale) establishes a single access point for all digital services

them many benefits. In fact, through the open API, PAs can easily interact with citizens by:

- **sending electronic communications** by simply knowing the tax code (without having to ask citizens for a contact address);
- **communicating deadlines and receiving electronic payments more easily**;
- **sending and requesting documents** in a simple and efficient way;
- **managing the preferences of each citizen** in a centralised way;
- **reducing management costs** (of notifications, payments, etc.) and facilitate payments.

The citizen could at any time deactivate the services that is not of interest, which from that moment.

Where are we at?

The **Closed Beta version** was released and included several services, such as the payment of fines, TARI, local taxes; notifications reminders for appointments with offices, info mobility and expiration of the ZTL pass. Several Italian municipalities such as **Milan; Turin; Ripalta Cremasca; Valsamoggia; Palermo** were tested to date, and around one thousand citizens have participated to the closed beta phase; many signalled bugs have been resolved, others are under WIP.

The **Open beta version** was released in **April 2020**. Anyone will be able to download from the **Android and iOS** store the app. The launch of the application will be done at a local level, in the territories wherein PAs have effectively integrated enough services in the App. In January 2021, IO services will be made available as a webapp, allowing citizens to access from their laptop, using the browser. Moreover, new design functionalities will be validated as well as other payments methods such as Bancomat Pay, PayPal and Satispay will be introduced.

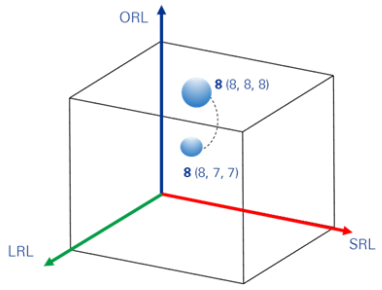
Technology Area	Technology Category
Software and Service Technologies Digital Identity and Security	APIs, Web Services, Microservices including Registries and Marketplaces Enterprise Service Bus Technologies & Government Service Utilities Digital Identity Frameworks

Country	Period	Catchment area

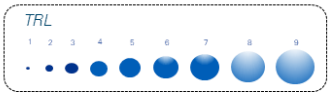
Italy	2017 - ongoing	National

Pilot Analysis

Readiness of the pilot



	Before	After
TRL	8	8
SRL	8	8
ORL	7	8
LRL	7	8



User centricity principles satisfied

Digital interaction	Accessibility, security, availability and usability	Reduction of the administrative burden	Digital Delivery of public services	Citizen engagement	Incentives for digital service use	Protection of personal data and privacy	Redress and complaint Mechanisms

Focus on Interoperability

Legal interoperability	*Organisational interoperability*	*Semantic interoperability*	*Technical interoperability*
4	3	3	3

Benefits & Impacts

In the following paragraphs, the main benefits and impacts related to user centricity and interoperability analysis are reported.

Regarding user centricity, the IO App was designed to put people at the centre of the innovation process of the Public Administration, by involving citizens in the

development of digital processes. Hence, the project evolution is based on constant communication, co-design with users, along different development stages. In fact, in the IO roadmap what dictates priority are the needs, the experience and the requests of people, not the technology.

If we look at the analysis made on the **8 User Centricity principles of the Tallinn Declaration**, IO successfully satisfies all of them. The idea in fact started with the vision to empower the relationship between the citizen and the Public Administration.

Regarding interoperability, the Digital Transformation Team, together with AgID, developed a clearly defined Interoperability Model, in accordance to the EIF, based on **Application Programmin**g Interface (API) to allow the entire information systems of the Public Administration to communicate with each other.

Observing the analysis made on the **four interoperability layers of the EIF,** IO App registers good interoperability scores.

- Legal Interoperability is fully compliant with EU GDPR in accordance with the principle of "privacy by design". Documents and messages are stored in a database deployed on European datacentres that uses "encryption at rest".
- **Organisational interoperability** scores good. A guide describing the steps necessary for PA to integrate into IO and be part of the project have been successfully set (PA needs to identify services that can be provided through IO, prepare technological integration using the IO API; review and sign legal documentation to join IO; communicate to citizens that they will be able to find the specific services on IO).
- **Semantic Interoperability** also does not pose great challenges. The aim of the project is in line with the EIF: "what is sent is what is understood". In the European context the databases of national interest correspond to Base Register (used in EIF to indicate reliable, authentic and official sources of particularly relevant data produced by PA), fundamental components to support interactions between PA and between these and private individuals. These data constitute the foundation for the construction of public services (*Codice dell'Amministrazione Digitale* - CAD art. 60).
- **Technical interoperability** scores high since PA can download the Open API specifications. This API enables Public Administration services to integrate with the IO platform. IO enables services to communicate with Italian citizens via the IO app. To get access to this API, PA will need to register on a specific IO Developer Portal. Technical interoperability is therefore well defined.

Main impacts and benefits:

The IO App will allow citizens to access to **PA local and national services** in a simple, modern and secure way. In this way, citizens will be able to have all the services in one place and will benefit from an improved user experience. The app will allow to drastically reduce the time of fulfilment of citizens' duties to the Public Administration. Thanks to a system of notifications, payments and deadlines, in a few minutes it is possible to carry out operations that previously took much longer. The benefits will be both for citizens and PAs: citizens will have greater knowledge of the services provided and will no longer need to provide and update their personal data (email address, mobile telephone number, bank details, preferred contact method,

etc.) on each site, this will enable PAs to dramatically reduce their administrative burden, reducing costs for both parties and increasing the uptake of services.

Risks & Challenges

The risks and future threats related to the implementation of the project are mainly focused on:

- **Organisational and Semantic issues:** today, most of the existing public databases have been designed and built in a distinct way, without the support of an overall vision, useful for directing regulatory and technical actions capable of favouring data quality. This characteristic has produced over time, the fragmentation of the information assets of the Public Administration into real information silos: "containers" in which the data are often replicated and stored in an uneven or even incoherent and misaligned with each other;
- **Low users' uptake of the solution;**
- **Low public authorities' uptake of the solution;**
- The project rests on experimental API that is (most probably) going to change as IO platform evolve.

The main challenges that IO could face:

- Increase organisational readiness;
- Increase the uptake and the readiness of European Public Administrations, citizens and businesses to interact digitally with the Public Administrations through education and training programs.

Table 13 *- Summary of IO App Analysis*

8 Final considerations and outlook

A typical approach followed by government bodies and agencies innovating their processes is built on the execution of pilot projects. These are small-scale experiments meant to reduce the costs and risks inherent to a diffused introduction of new technologies or other elements of transformation of the "machinery" of Public Administrations, its functioning and input and output. By definition, pilot projects are more likely to be a failure, rather than a success. Whatever the outcomes, their "owners" – responsible persons of the execution and sometimes evaluation of pilot results – are expected to learn useful lessons from them, which will possibly be shared with a broader audience on due time and are supposed to be useful (and used) internally to support the decision of whether and how to follow up. Most of these pilot projects are financially supported by third party grants, such as from the EU research, innovation, or territorial cooperation programmes. As already mentioned, such circumstance does not only contribute to further reducing the costs and the risks of technology introduction, but also provides the best guarantee that pilot results will be shared widely to the promoting and financing agencies.

Unfortunately, to date, as also reported in the aforementioned JRC research[28], the propensity of pilot owners to share results and lessons learnt in a structured manner seems to be still quite low and hampers the possibility to fully evaluate their scalability potentials, and the definition of finding reliable reuse or transfer pathways involving other public sector organisations than those in the original pilots. This lack of information is particularly critical in case of new and emerging technologies, such as Blockchain or Artificial Intelligence, which naturally lend themselves to being trialled in very similar – yet never too much – pilot contexts, thus increasing the risk of "reinventing the wheel" – i.e. of duplication, if not proliferation, of limited size experiments.

In response to this and other needs, the Study reported about in this publication has developed and tested an innovative and original multi-dimensional framework for evaluating public service digitalisation pilot projects and later for gathering pilot projects in a unique portal accessible to European Member States to foster a culture of knowledge sharing and build consensus on solutions and on their practical implementation. This is in order to satisfy the objective of the IPS action and to give continuity to the follow up activities of the ISA^2 programme, that is aimed at developing insights for an Observatory at EU level.

In this regard, the framework, accompanied by a MS Excel database facilitating data collection, searching and visualisation, has been purposefully designed to be, at the same time:

- **Respectful** of the variety of innovation modes that characterise the digital public service landscape in EU. For instance, some technological innovations may be disruptive if properly introduced, despite their not being based on new cutting-edge technologies. Or the same consolidated and well-functioning technology may not be easily transferred to another similar context, unless all relevant variables are controlled for;

[28] Barcevičius, E., Cibaitė, G., Codagnone, C., Gineikytė, V., Klimavičiūtė, L., Liva, G., Matulevič, L., Misuraca, G., Vanini, I., Editor: Misuraca, G., Exploring Digital Government transformation in the EU - Analysis of the state of the art and review of literature, EUR 29987 EN, Publications Office of the European Union, Luxembourg, 2019, ISBN 978-92-76-13299-8, doi:10.2760/17207, JRC118857.

- **Attentive** to the combination of contextual aspects (legal, organisational, societal and sometimes cultural or capacity related) that enables the adoption of a technology, in order to contribute to the necessary changes;
- **Compatible** with a wide variety of technological and even non technological domains, some with definitions that may look sometimes loose or actually an 'ensemble' gathered under umbrella terms, and thus require further adaptation and specification to become meaningful at pilot project (and community) levels;
- **Verifiable** as for TRL, also SRL, ORL and LRL include high level descriptions that are adaptable to different pilot contexts and nevertheless make the results of the analysis (in terms of lessons learned) comparable and replicable;
- **Parsimonious** collection of evidence can be discontinued at any time, without procuring harm to the proposed model or hampering its heuristic and informative value for the cases already analysed;
- **Usable** not only for the trivial reason that the framework works the same if/when the number of collected items goes up, but also because with a little more attention paid to the details, each surveyed pilot may genuinely and uniquely be associated with a longer string of cardinal numbers. The first 4 of them are the attributed/observed values for the (t, s, o, l) quadruplet, while others reflecting the contextual conditions domain characteristics and impact areas of the pilot at hand;
- **Interactive** not only for the use of buttons and "**data entry"** section to ensure users a simple and easy navigation and fast load time, but also because of the presence of data filter and data visualisation representations that provide users to interact with data, see and understand trends and patterns.

The framework revealed to be a useful tool to assess innovative pilots in the public service provision domain. On one hand, it has the potential to assess the societal, organisational, technological and legal readiness level of the developed solutions over time; on the other hand, it has the merit of highlighting the impacts and challenges of interoperability aspects and user centricity principles.

According to the proposed framework, successful projects are those that registered a quite homogenous growth of all the 4 readiness levels, reaching, each of them, near the top score, at the end of the pilot testing phase, and those that during the deployment of their innovative solutions have managed to put citizens and business at the centre of service design while following precise guidelines to make services interoperable at EU level.

Moreover, results suggest that projects that at the beginning registered low scores and at the end reached high grades in terms of readiness are those that are likely to produce the greatest impact on the public sector modernisation.

Conversely, the absence of a strict correlation between the 4 variables leads to classify the pilot as a failure, which means that at the end of the experimentation, significant gaps continue to exist that are negatively affecting the technological, societal, organisational or legal dimensions of the pilot environment.

Key findings of the Study include:

- The preliminary identification of 8 thematic clusters of existing and/or emerging digital technologies as relevant for the EU public sector digital transformation goals;
- A thorough assessment of the capacity of the 8 chosen thematic clusters to be interoperable and user centric, giving special attention to the analysis of challenges and barriers;
- An initial case study database composed of 150+ IPS pilot initiatives coming from 24 European countries;
- 80 pilot projects selected for deeper analysis;
- 31 of them defined "successful" based on the application of the proposed evaluative framework;
- 2 successful projects further inspected collecting additional information also in cooperation with the project owners.

In light of the above, we consider this Study an important milestone in the assessment of the transformation potential of digital technologies in the public sector and the search for pilot applications that are truly transferable, replicable and leading to the establishment of user centric and interoperable cross-border and cross-domain services.

Future investigations as a follow up to the desk and field research done can additionally:

- Refine and popularise the classification of digital technologies;
- Increase the number and territorial coverage of the initial case study database;
- Reiterate the approach to determine the "success" of "failure" of digitalisation pilot projects;
- Elaborate on the "readiness" concept as an instrument to support EU policy making, as proposed in[29];
- Upgrade the framework to help the policy makers to better interface with innovative technologies thanks to guidelines and lessons learnt and build consensus on solutions and on their practical implementation to enhance public service delivery at an EU level;
- Find additional elements to (dis)confirm the evaluation results and therefore make the proposed framework stronger and possibly reusable in other contexts (e.g. for non-digital innovation projects and/or outside the public sector).

[29] Bruno I., Lobo G., Molinari F., Valente Covino B., Marchetti V., Schiavone Panni A., Donarelli A., Technology Readiness revisited: A proposal for extending the scope of impact assessment of European public services. Paper approved for the forthcoming ICEGOV 2020 Conference, Athens, Greece.

In this regard, the findings of the Study pave the way to the follow up activities part of the IPS Action of the ISA^2 programme that is aimed at developing a proposal for a fully-fledged Observatory at EU level. This should be considered a useful tool to facilitate exchange of knowledge and provide indications to policy makers for further developing comprehensive strategies for digital government transformation and cross-border interoperability. This is in line with the key principles underpinning the ISA² programme that has been pioneering beyond techno-centric approaches to digital transformation of government, as it is acknowledged in the vision of interoperability supported by the programme.

In particular, the IPS action of the ISA² programme aims to support the further revision of the European Interoperability Framework, which has already put a on an equal foot, non-technical aspects such as governance, organisational and legal requirements with technical ones to successfully implement digital government transformation.

In this respect, as underlined in the new Digital Strategy for Europe adopted in February by the von der Leyen Commission, there is a need to develop a reinforced EU governments interoperability strategy, which should be completed by the end of 2021.

Based on the assessment results, EU governments at all levels need to invest significantly to tackle interoperability and user-centricity challenges of most promising technologies in the Public Sector, in order to provide seamless access to cross border digital solutions in line with citizens and businesses expectations.

The results of this Study should be therefore taken into consideration in supporting the development of the seamless flow of data across sectors and borders, while stimulating cross-fertilisation of innovative public services, through the establishment of a permanent Observatory to contribute sharing knowledge and practices across Public Administrations at a national, regional and city level in the EU.

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